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AQUATIC HABITAT IMPACT ASSESSMENT

for the

PROPOSED DEVELOPMENT OF A RETIREMENT VILLAGE ON ERF 103 AND 104 IN WITTEDRIFT, PLETTENBERG BAY

PREPARED FOR: The Home Market NPC
Contact person: Lance del Monte

PREPARED BY: Sharples Environmental Services cc
Contact Person: Debbie Fordham
Email: debbie@sescc.net

DATE: May 2020

DECLARATION OF INDEPENDENCE

I, Debbie Fordham, declare that I:

- Act as an independent specialist consultant, in this application, in the field of wetland ecology;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the amended EIA Regulations, 2014 (amended);
- Have, and will have, no vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- Undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the amended EIA Regulations, 2014; and
- Will provide the competent authority with access to all the information at my disposal regarding the application, whether such information is favourable to the applicant or not.

The following report has been prepared:

- As per the requirements of Section 32 (3) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) Environmental Impact Assessment Regulations 2017 as per Government Notice No. 326 Government Gazette, 7 April 2017.
- In accordance with Section 13: General Requirements for Environmental Assessment Practitioners (EAPs) and Specialists as well as per Appendix 6 of GNR 982 - Environmental Impact Assessment 2014 Regulations and the National Environmental Management Act, 1998.
- With consideration to Cape Nature’s standard requirements for biodiversity assessments.
- In accordance with DEA&DP’s Guideline on Involving biodiversity specialists in the EIA process.
- Independently of influence or prejudice by any parties.

PROJECT TEAM

The authors of this report are in agreeance with the 'Declaration of Independence'.

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CONSULTANT	**QUALIFICATIONS**	**ROLE**	**DETAILS**
MARITA BURGER HONS	BSc (Hons) – Environmental Science	Co-author	Marita is an environmental assessment practitioner. She holds a BSc in Environmental and Biological Sciences and a BSc Hons in Environmental Science. Her interests lie in GIS spatial analysis and mapping and the water use legislation under the National Water Act (1998). She has undertaken WULAs, GAs, Spatial Plans, and co-authored numerous aquatic specialist reports.

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Report citation: *Sharples Environmental Services cc, 2019. Aquatic Habitat Impact Assessment for the proposed development of Erf 103 and Erf 104, Wittedrift, Plettenberg Bay.*

EXECUTIVE SUMMARY

Sharples Environmental Services cc (SES) was appointed by The Home Market NPC to conduct an Aquatic Specialist Impact Assessment for the proposed residential development of Erf 103 and Erf 104, Wittedrift near Plettenberg Bay. The site is within quaternary catchment K60F and falls under the jurisdiction of the Breede Gouritz Catchment Management Agency.

The Bosfontein River flows past the study site and was identified as likely to be impacted by the proposed development. An infield assessment was conducted on 22 August 2019 to confirm this. It was determined that it is likely that the watercourse known as the Bosfontein River was a floodplain wetland system historically. However significant degradation has resulted in only fragmented wetland habitat remaining on the valley floor. The small fragments of remaining wetland habitat are the only indicator of the former wetland type of the entire valley floor and are most similar to the natural reference condition of the area. One such pocket of remaining wetland habitat is situated within the northern section of the site proposed for development. This wetland area is likely to capture sediments and nutrients from upstream during peak flows, but it mainly serves as a buffer between the urban area and the channel. Due to the importance of the downstream Bitou and Keurbooms River and wetland systems it is essential that functions of this habitat are not further compromised. Therefore, an aquatic buffer area and stringent mitigation must be adopted in order to maintain the present state of the wetland and avoid any further degradation of the system.

There are two proposed development layouts, Alternative A and Alternative B, assessed in this report. Alternative A is the original layout where development encroaches significantly into aquatic habitat. Alternative B was designed after aquatic specialist input was obtained and therefore considers the 10m aquatic buffer. Alternative B is the preferred alternative from an aquatic perspective and even though there is still some infrastructure proposed within the buffer, it is unlikely to cause high impacts on aquatic habitat. It is however still recommended that all infrastructure be set back to be completely outside the buffer.

The proposed development activities will trigger a water use licence in terms of Section 21 (c) and (i) of the National Water Act (Act 36 of 1998). It is recommended that a water use application for this proposed development be submitted to the Breede Gouritz Catchment Management Agency.

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1 INTRODUCTION

Sharples Environmental Services cc (SES) was appointed by The Home Market NPC to conduct an Aquatic Specialist Impact Assessment for the proposed residential development of Erf 103 and Erf 104 in the town of Wittedrift in the Western Cape. Wittedrift is a small settlement consisting of approximately 110 residential homes within a largely agricultural area. The area is situated approximately 11 km away from the Town Centre of Plettenberg Bay (Figure 1). The urban area is situated at the confluence of the Bosfontein and Bitou Rivers that flow into the Keurbooms Estuary's near the coast.

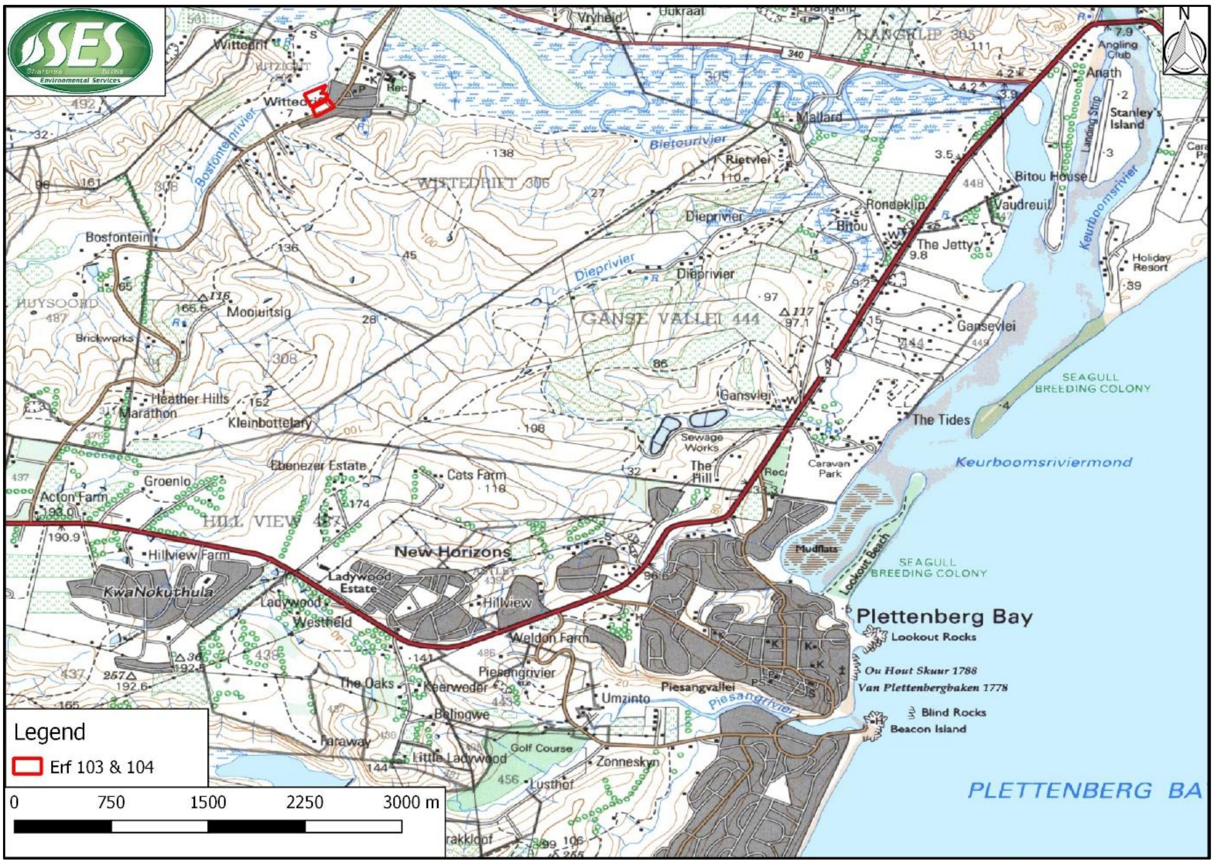

Figure 1: Cadastral map showing the location of the study site in relation to Plettenberg Bay

The 2018 Bitou Local Municipality Spatial Development Framework (Bitou MSDF) describes the Local Area Spatial Structure and Land Use of Wittedrift. According to the MSDF, the settlement is located on the edge of the floodplain of the Bitou River and surrounded by extensive agricultural activity. The central part is the retail node with the Wittedrift High School, primary school and cemetery to the north-west side and the community hall, municipal office and clinic to the south-west.

The Home Market NPC proposes to develop a retirement village on Erf 103, Erf 104 and the portion of Rotterdam Road between the two erven (Figure 2). The company owns the erven and are in the process of rezoning the land from Institutional Zone I to Residential Zone II. The proposed development will have 53 single storey retirement housing units which will be between 104 m^2 and 124 m^2. The retirement village will also hold a Community Centre and Assisted Living Facility, located close to the entrance which is proposed off Protea Street.

Figure 2: Google Earth image of the area proposed to be developed showing Erf 103 and 104 as well as the approximate extent of Rotterdam Road that will form part of the development.

Currently both erven are undeveloped and vacant. Erf 104 is considered more developable with a gentle north-western slope extending from Main Road to Rotterdam Street. Erf 103 is situated north of Erf 104 and opposite Rotterdam Street. The lowest part of Erf 103, adjacent to the Bosfontein River, is subject to flooding. The Home Market NPC appointed Frazer Consulting Civil Engineers to determine the 1:100 year flood line. Frazer concluded that the proposed development area of Erf 103 is well above the 100-year Recurrence Interval (R.I.) flood line.

1.1 Development Alternatives

There are three alternatives assessed and discussed in this report. Alternative A is the original layout and shown in Figure 3. The development encroaches into the watercourse and 1:100 year floodline on the eastern side where the community centre is proposed. This alternative involves infilling and transformation of the terrace to accommodate housing, a swimming pool and stormwater outlet within wetland habitat. After input from the aquatic specialist, the layout was amended to be more sensitive to aquatic habitat.

Alternative B is the amended layout that adopts an aquatic buffer area to consider the aquatic sensitivities of the site (Figure 4). The houses and community area in this alternative have been set back from the aquatic habitat. There will be no terrace bank transformation or infilling activities within the buffer.

Alternative C is the No-Go alternative and is assessed as 'Trajectory of Change' within the study. The No-Go Alternative assumes that the development will not occur, and that the status quo of the site will continue. It is assumed during this scenario that the landowner will clear the alien invasive plants, as required by the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983), and apply Section 28 of the NEMA, "Duty of Care". The Duty of Care states that reasonable measures must be taken to prevent pollution or degradation from occurring, continuing or reoccurring.

Figure 3: Alternative A: Layout 1

Figure 4: Alternative B: Amended Layout 2

1.2 Relevant Legislation

The protection of water resources is essential for sustainable development and therefore many policies and plans have been developed, and legislation promulgated, to protect these sensitive ecosystems. The proposed project must abide by the relevant legislative requirements. Table 1 below shows an outline of the environmental legislation relevant to the project.

Table 1: Relevant environmental legislation

Legislation	Relevance
South African Constitution 108 of 1996	The constitution includes the right to have the environment protected
National Environmental Management Act 107 of 1998	Outlines principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for coordinating environmental functions exercised by organs of state.
Environmental Impact Assessment (EIA) Regulations	The 2014 regulations have been promulgated in terms of Chapter 5 of NEMA and were amended on 7 April 2017 in Government Notice No. R. 326. In addition, listing notices (GN 324-327) lists activities which are subject to an environmental assessment.

The National Water Act 36 of 1998	Chapter 4 of the National Water Act addresses the use of water and stipulates the various types of licensed and unlicensed entitlements to the use of water. The water uses under Section 21 (NWA) that are associated with the proposed development are most likely section 21 (c) and (i). Also, according to the Department of Water and Sanitation (DWS), any structures within a 500 metre radius from the boundary of a wetland constitutes a Section 21(c) and (i) water use and as such requires a water use licence.
General Authorisations (GAs)	Any uses of water which do not meet the requirements of Schedule 1 or the GAs, require a license which should be obtained from the Department of Water and Sanitation (DWS). The project will require a Water Use Authorisation or General Authorisation in terms of Section 21 (c) and (i) of the National Water Act (NWA), Act 36 of 1998, as the development will impact watercourses. Government Notice R509 of 2016 was issued as a revision of the General Authorisations (No. 1191 of 1999) for section 21 (c) and (i) water uses (impeding or diverting flow or changing the bed, banks or characteristics of a watercourse) as defined under the NWA. Determining if a water use licence is required is associated with the risk of impacting on that watercourse. A low risk of impact could be authorised in terms of a General Authorisations (GA). However, this does not apply when there is sewage infrastructure proposed within the regulated area. Therefore, a full WUL application is currently being undertaken in consultation with the BGCMA.
National Environmental Management: Biodiversity Act No. 10 of 2004	This is to provide for the management and conservation of South Africa's biodiversity through the protection of species and ecosystems; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits arising from bioprospecting involving indigenous biological resources; and the establishment of a South African National Biodiversity Institute.
Conservation of Agricultural Resources Act 43 of 1967	To provide for control over the utilization of the natural agricultural resources of the Republic in order to promote the conservation of the soil, the water sources and the vegetation and the combating of weeds and invader plants; and for matters connected therewith.

1.3 Scope of Work

The Scope of Work in accordance with the specific Terms of Reference are described below:

Phase 1 (Contextualisation of study area)

- ✓ Contextualization of the study area in terms of important biophysical characteristics and the latest available aquatic conservation planning information (including but not limited to vegetation, CBAs, Threatened ecosystems, any Red data book information, NFEPA data, broader catchment drainage and protected areas).
- ✓ Desktop delineation and illustration of all watercourses within and surrounding the site utilising available site-specific data such as aerial photography, contour data and water resource data.
- ✓ A risk/screening assessment of the identified aquatic ecosystems (as well as within the surrounding NWA regulated area) to determine which ones will be impacted upon by the proposed development and therefore require groundtruthing and detailed assessment.

Phase 2 (Delineation and classification)

- ✓ Ground truthing, infield identification, delineation and mapping of any potentially affected aquatic ecosystems in terms of the Department of Water and Sanitation (DWAF 2008) *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas*.
- ✓ Field delineation must follow the accepted national protocol and should result in a map that includes the identified boundary and the field data collection points (which should include at least one point outside the wetland or riparian area), and a report that explains how and when the boundary was determined.
- ✓ Classification of the identified aquatic ecosystems in accordance with the, '*National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa'* (Ollis *et al*. 2013) and *WET-Ecoservices* (Kotze *et al*. 2009).
- ✓ Description of the identified watercourses with photographic evidence.

Phase 3 (Aquatic Assessment)

- ✓ Conduct a Present Ecological State (PES), functional importance assessment and Ecological Importance and Sensitivity (EIS) assessment of the delineated wetland habitat, utilising the latest tools, such as:
  - → Level 2 WET-Health Version 2 tool (Macfarlane *et al*., 2009) – PES
  - → WET-Ecoservices (Kotze *et al*., 2009) and/or the Wetland EIS assessment tool of Rountree and Kotze (2013). - Functional assessment
- ✓ Conduct a Present Ecological State (PES) and Present Ecological Importance and Sensitivity (EIS) assessment of the delineated river/riparian habitats, utilising:
  - → Qualitative Index of Habitat Integrity (IHI) tool adapted from (Kleynhans, 1996) – PES

  - → DWAF (DWS) River EIS tool (Kleynhans, 1999) - EIS
- ✓ Indicate the Recommended Ecological Category (REC) of the impacted aquatic ecosystems.

Phase 4 (Impact Assessment)

- ✓ Identification, prediction and description of potential impacts on aquatic habitat during the construction and operational phases of the project. Impacts are described in terms of their extent, intensity, and duration. The other aspects that must be included in the evaluation are probability, reversibility, irreplaceability, mitigation potential, and confidence in the evaluation.
- ✓ All direct, indirect, and cumulative impacts for each alternative must be rated with and without mitigation to determine the significance of the impacts.

Phase 5 (Mitigation and monitoring)

- ✓ Recommend actions that should be taken to avoid impacts on aquatic habitat, in alignment with the mitigation hierarchy, and any measures necessary to restore disturbed areas.
- ✓ Determination and mapping of any necessary buffer zones with consideration to the *Buffer zone guidelines for rivers, wetlands and estuaries* (Macfarlane & Bredin, 2016).
- ✓ Rehabilitation guidelines for disturbed areas and monitoring.

2 STUDY AREA

2.1 Drainage Setting

Wittedrift falls within quaternary catchment K60F of the Breede Gouritz Water Management Area (Figure 5). The Bitou River is the largest system within this catchment and joins the Keurbooms River in the south to form the Keurbooms Estuary. The study site is located within the Bosfontein River valley that flows in a north easterly direction towards the Bitou River. This reach of the Bitou contains vast floodplain wetland habitat of national biodiversity importance.

The broad floodplain wetland of the Bitou River is more than 600ha in size and is a valuable ecological resource. The Bitou wetland is essentially part of the greater Keurbooms Estuary and therefore impacts on the Bitou will in turn impact the Keurbooms system. Similarly, impacts upon the tributaries of the Bitou, such as the Bosfontein River, will indirectly impact upon the Keurbooms river system. Therefore, the value of the aquatic habitat of the site is assessed within the context of the ecologically important downstream aquatic habitats.

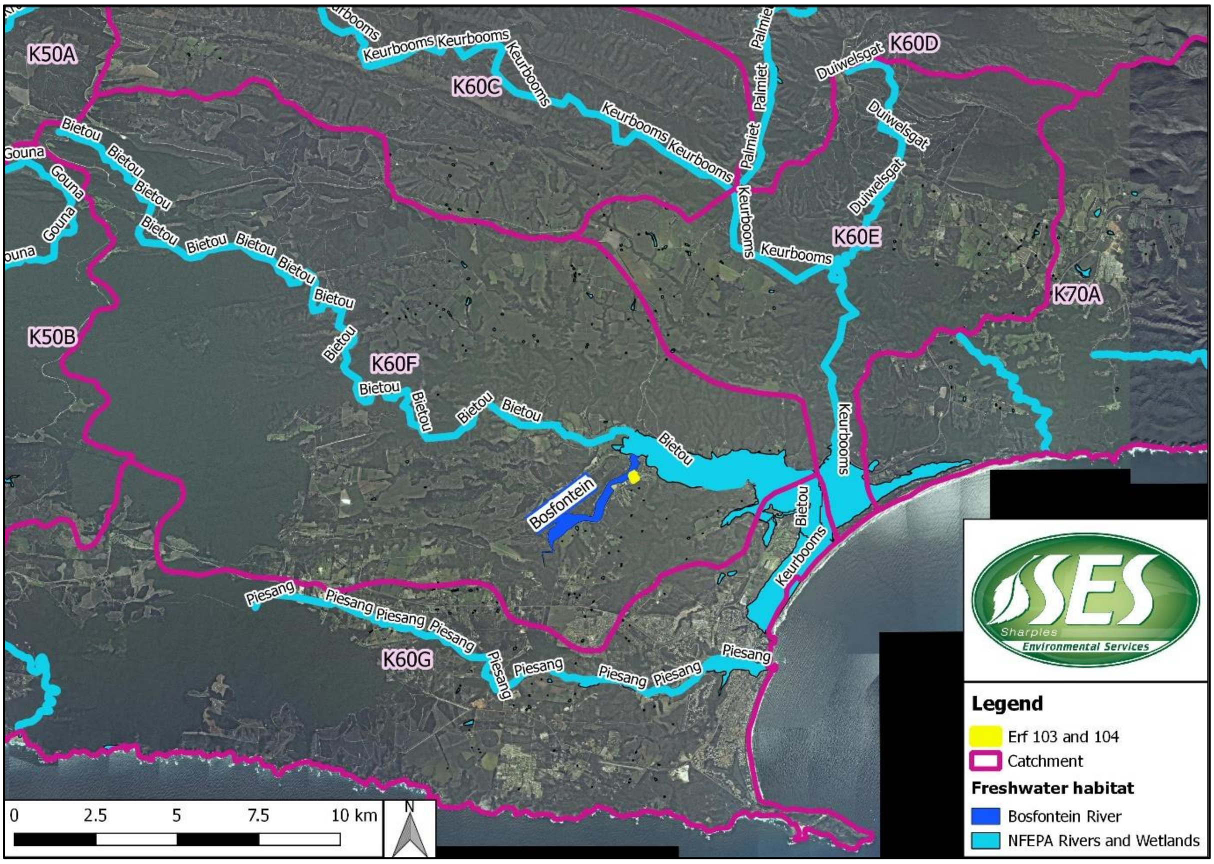

Figure 5: Map showing the study site in relation to quaternary catchments of the area. The study site is in the K60F quaternary catchment.

The geology of the larger area is mapped as conglomerate sandstone and claystone belonging to the Uitenhage Group. The Bosfontein River has an alluvium floodplain. The climate of the region is characterized by a temperate coastal climate that causes all year rainfall. The temperature is moderated by the sea and varies from between 20°C and 30°C in the summer months (October to April) to between 10°C and 20°C in the wetter winter months (South African National Parks, 2014).

The National Freshwater Ecosystem Priority Areas (NFEPA) map provides strategic spatial priorities for conserving South Africa's aquatic ecosystems and supporting sustainable use of water resources. FEPAs were identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries (Driver *et al.* 2011). No FEPA habitat was identified within or adjacent to the study site by the NFEPA project (Figure 6). The Bitou River downstream and its associated floodplain wetland were mapped as a FEPA system, as shown in blue and green on the map in Figure 6. The map clearly shows the large extent and close proximity of this wetland system to the development.

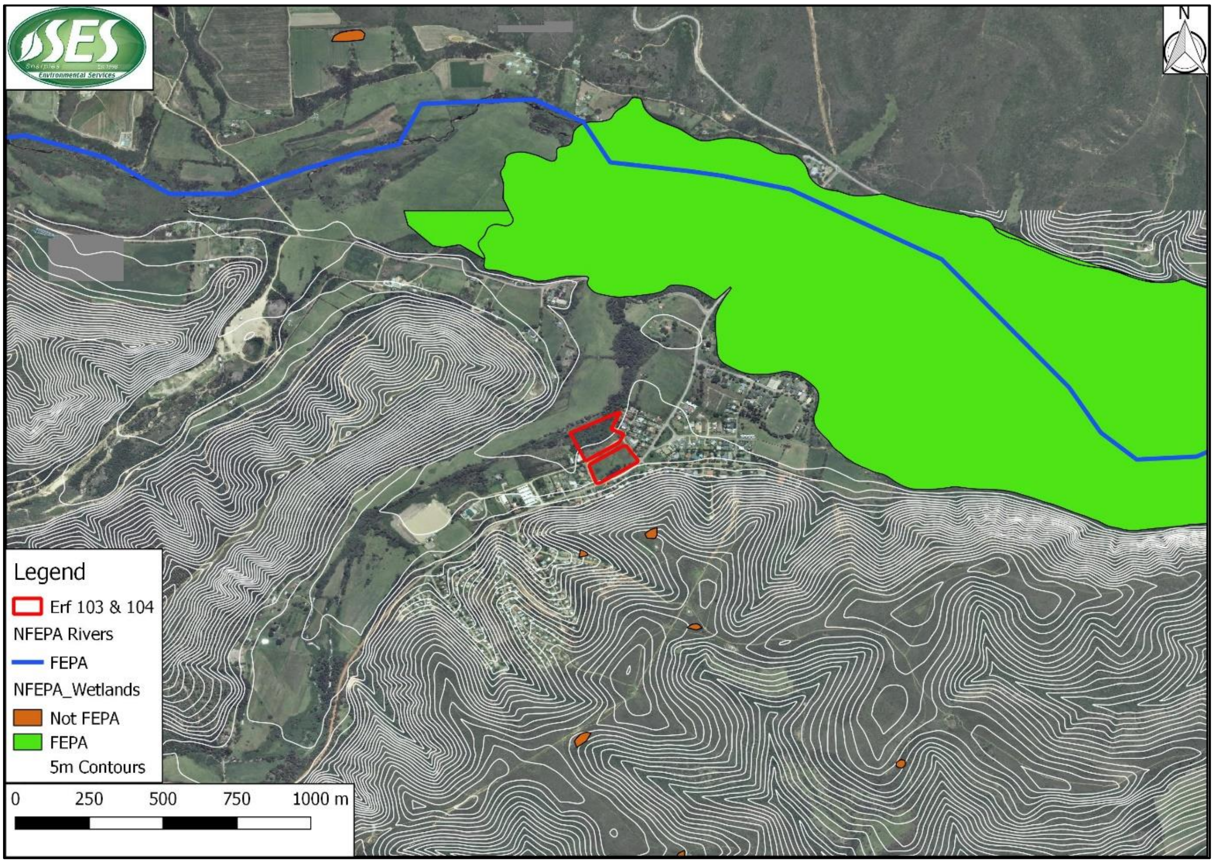

Figure 6: The map indicates wetlands and rivers identified by the National Freshwater Ecosystem Priority Area project.

The active channel (Figure 7) of the Bosfontein River flows north of Erf 103 and is well beyond the proposed development area. The broad floodplain reaches across a big portion of the valley floor, up to a terrace. The relic channel and remnant wetland habitat on site is located along this terrace. The fluvial terrace is situated south of the study site and at the foot of the hillslope. According to a study on flood lines of the site by Fraser Consulting Civil Engineers, the size of the applicable catchment area is 4.2 km^2 and it has a Mean Annual Precipitation of 647 mm. Table 2 was taken from the report by Fraser Consulting Civil Engineers (2019) and contains further information regarding hydrology of the area.

Table 2: Key Hydrological Information (Fraser, 2019)

Description	**Value**
Applicable Rain gauge	Gauge 014633W Plettenberg Bay
Mean Annual Precipitation (MAP)	647mm
100-year RI one day rainfall	194 mm
Catchment Area	4.2 km^2
Time of Concentration	1.25 hours
Rainfall Intensity	74 mm/h
Rational Formula C value	0.32
100-year RI peak flow rate	30 m^3/s

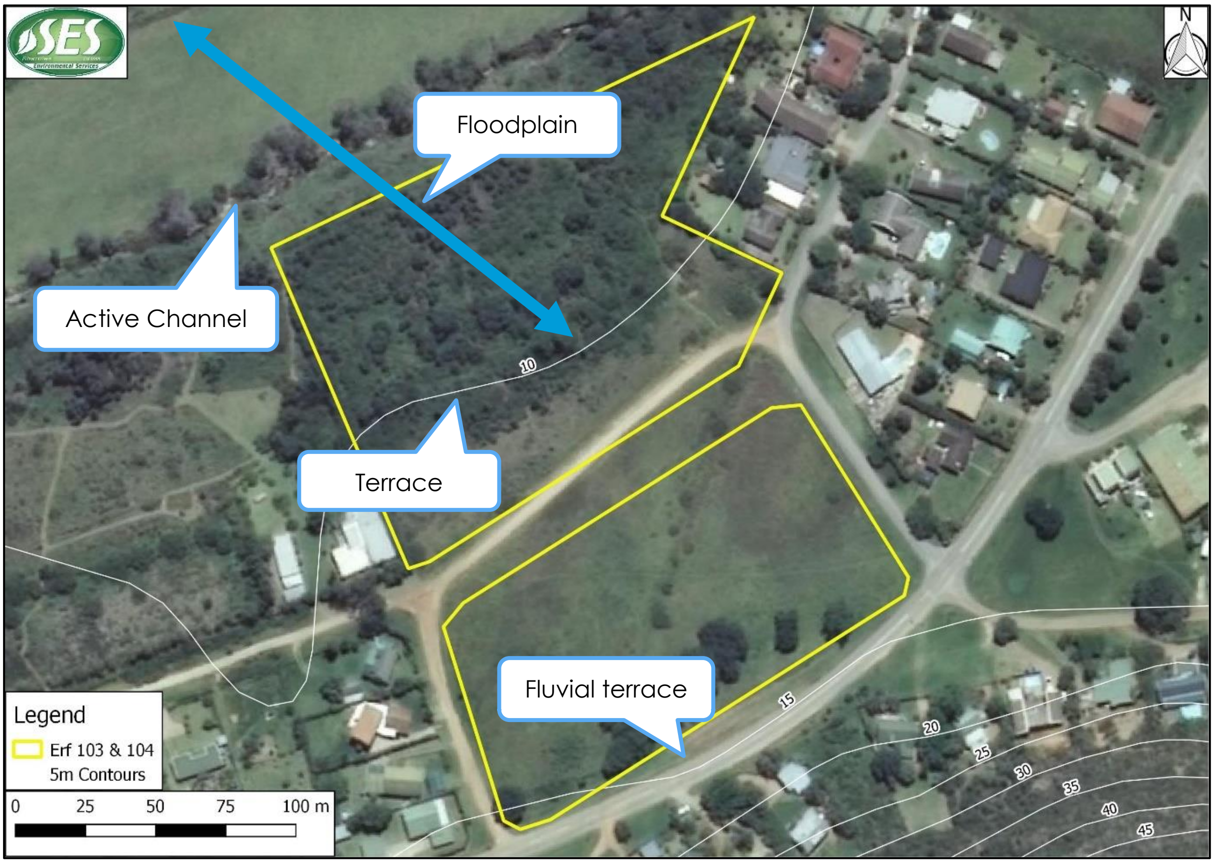

Figure 7: Landscape features dictating aquatic habitat extent on site.

2.2 Vegetation

Mucina and Rutherford (2006) delineated vegetation units throughout Southern Africa and updated this data in 2012 and again in 2018. The 2018 Vegetation Map indicates the site as being situated within the Garden Route Shale Fynbos vegetation unit (Figure 8). The threat status of the ecosystems associated with the area increased from Vulnerable in 2014 to a higher threat status of Endangered in 2016 (Figure 9).

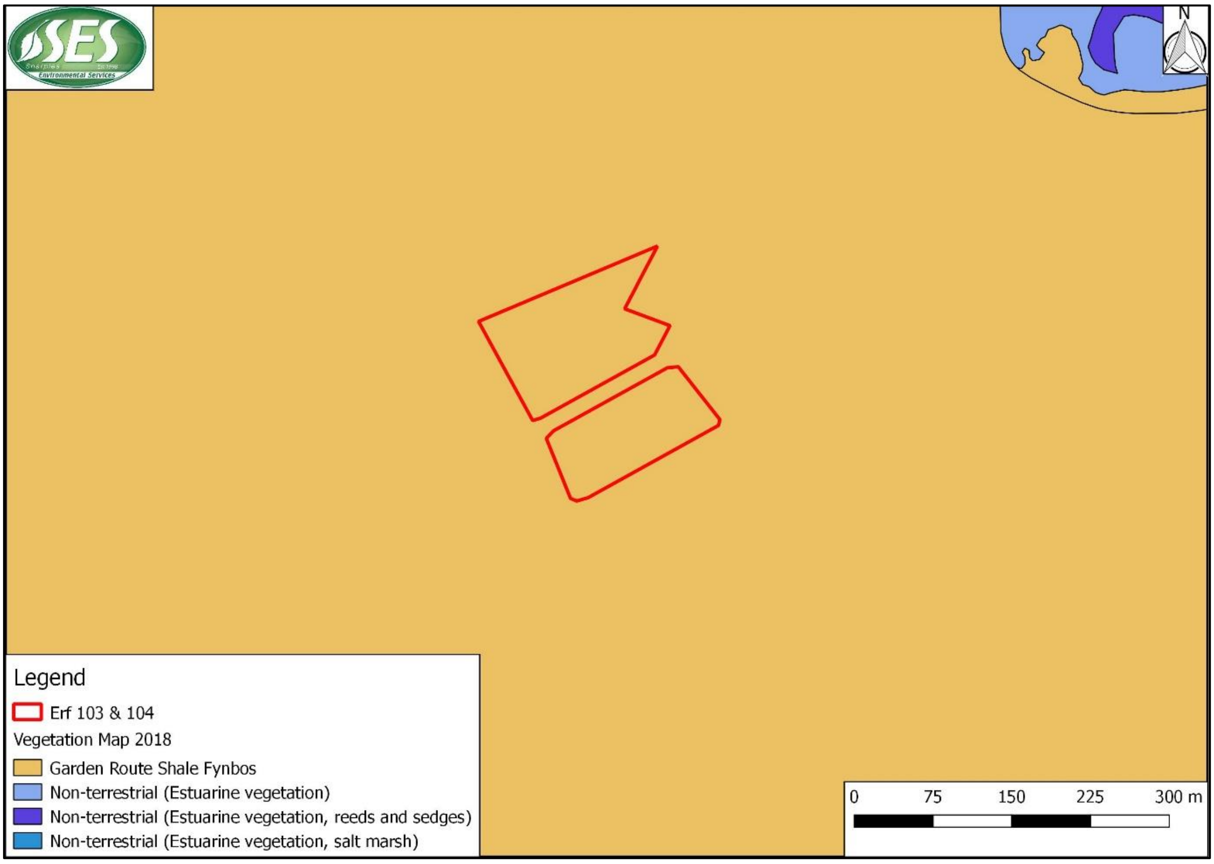

Figure 8: 2018 Vegetation Map showing the site is located in Garden Route Shale Fynbos vegetation.

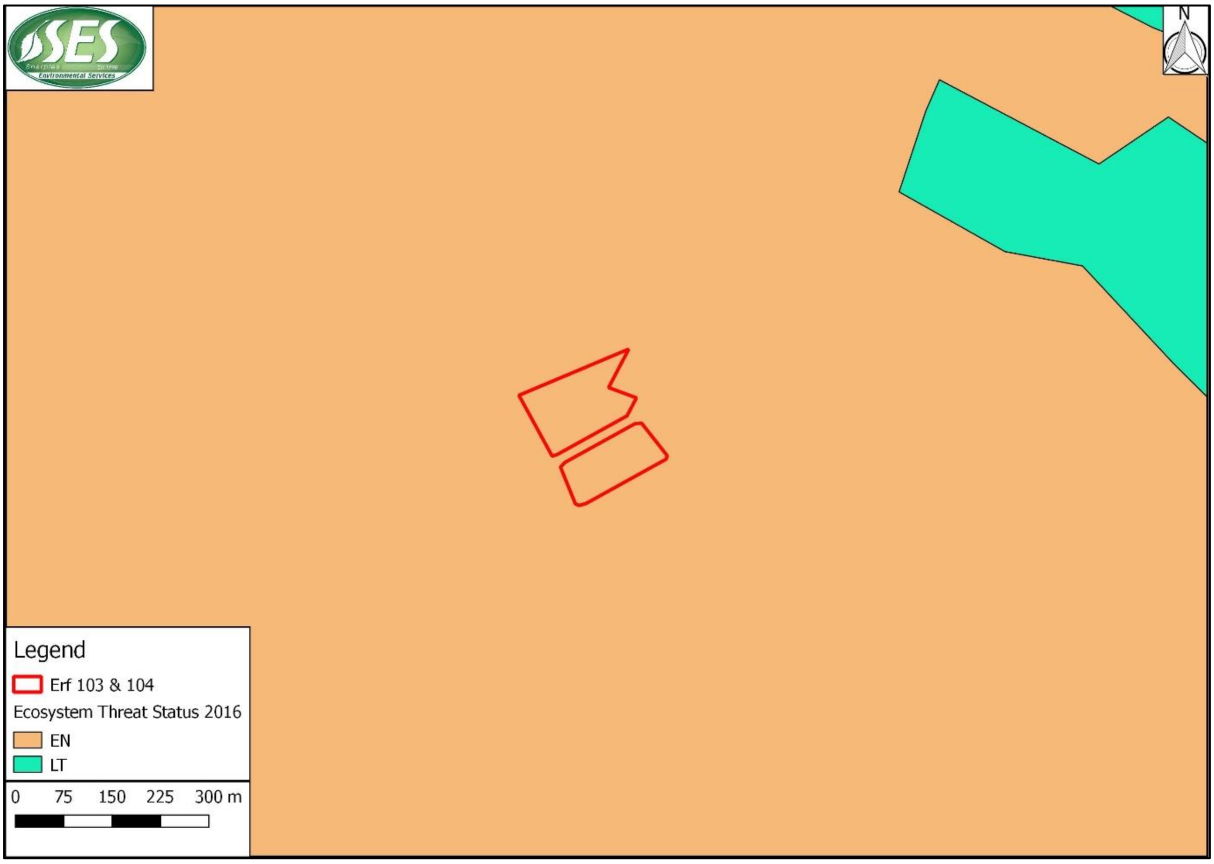

Figure 9: The Ecosystem Threat Status associated with the site of the proposed development.

2.3 Conservation Context

The Western Cape Biodiversity Spatial Plan (WCBSP) is recognized by both the Department of Environmental Affairs and South African National Biodiversity Institute. The primary purpose of a map of Critical Biodiversity Areas and Ecological Support Areas is to guide decision-making about where best to locate development. Critical Biodiversity Areas (CBA's) are required to meet biodiversity targets. These areas have high biodiversity and ecological value and therefore must be kept in a natural state without further loss of habitat or species. Low-impact, biodiversity sensitive land uses are the only land uses allowed in CBA's. Critically Endangered (CR) ecosystems, critical corridors for maintaining landscape connectivity and areas required to meet biodiversity pattern targets, are included in CBA's. The WCBSP made a distinction between areas likely to be in a natural condition (CBA1) and areas that could be degraded (CBA2). Ecological Support Areas (ESA's) are not essential for meeting biodiversity targets but are important as they support the functioning of CBA's and Protected Areas (PA's). ESA's support landscape connectivity, surrounds ecological infrastructure that provide ecosystem services, and strengthen resilience to climate change. These areas include Endangered vegetation; water source and recharge areas; and riparian habitat around rivers and wetlands. The WCBSP also made a distinction between ESA's in a functional condition (ESA1) and degraded areas in need of restoration (ESA2).

Figure 10 shows that no aquatic CBAs were identified within or adjacent to the study area by the WCBSP (Pence 2017). The Bosfontein River and associated riparian area are identified as ESA2 and Terrestrial CBA1. The majority of the development area is described as terrestrial ESA1. There are inaccuracies with this data since the wetland habitat adjacent to the study site has been identified as terrestrial instead of aquatic CBA. This proves the importance of ground truthing the WCBSP data. The closest aquatic CBA to the site is to the east and forms part of the floodplain wetland of the Bitou River.

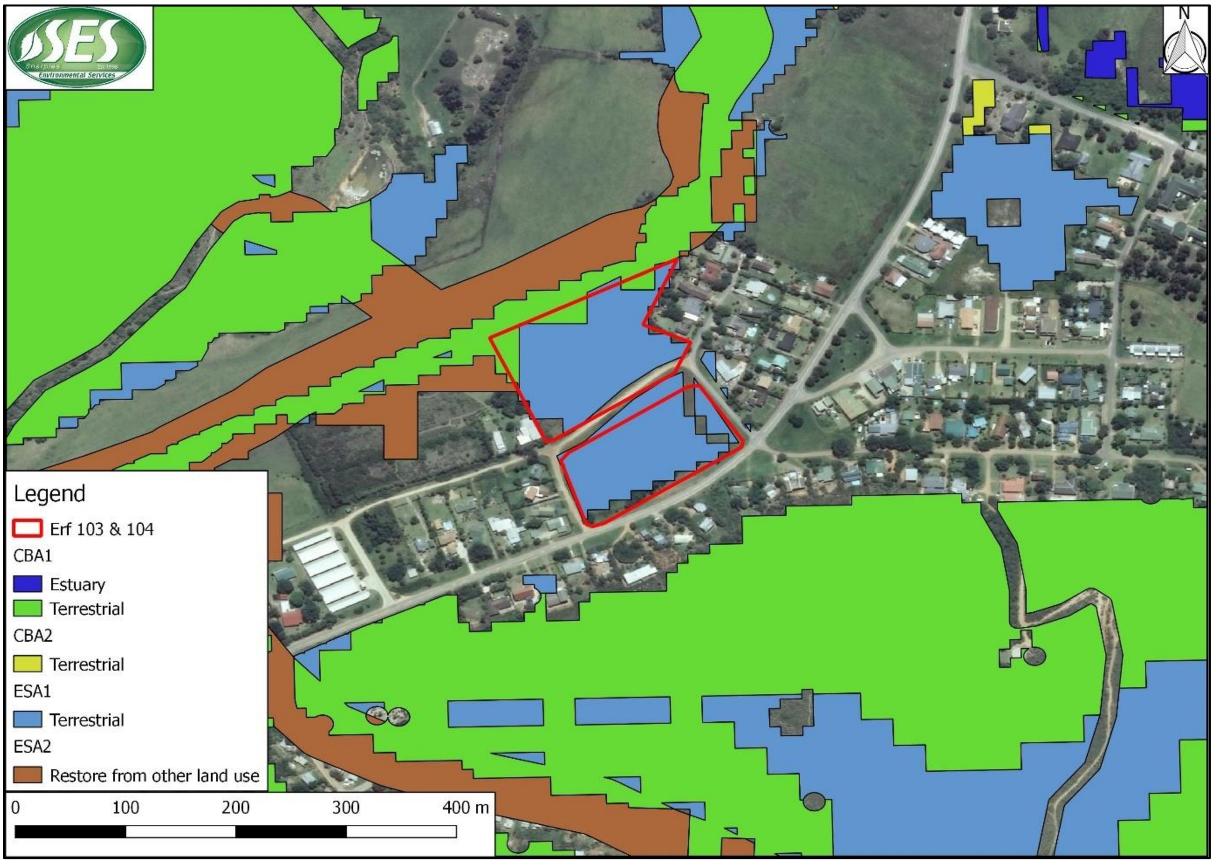

Figure 10: The site in relation to Western Cape Spatial Biodiversity Plan (Pence 2017)

2.4 Existing Impacts Upon Watercourses

Catchment and site-specific impacts are important for determining a baseline of the current status quo for the watercourses that will be impacted by any proposed developments. These characteristics are also important to note as they are used in assessing the various systems.

2.4.1 Catchment Status Quo

The watercourse to be impacted by this development, the Bosfontein River wetland, has been impacted by agricultural activities and dams within the catchment for several decades. Agricultural activities include cultivation and grazing pastures for livestock. The aerial imagery in Figure 11 to 14 shows how agriculture progressively encroached into the floodplain area over the years. This has inter alia caused straightening of the channel from its natural course. Cultivation of the riparian zone not only destabilises the river banks, which often leads to erosion and sedimentation, but it also removes any biodiversity corridor for movement of species along the river.

Urban development, such as housing infrastructure, in close proximity to the river impacts the system through altered banks and increased runoff from hardened surfaces. This runoff is also likely to have a higher pollution load and altered sediment regimes compared to natural runoff. The greater the extent of hardened surfaces (e.g. roofs, parking lots etc.), the lower the infiltration of stormwater and therefore the greater the surface runoff and increase in flood peaks. A change in water distribution generally results in altered wetness regimes, which in turn affect the biophysical processes and the vegetation patterns. Urbanization of the catchment and its associated stormwater runoff is increasingly recognised as a threat to aquatic biodiversity not only because of the increased hydrological disturbance and habitat loss, but also because of an increased delivery of pollutants to streams. Stormwater runoff from urban surfaces may include nutrients, pollutants, raw sewage and other domestic waste. This waste can lead to eutrophication, excess plant growth causing changes to community dynamics, hypoxia (oxygen depletion) as well as inhibit the growth of bacteria that play an important role in removing nitrogen from water.

The disturbance caused by development and agricultural activities as well as forestry activities likely contributed to the alien plant infestation in the riparian area of the Bosfontein River. Alien vegetation outcompetes natural vegetation and requires more water, therefore causing altered surface runoff and decreased water inputs from the catchment to watercourses downstream. This has likely contributed to the deterioration of wetland habitat adjacent to the channel, replacement of wetland vegetation with riparian vegetation and incision of the channel. Like alien invasive trees, the commercial forestry in the catchment has replaced natural habitat, altered surface water movement, and reduced flows. This land use has long-term impacts due to the disturbance of the soil profile which has likely led to the proliferation of mostly Black Wattle trees. Additionally, the periodic harvesting of the trees exposes bare earth that potentially results in large sediment inputs into the drainage lines.

All such land disturbances affect the processes and features of upstream reaches that influence those further downstream or eventually estuaries. The Bitou River is only approximately 500 meters downstream of the site and is influenced by the Bosfontein River tributary. Furthermore, the Bitou River’s confluence with the Keurbooms Estuary is only approximately five kilometres away. Therefore, any impacts on this tributary, even seemingly small, have the potential to impact upon the estuary and the ocean.

Historic aerial imagery indicates the significant impact the past land uses have had on the extent of the river habitat. The study site is indicated with a red circle on the images below. In 1936 (Figure 11), the channel has already been impacted by agriculture. The imagery shows the river meandering through ploughed cultivated land within the floodplain, restricting the naturally wide extent of the river to a few narrow streams. By 1956 (Figure 12) agriculture has encroached further into the riparian area, causing the river to narrow and incise. Additionally, new forestry activities appear to have commenced on the more mountainous area northeast of the study site altering the catchment cover. The image of 1989 clearly shows the development which increasingly impacts the river (Figure

15) as well as bigger trees next to the drainage line. The trees are likely alien vegetation, such as Black Wattle trees, that are encroaching into the riparian area. In Figure 12 and 13 there is evidence of channel straightening through the excavation of a drain to direct flow away from the study site. Such activities may have led to the incision of the river channel; and lateral disconnectivity with its floodplain.

Figure 11: Historic aerial photograph from 1936 indicating the already disturbed floodplain.

Figure 12: Historic aerial photograph showing the floodplain under agricultural use in 1956.

Figure 13: Historic aerial photograph showing land use changes of 1960.

Figure 14: Historic aerial photograph of the area in 1989 showing the establishment of the settlement.

2.4.2 Study Site Status Quo

The study site has been subject to various anthropogenic impacts. Historically the impacts to the site are similar to the agricultural impacts of the catchment with the erven forming part of cultivated lands. The current terrestrial vegetation on site include few indigenous species. This is likely due to agriculture transforming the land through clearing and ploughing. The proposed development area has flat topography and is mainly covered in grass species (Figure 15A) such as kikuyu (*Pennisetum Clandestinum*) and *Eragrostis curvula*. A large group of poplar trees (*Populus alba*) are found on the western boundary of the study site (Figure 15B). Some individuals grow in-between the mature trees next to Main Road and just upslope of the aquatic habitat. Seven oak trees (*Quercus sp.*) line the southern boundary of the property, next to a grassed stormwater v-drain. A few young Milkwood trees grow close to the stormwater outlet at the south-western corner of the study site. This is one of South Africa's protected tree species and should therefore not be damaged, moved or felled.

The area proposed for development is on top of a fluvial terrace on site and covered in terrestrial vegetation with negligible natural habitat remaining. However, the aquatic habitat on site is located downslope of the terrace, largely outside of any development area and holds viable habitat. This will be discussed further in the following sections of this report.

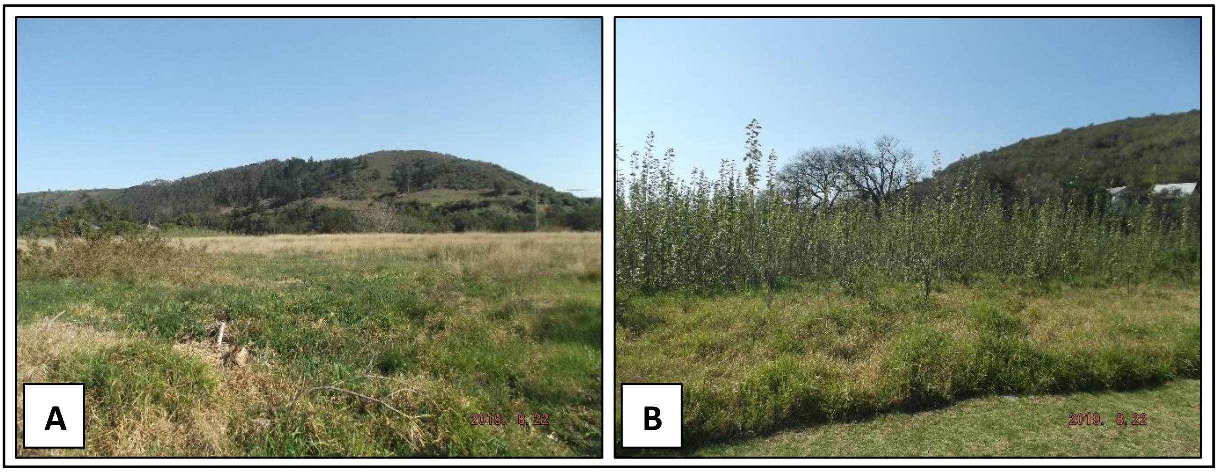

Figure 15: Vegetation cover of Erf 104

Currently, urban development has a bigger impact than agriculture due to the town of Wittedrift expanding. Visible formal changes include stormwater infrastructure and manholes. One stormwater outlet (Figure 16A) is located close to the riparian area. The v-drain next to Main Road gets fed through a stormwater pipe underneath the road (Figure 16B). There is also a slight bulge that runs diagonally through Erf 104 from the southwestern to the north-eastern corner. This could be a pipeline, but it is not indicated on the services layout. Another explanation is that it is a type of furrow that was constructed to block excess runoff from cultivated lands.

Existing regular human use of the area can be seen by the footpaths through the site. A well-used path cuts diagonally through erf 104 (Figure 16G) and is scattered with solid domestic waste and garden refuse. There is also a trail leading from the gravel road to the active channel of the river in the northeast of the study site (Figure 16H). This trail has denser vegetation cover and large volumes of domestic waste as well as human waste is scattered in the area. The study site overall seems to be used as a dump site for garden waste (Figure 16C), building rubble (Figure 16D) and black bags with domestic waste (Figure 16E and F). Garden waste include leaves, soil and grass cuttings and building rubble vary from pieces of brick to broken concrete and plastic.

Figure 16: Existing human impacts on site: A & B show stormwater infrastructure. C – F show various dumpsites found at sites. G & H show the two prominent footpaths through the site.

3 APPROACH AND METHODS

3.1 Desktop Assessment Methods

- The contextualization of the study area was undertaken in terms of important biophysical characteristics and the latest available aquatic conservation planning information in a Geographical Information System (GIS). It is imperative to develop an understanding of the regional drainage setting and longitudinal dynamics of the watercourse. The conservation planning information aids in the determination of importance and sensitivity, management objectives, and the significance of potential impacts.
- Following this, desktop delineation and illustration of all watercourses within the study area was undertaken utilising available site-specific data such as aerial photography, contour data and water resource data. Digitization and mapping were undertaken using QGIS 2.18 GIS software (Table 3).
- These results, as well as professional experience, allowed for the identification of specific watercourses that could potentially be impacted by the development and therefore required groundtruthing and detailed assessment. The following data sources listed within Table 3 assisted with the assessment.

Table 3: Utilised data and associated source relevant to the proposed project

Data	Source
Google Earth Pro™ Imagery	Google Earth Pro™
DWS Eco-regions (GIS data)	DWS (2005)
South African Vegetation Map (GIS Coverage)	Mucina & Rutherford (2018)
National Biodiversity Assessment Threatened Ecosystems (GIS Coverage)	SANBI (2016)
Geology	Surveyor General
Contours (elevation) - 5m intervals	Surveyor General
NFEPA river and wetland inventories (GIS Coverage)	CSIR (2011)
NEFPA river, wetland and estuarine FEPAs (GIS Coverage)	CSIR (2011)
Western Cape Biodiversity Spatial Plan 2017: Critical Biodiversity Areas of the Western Cape.	CapeNature. 2017 WCBSP Bitou

3.2 Baseline Assessment Methods

- An infield site assessment was conducted on the 22nd of August 2019 to confirm the location and extent of the systems identified as likely to be impacted by the proposed project. There are a number of factors which influence the level of impact, such as type of system, position of the system in relation to the project and position the system is located in the landscape. The identified aquatic ecosystems were classified in accordance with the, '*National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa'* (Ollis *et al*. 2013) and *WET-Ecoservices* (Kotze *et al*. 2009).

- Infield delineation was undertaken with a hand-held GPS, for mapping of any potentially affected aquatic ecosystems, in alignment with standard field-based procedures in terms of the Department of Water and Sanitation (DWAF 2008) *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas*. The delineation is based upon observations of the landscape setting, topography, vegetation and soil characteristics (using a hand-held soil auger for wetland soils).
- Determination of the Present Ecological State (PES), functional importance assessment and Ecological Importance and Sensitivity (EIS) assessment of the delineated wetland habitats.
    - The health/condition or Present Ecological State (PES) of the wetland was assessed using the Level 2 WET-Health Version 2 assessment tool (Macfarlane *et al.* 2008), which is based on an understanding of both catchment and on-site impacts and the effect that these impacts have on system hydrology, geomorphology and the structure and composition of wetland vegetation.
    - Wetland benefits can be classified into goods/products (directly harvested from wetlands), functions/ services (performed by wetlands), and ecosystem scale attributes. The WET-Ecoservices tool (Kotze *et al*., 2009) is utilised to assess the goods and services that the individual wetlands under assessment provide, thereby aiding informed planning and decision-making. The tool provides guidelines for scoring the importance of a wetland in delivering each of 15 different ecosystem services (including flood attenuation, sediment trapping and provision of livestock grazing).
    - The Ecological Importance and Sensitivity (EIS) of aquatic habitats is an expression of the importance of the water resource for the maintenance of biological diversity and ecological functioning on local and wider scales; whilst Ecological Sensitivity (or fragility) refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007). There Wetland EIS Tool was utilised to determine EIS (Kleynhans, 1999).
- The PES and EIS results then allowed for the determination of management objectives for the potentially impacted aquatic ecosystems. Refer to the Table below and Annexure 12 for a list and description of the tools utilised.

Table 4: Tools utilised for the assessment of water resources impacted upon by the proposed project.

METHOD/TOOL*	SOURCE	REFERENCE	APPENDIX (ANNEXURE)
Delineation of wetland and/or Riparian areas	*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas.*	(DWAF 2005)	12.1
Classification of wetlands and/ or other aquatic ecosystems	*National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa & WET-Ecoservices*	(Ollis *et al.*, 2013), Kotze *et al.*, 2009)	12.2
Present Ecological State (PES) Assessment (Wetland)	*WET-Health V2 Assessment*	(MacFarlane *et al.* 2009)	
Functional Importance Assessment (Wetland)	*WET-Ecoservices Assessment*	(Kotze *et al.*, 2009)	12.4
Ecological Importance & Sensitivity (EIS) Assessment (wetland)	*DWAF Wetland EIS Tool*	(Duthie 1999)	12.5

3.3 Impact Assessment Methods

- The approach adopted is to identify and predict all potential direct and indirect impacts resulting from an activity from planning to rehabilitation. Thereafter, the impact significance is determined.
- Impact significance is defined broadly as a measure of the desirability, importance and acceptability of an impact to society (Lawrence, 2007). The degree of significance depends upon three dimensions: the measurable characteristics of the impact (e.g. intensity, extent and duration), the importance societies/communities place on the impact, and the likelihood / probability of the impact occurring. A methodology for assigning scores to the respective impacts is described in Annexure 12.
- Actions are thereafter recommended to prevent and mitigate the identified impacts on aquatic habitat, in alignment with the mitigation hierarchy, as well as any measures necessary to restore disturbed areas or ecological processes.

3.4 Opportunities and Constraint Analysis

- Regarding any proposed development on the property, a buffer area from the boundary of the aquatic habitat must be determined. The specific size of the buffer zone was determined by a tool developed by Macfarlane and Bredin (2016) called *Buffer zone guidelines for rivers, wetlands and estuaries*, site-based information and professional opinion. The final buffer requirement includes the implementation of practical management considerations/mitigation measures.

- Identify legislation and permit requirements that are relevant to the development proposal from an aquatic perspective.
- Present recommendations of the suitability of the site based on sensitivity analysis.

4 ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations are relevant:

- The location of the proposed development was extrapolated from data provided by the client. No shapefiles with a more accurate layout have been provided as of yet.
- No stormwater management plan was provided by the client.
- Aquatic ecosystems vary both temporally and spatially. Once-off surveys such as this are therefore likely to miss certain ecological information due to seasonality, thus limiting accuracy and confidence. The aquatic wetland habitat is cryptic in this instance and therefore not easy to classify.
- Infield soil and vegetation sampling was only undertaken within a specific focal area around the proposed development, while the remaining watercourses were delineated at a desktop level with limited accuracy.
- No detailed assessment of aquatic fauna/biota was undertaken.
- The vegetation information provided is based on observation not formal vegetation plots. As such species documented in this report should be considered as a list of dominant and/or indicator wetland/riparian species and only provide a very general indication of the composition of the riverine vegetation communities.
- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological concerns arising from the field survey and based on the assessor's working knowledge and experience with similar development projects. The degree of confidence is considered medium.
- The study does not include offset calculations.
- The study area has been subject to significant disturbances and the habitat is modified from the natural condition. The references condition is an estimation based on professional knowledge.
- The WET-Health-V2 assessment tool used is still in beta format. The assessor cannot be held liable for incorrect results due to errors with the functioning of the tool. The results are however believed to be an accurate representation of aquatic health.

5 RESULTS

Erf 103 and 104 are between Main Road and the Bosfontein River channel with Rotterdam Street separating the two erven. This entire area is proposed to be merged into one erf for development. All aquatic habitat within the regulated area (500m radius) of the development was identified and mapped. The systems that are likely to be impacted upon by the development were assessed in further detail, groundtruthed and delineated. The aquatic habitat discussed and assessed in this report is limited to the reach in the direct area of the study site. The assessment does, however, consider the setting within the broader catchment.

5.1 Wetland assessment

The Bosfontein River flows in an easterly direction across the northern portion of the site before joining the Bitou River system. Historically it is likely that the watercourse known as the Bosfontein River was a floodplain wetland system. However significant degradation has resulted in only fragmented wetland habitat remaining on the valley floor. There has been a disconnect between the incised channel and lateral wetland habitat resulting in an altered ecological state and decreased ecological functioning of the remaining pockets. The degraded habitat within the rest of the valley is presently more characteristic of a lowland river than its estimated historic wetland state. It contains an incised channel with a sandy substrate and the approximately two meter high banks are vegetated with invasive tree and grass species (Figure 17). Vegetation in the instream area includes *Wachendorfia sp.* and *Zantedeschia aethiopica*. The small fragments of remaining wetland habitat are the only indicator of the former wetland type of the entire valley floor and are most similar to the natural reference condition of the area.

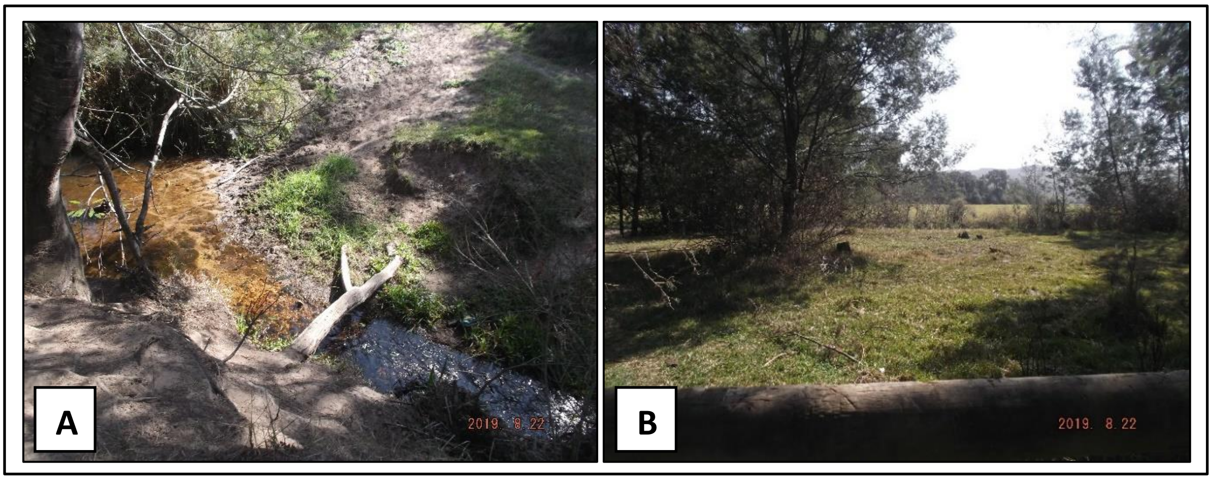

Figure 17: Photo A shows the incised channel from the southern side. Photo B shows the area directly south of the channel from the border of Erf 103. Grass for livestock grazing is visible on either side of the channel, as well as numerous <u>Acacia mearnsii</u> trees on the banks.

One such pocket of remaining wetland habitat is situated within the northern section of the site proposed for development (Figure 18). It lies within the low lying relic channel, a floodplain meander cut-off, at the base of the floodplain terrace. The linear, bow-shaped depression is intermittently inundated by periodic overbank flooding from the channel but also receives surface runoff from the terrace and increased water inputs from the nearby stormwater outlet. This wetland area is likely to capture sediments and nutrients from upstream during peak flows, but it mainly serves as a buffer between the urban area and the channel. Due to the importance of the downstream Bitou and Keurbooms river and wetland systems it is essential that functions of this habitat are not further compromised. Therefore, an aquatic buffer area and stringent mitigation must be adopted in order to maintain the present state of the wetland and avoid any further degradation of the system.

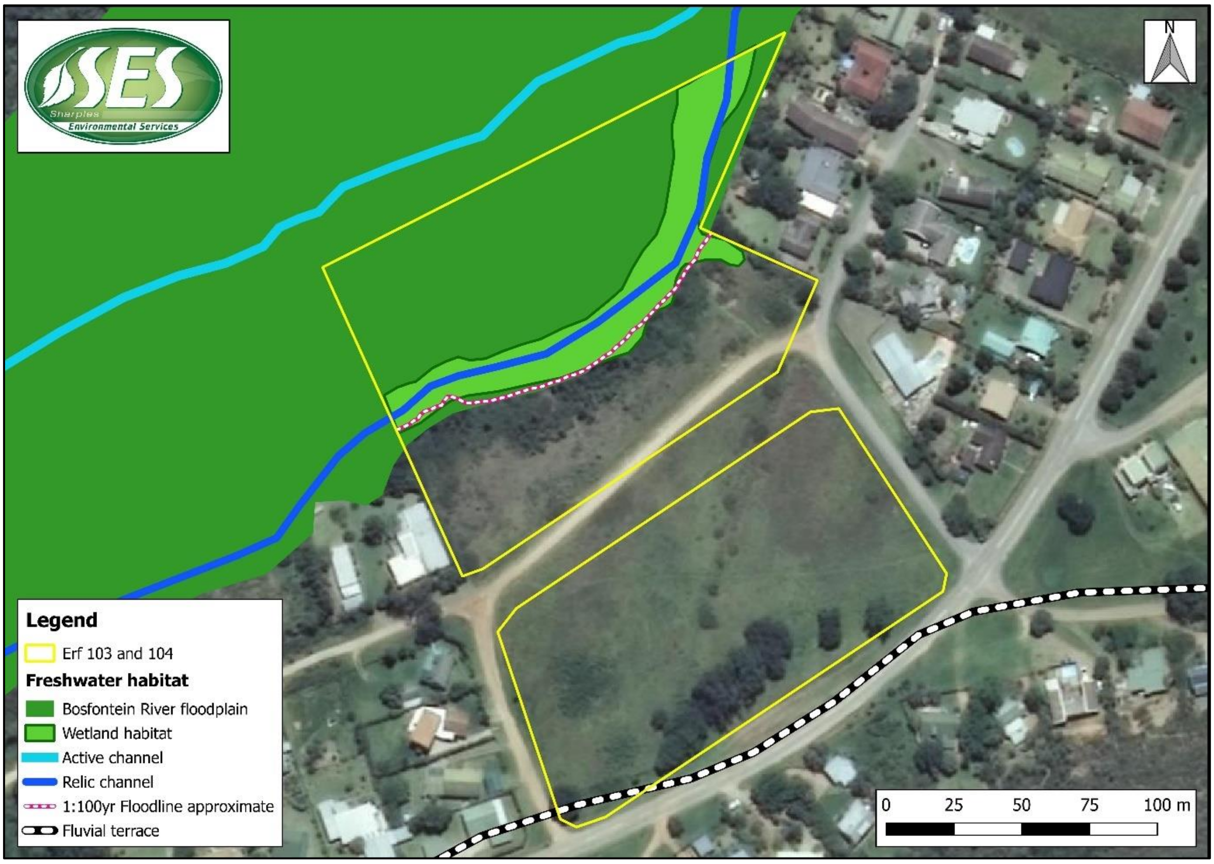

Figure 18: Map indicating the 100-year Recurrence Interval floodline, wetland habitat, as well as the relic and active channel and the floodplain of the Bosfontein River.

A terrace slope runs east-west through the middle of Erf 103 adjacent to the remnant wetland vegetation. Figure 19A is a photo taken from the top of the terrace in an eastern direction and shows the dominant vegetation cover of the slope, forming the boundary between terrestrial grass species and wetland habitat. The entire terrace slope and floodplain are covered in dense vegetation, except for a footpath in the east that cuts through the wetland habitat. Beyond Erf 103, grassy pastures and invasive *Acacia mearnsii* (Black wattle) cover most of the channel banks. Table 5 and 6 has a full species list.

The remnant wetland habitat is located along the relic channel at the foot of the fluvial terrace and on the floodplain as shown in Figure 19. Some wetland habitat was observed on the terrace slope on the eastern side, below a stormwater outlet. The presence of this outlet likely contributed to the wetland habitat extending upslope in this area. Wetland characteristics, such as hydric soils and hydrophilic vegetation, were confirmed by soil augering and observation during the site assessment. The wetland vegetation observed during assessment include *Cliffortia odorata, Phragmites australis* and *Cyperus thunbergii*. Soil augering determined that mottles (Figure 19B) occur at a depth of 40cm and thus the temporary zone of the wetland was delineated.

Mottles indicating wetland downslope of the terrace is shown in Figure 19B. Soil augering proved the presence of wetland habitat along the foot of the terrace slope where both wetland indicator species and riparian vegetation grow intermittently. The indicator wetland sedge, *Cyperus thunbergii*, was one of the observed species along the foot of the terrace slope as well as in the area below the stormwater outlet (Figure 19D). Figure 19C shows some of the *Phragmites australis* growing tall along the relic channel.

Classifying the wetland was challenging due to the extensive anthropogenic impacts within the catchment that degraded the natural system to a large extent. Dominant inputs to the wetland are from the channel and adjacent slopes, with groundwater inflow likely contributing as well. The occasional overtopping of the channel banks leaves the wetland intermittently inundated. The water outflow is diffused flow and throughflow to the Bosfontein River channel. The alluvial channel substrate with mottling in the meander cut of, and floodplain features of the watercourse resulted in the floodplain wetland classification.

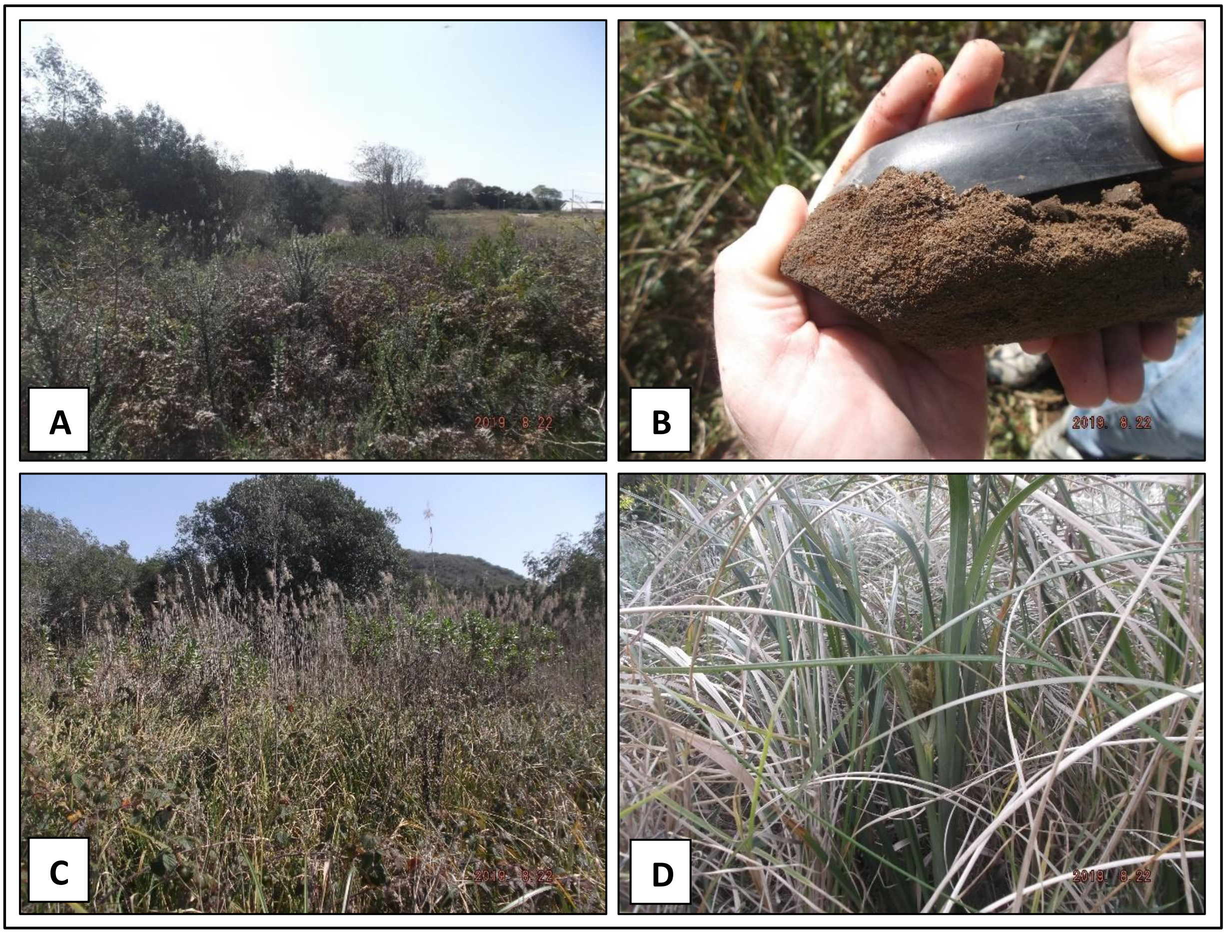

Figure 19: Photos taken on Erf 103. A, C & D are pictures of some vegetation found on site. B shows mottling in an auger sample.

A few individuals of *Cyperus thunbergii* (Figure 20A), an indicator wetland sedge, grows in between kikuyu grass (*Pennisetum clandestinum*) on the corner of Rotterdam and Kammassie Street. Soil augering found mottles (Figure 20B) within the soil profile but they only occurred more than 50cm below the surface within sandy alluvial soils. Therefore, there were insufficient wetland indicators to confirm the presence of wetland habitat in this area.

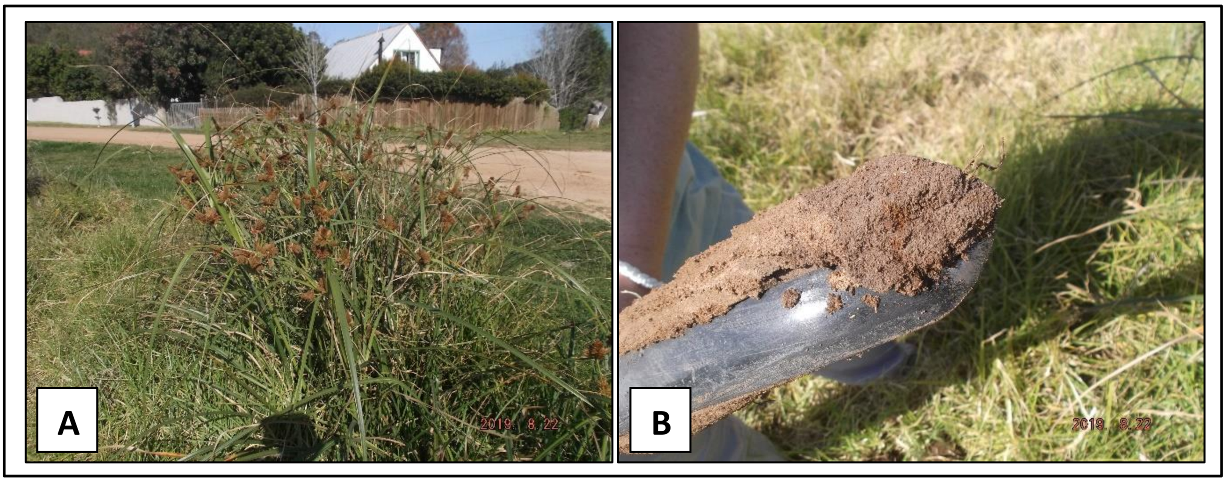

Figure 20: A: One of the Cyperus thunbergii individuals observed at the corner of Rotterdam and Kammassie street. B: photo of mottling found deep within sandy floodplain deposits.

Table 5: List of indigenous plant species observed on site

Scientific name	Common name	Aquatic species
Carpobrotus sp.	Sour fig / Pigface	
Cliffortia odorata		x
Conyza scabrida		
Cyperus thunbergii		x
Eragrostis curvula	Weeping love grass	
Leonotis leonurus	Wild dagga/Lion's ear	
Osteospermum moniliferum	Bietou	
Phragmites australis	Common reed	x
Pteridium aquilinum	Bracken fern	x
Rapanea melanophloeos	Boekenhout/Cape beech	
Searsia chirindensis	Rhus	
Sideroxylon inerme	White milkwood	
Tarchonanthus littoralis	Coastal camphor bush	
Wachendorfia sp.		x
Zantedeschia aethiopica	Arum lily	x

Table 6: List of alien plant species observed on site

Scientific name	Common name
Acacia mearnsii	Black wattle
Bidens pilosa	Blackjack
Cestrum laevigatum	Inkberry
Melia azedarach	Syringa tree
Pennisetum clandestinum	Kikuyu grass
Pinus sp.	Pine tree
Populus alba	White poplar
Quercus sp.	Oak
Rubus cuneifolius	Bramble
Verbena bonariensis	Tall verbena

5.2 Wetland PES

The floodplain wetland below the study site was assessed to determine the Present Ecological State of the wetland that would have naturally occurred in the area. The assessed portion is limited to the reach directly adjacent to the site and not the entire system. However, the assessment does take the catchment into account according to the requirements of WET-Health-V2.

Table 7 below shows the results of the PES assessment. The 'D' score for hydrology can be attributed to agricultural and forestry activities in the catchments that altered the runoff into the channel and therefore the flow through wetland habitat. Under natural conditions the channel would be less incised which would lead to more frequent overtopping to sustain the wetland habitat on the banks of the channel. Geomorphological change ('C' score) is linked to agricultural encroachment into the floodplain and the infestation of alien plant species. This has led to the natural broad channel becoming incised with steep, eroded banks. The terrace slopes that formed historically is however still intact and the general slope of the wetland adjacent to the channel has not been significantly altered. Water quality scored a 'B' and are influenced by pollution sources within the catchment. The extent of urban development has been limited and therefore most inputs are runoff from natural areas in the upper reaches and agricultural land or plantations in the lower of the catchment. Although this is not all natural input, the water quality of runoff from grazing pastures is significantly better than polluted runoff from hardened surfaces in urban development. The extent of wetland vegetation has been reduced to only a fraction of the original extent and has been replaced with grazing pastures and alien vegetation which accounts for the 'D' score. However, there is still some indigenous riparian vegetation within the floodplain and the remaining wetland habitat has dense vegetation.

An overall 'D' PES score for the wetland indicates a Poor system. However, this is an indication of the health of the whole reach of natural wetland directly adjacent to the site. The fragment of wetland habitat remaining is in better health with dense vegetation cover and no signs of erosion. The wetland is functional and performing ecosystem services.

Table 7: Results of the PES assessment

	Wetland PES Summary			
Wetland name	**Bosfontein River wetland**			
Assessment Unit	**Reach of Erf 103 and 104, Wittedrift**			
Wetland area (Ha)	6,1 Ha			
PES Assessment	HYDROLOGY	GEOMORPHOLOGY	WATER QUALITY	VEGETATION
Impact Score	5,2	2,9	1,9	5,7
PES Score (%)	48%	71%	81%	43%
Ecological Category	**D**	**C**	**B**	**D**
Combined Impact Score	4,1			
Combined PES Score (%)	59%			
Combined Ecological Category	**D**			
Hectare Equivalents	3,6 Ha			
Confidence	Moderate: Desktop assessment based on refined landcover mapping after site visit to achieve groundtruthing			

5.3 Functional Importance

Wetland benefits can be classified into goods/products (directly harvested from wetlands), functions/ services (performed by wetlands), and ecosystem scale attributes. The WET-EcoServices assessment highlights these benefits and the extent of each benefit for the wetlands. The assessment indicates that the wetland habitat has a Low to Moderate functional importance. The functionality of the wetland has been compromised by degradation as a result of forestry, urbanization and agricultural activities in the catchment.

The wetland fulfils its function in contributing ecosystem services. The most important services include flood attenuation, sediment trapping and erosion control. These services will benefit the downstream Bitou River wetland by acting as buffer between this system and developments upstream. Increased stormwater inputs and altered runoff from the hardened surfaces of the proposed development will be mitigated by the wetland to prevent erosion and flooding downstream. The wetland's ability to trap pollutants are also beneficial considering the higher pollution load associated with the development's construction and operational phase.

The wetland has potential to be utilised as recreational area especially once the development is completed and residents have access to the area, but it is not known to currently provide this service significantly. There are also no known cultural practices occurring. The wetland does provide some agricultural benefits as source of drinking water for cattle (Figure 22).

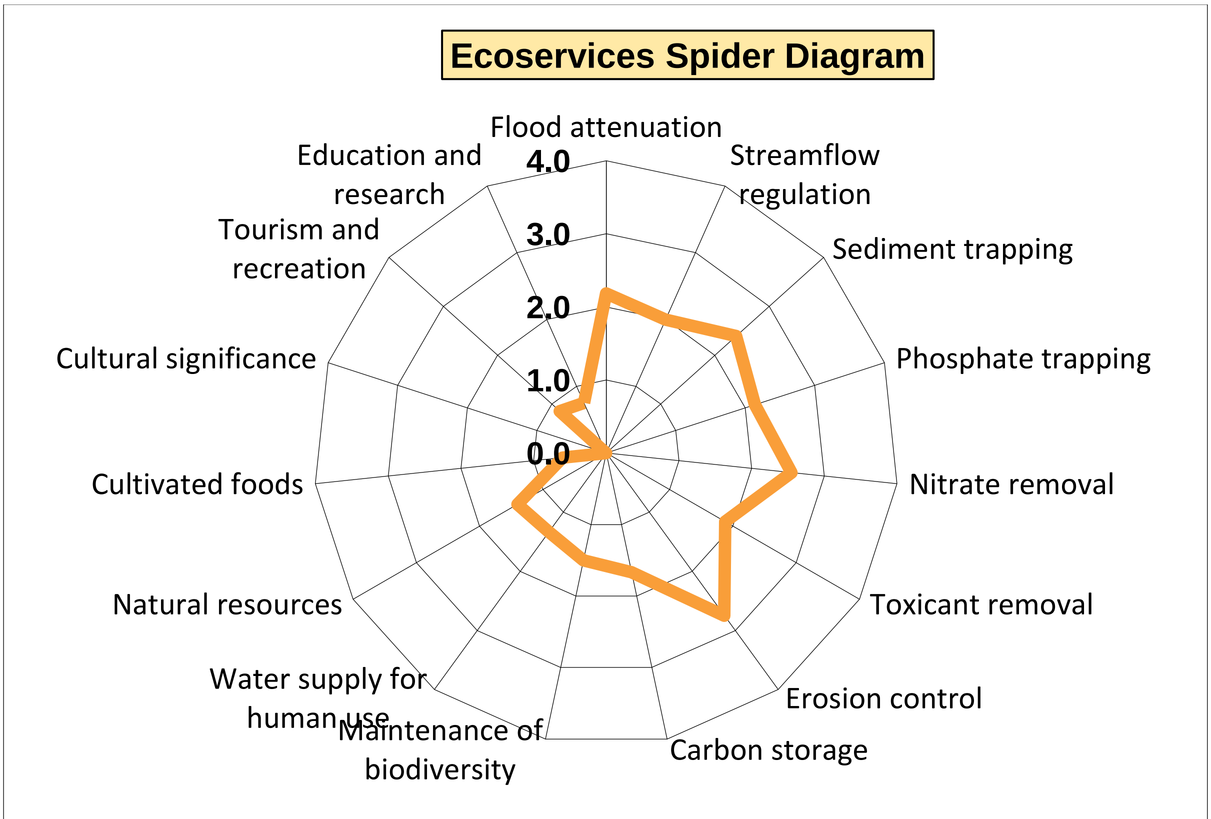

Figure 21: Functional importance results for the potentially impacted wetland

5.4 Wetland EIS

The wetland has a Moderate overall EIS score (Table 8). The biodiversity importance is moderate due to its sensitivity to changes in floods and water quality; the protection status of the surrounding vegetation type and its ability to act as a migration route. The wetland itself is not being conserved in any way due to errors in the WCBSP and NFEPA data that failed to identify and/or appropriately classify the aquatic habitat. The hydrological importance of the system is limited due to the size of the remnant wetland habitat. However, the wetland is still capable of flood attenuation and erosion control which will help to limit degradation of the downstream aquatic habitat when altered runoff from the proposed development enter the system. Direct benefits to society include the area being utilized as grazing pastures for cows. The wetland's recreational importance will likely increase once the development is finished since the proposed walkways will ensure access to this Open Space.

Table 8: Wetland EIS Assessment Results

SUMMARY	Floodplain	
	Score (out of 4)	**Rating**
BIODIVERSITY IMPORTANCE	2,67	Moderate
FUNCTIONAL/HYDROLOGICAL IMPORTANCE	1,38	Low
DIRECT BENEFITS TO SOCIETY	1,33	Low
Ecological Importance and Sensitivity (EIS)	**2,67**	**Moderate**

5.5 Recommended ecological category and management objectives

The recommended ecological category (REC) is used to inform the future management objective for an aquatic ecosystem. The REC can be determined by using the PES (Present Ecological State) and EIS (Ecological Importance and Sensitivity) scores of the system (DWAF 2007). Due to the wetland having a Poor PES score and Moderate EIS score, the management objective is to maintain the system in its current state.

6 POTENTIAL IMPACTS

Aquatic ecosystems are particularly vulnerable to human activities and these activities can often result in irreversible damage or longer term, cumulative changes. The significance of an impact to the environment or ecosystem can only be assessed in terms of the change to ecosystem services, resources and biodiversity value associated with that system or component being assessed. The approach adopted is to identify and predict all potential direct and indirect impacts resulting from an activity from planning to rehabilitation. The direct and indirect impacts associated with the project are grouped into four encapsulating impact categories where associated or interlinked impacts are grouped. Impacts have been separated into construction and operational phases of the project within these categories.

There are two alternative layouts assessed. Alternative A is the original layout that encroaches into wetland habitat and would require alterations to the terrace slope and infilling. This layout has a swimming pool and stormwater outlet proposed within aquatic habitat. This layout was amended after input from the aquatic specialist to provide Alternative B. This layout is restricted to the top of the terrace slope and predominantly adheres to the 10 m aquatic buffer. There are no road crossings or pipelines proposed through the wetland habitat in either of the layout alternatives. The only crossing will be a boardwalk that is proposed along the route of the existing footpath that cuts through wetland habitat.

6.1 Disturbance/loss of aquatic vegetation and habitat

The disturbance or loss of aquatic vegetation and habitat refers to the direct physical destruction or disturbance of aquatic habitat caused by vegetation clearing, disturbance of riparian habitat, encroachment and colonisation of habitat by invasive alien plants.

6.1.1 Construction Phase

The project requires the removal of most of the vegetation on the fluvial terrace. However, this area is mainly comprised of Kikuyu grass (*Pennisetum clandestinum*) and few indigenous species occur. The development will not occur within the riparian zone, but it will encroach onto it and therefore construction phase impacts are possible. There is potential for loss or disturbance of riparian zone vegetation during construction from machinery, vehicles and workers. The movement of topsoil and incorrectly placed stockpiles could bury aquatic habitat. This impact could be enhanced through stockpiling close to or on the slope of the terrace which will make the stockpiles unstable. Due to construction, alien invasive species may encroach further into any disturbed areas and outcompete indigenous vegetation thereby reducing aquatic biodiversity.

6.1.2 Operational Phase

The project will promote the establishment of disturbance-tolerant biota, including colonization by invasive alien species, weeds and pioneer plants within the remaining aquatic habitat. Although this impact is initiated during the construction phase it is likely to persist into the operational phase. The stormwater infrastructure of the housing and associated road network will increase and concentrate flows into the wetland. This may lead to erosion in the system that compromises remaining vegetated habitat.

6.2 Sedimentation and erosion

Sedimentation and erosion refer to the alteration in the physical characteristics of the aquatic habitat as a result of increased turbidity and sediment deposition, caused by soil erosion and earthworks that are associated with construction activities, as well as instability and collapse of unstable soils during project operation. These impacts can result in the deterioration of aquatic ecosystem integrity and a reduction/loss of habitat for aquatic dependent flora & fauna.

6.2.1 Construction Phase

Vegetation clearing and exposure of bare soils adjacent to the wetland habitat during construction will decrease the soil binding capacity and cohesion of the upslope soils and thus increase the risk of erosion and sedimentation downslope. The majority of the site has a gentle slope. However, the terrace slope at the wetland habitat is steeper which will increase velocity of runoff into the wetland. This can lead to the erosion and burying of aquatic habitat depending on the sediment load of runoff. It may lead to the wetland ceasing to function. Ineffective site stormwater management, particularly in periods of high runoff, can lead to soil erosion from confined flows. The formation of rills and gullies from increased concentrated runoff can also be expected. This increase in volume and velocity of runoff increases the particle carrying capacity of the water flowing over the surface.

6.2.2 Operational Phase

Where soil erosion problems and bank stability concerns initiated during the construction phase are not timeously and adequately addressed, these can persist into the operational phase of the development project and continue to have a negative impact downstream. The increase in hardened surface by development, if not mitigated against, will result in further erosion. Surface runoff and velocities will be increased, and flows will be concentrated by stormwater infrastructure. This will likely have a very significant impact on the functioning of the wetland that is located along the foot of the terrace.

6.3 Water Pollution

Water and/or soil pollution cause negative changes in the physical, chemical and biological characteristics of water resources (i.e. water quality). This can result in possible deterioration in aquatic ecosystem integrity and a reduction in, or loss of, species of conservation concern (i.e. rare, threatened/endangered species). Additionally, litter indirectly decreases the aesthetic value of the aquatic habitat.

6.3.1 Construction Phase

During construction there are a number of potential pollution inputs into the wetland (such as hydrocarbons and raw cement). These pollutants alter the water quality parameters such as turbidity, nutrient levels, chemical oxygen demand and pH. These alternations impact the species composition of the systems, especially species sensitive to minor changes in these parameters. Sudden drastic changes in water quality can also have chronic effects on aquatic biota in general and result in localised extinctions. Hydrocarbons including petrol/diesel and oils/grease/lubricants associated with construction activities (machinery, maintenance, storage, handling) may potentially enter the system by means of surface runoff or through dumping by construction workers. Raw cement could enter the systems through incorrect batching procedure and/or direct disposal. The incorrect positioning and maintenance of the portable chemical toilets and use of the surrounding environment as ablution facilities may result in sewage and chemicals entering the systems. The construction activities are largely proposed on the terrace and outside the wetland habitat, and therefore this impact will likely be caused by runoff from the construction area into the wetland rather than direct input/spills.

6.3.2 Operational Phase

If not prevented, litter, and contaminants, including sand, silt, and dirt particles, will enter storm water runoff and pollute the wetland. Micro-litter such as cigarette butts may travel through certain stormwater grids and grids may not be regularly cleared. The number of vehicles on the property due to the development increases the potential for pollutants to enter the system. During maintenance of the development there could be water pollution impacts similar to those encountered in the construction phase. The impacts on the wetland next to the development is likely to affect the wetland systems further downstream as well.

6.4 Flow Modification

This impact addresses changes in the quantity, timing and distribution of water inputs and flows within the watercourses. Possible ecological consequences associated with this impact may include: deterioration in aquatic ecosystem integrity, reduction/loss of habitat for aquatic dependent flora & fauna, and a reduction in the supply of ecosystem goods & services.

6.4.1 Construction Phase

Land clearing and earth works adjacent to the wetland will reduce infiltration rates and increase the surface runoff volume and velocity. Such changes in surface roughness and runoff rates may lead to some rill and gully erosion. Altered water inputs from upslope disturbances as well as modified water distribution and retention patterns will ultimately affect the hydrological integrity of water resources.

6.4.2 Operational Phase

Ultimately, the hardened/ artificial infrastructure will alter the natural processes of rainwater infiltration and surface runoff, promoting increased volumes and velocities of storm water runoff, which can be detrimental to the wetland receiving concentrated flows off of the area. According to the SANRAL (2006), urbanisation typically increases the runoff rate by 20-50%, compared to natural conditions. Increased volumes and velocities of storm water draining from the area and discharging into the wetland will alter the natural ecology, increasing the risk of erosion and channel incision/scouring. The terrace will increase this effect due to the slope increasing velocity of already concentrated runoff from the development.

7 IMPACT SIGNIFICANCE ASSESSMENT

Impact significance is defined broadly as a measure of the desirability, importance and acceptability of an impact to society (Lawrence, 2007). The degree of significance depends upon three dimensions: the measurable characteristics of the impact (e.g. intensity, extent and duration), the importance societies/communities place on the impact (or resource being affected), and the likelihood / probability of the impact occurring. A methodology for assigning scores to the respective impacts is described in Annexure 12.8.

The impact significance of the two alternative layouts of the proposed development was determined for each potential impact of each phase of the project. Alternative A (Table 9) is the original layout that was overlaid with the 10m aquatic buffer. After aquatic specialist input, the layout was amended to produce Alternative B (Table 10). This layout alternative has a portion of the development set back in order to largely comply with the 10m buffer. Alternative C (Table 11) is the No-Go alternative and assumes that no development will take place and alien vegetation be cleared.

The Alternative A includes infrastructure within aquatic habitat. The development will also require alterations to the terrace and infilling to accommodate a swimming pool at the Community Centre. Furthermore, there is stormwater infrastructure proposed within the remnant wetland habitat. The impacts associated with this Alternative range from High to Low (after mitigation). Flow Modification is the only impact that is expected to be high during the Operational phase if no mitigation is implemented. Loss and disturbance of aquatic habitat and sedimentation and erosion are expected to be Medium during construction, with or without mitigation, due to the encroachment into wetland habitat which will definitely lead to wetland habitat loss.

Impacts associated with Alternative B are less significant than those associated with Alternative A. The impacts range from Medium to Low (after mitigation). The lower significance is attributable to the infrastructure being setback to comply with the 10m aquatic buffer and the proposal not including infilling or alterations to the terrace. Flow modification is likely to be the most significant impact. From an aquatic perspective, Alternative B is preferred over Alternative A.

Impacts associated with Alternative C are all of Low significance. It is likely that the health of the wetland will improve and the extent increase if ‘Duty of Care’ is implemented.

Table 9: Evaluation of potential impacts of Alternative A: Layout 1 on aquatic habitat

	Impact	Mitigation	Extent	Duration	Magnitude	Probability	Significance	Reversibility	Mitigation Potential	Irreplaceable Resource Loss
Construction Phase	Loss and disturbance of aquatic vegetation & habitat	Without Mitigation	Local (2)	Permanent (5)	Low (4)	Definite (5)	**Medium (55)**	Irreversible	Medium	Yes
		With Mitigation	Site only (1)	Permanent (5)	Minor (2)	Highly likely (4)	**Medium (32)**	Partly	Low	Yes
	Erosion & sedimentation	Without Mitigation	Local (2)	Long (4)	High (8)	Highly likely (4)	**Medium (56)**	Partly	Medium	Yes
		With Mitigation	Site only (1)	Medium (3)	Moderate (6)	Probable (3)	**Medium (30)**	Barely	Low	Yes
	Water Pollution	Without Mitigation	Local (2)	Medium (3)	Low (4)	Highly likely (4)	**Medium (44)**	Partly	High	No
		With Mitigation	Site only (1)	Short (2)	Minor (2)	Probable (3)	**Low (15)**	Barely	Low	No
	Flow modification	Without Mitigation	Local (2)	Long (4)	Moderate (6)	Highly likely (4)	**Medium (48)**	Partly	Medium	Yes
		With Mitigation	Local (2)	Medium (3)	Low (4)	Probable (3)	**Low (27)**	Barely	Low	Yes

	Impact	Mitigation	Extent	Duration	Magnitude	Probability	Significance	Reversibility	Mitigation Potential	Irreplaceable Resource Loss
Operational Phase	Loss and disturbance of aquatic vegetation & habitat	Without Mitigation	Local (2)	Permanent (5)	Low (4)	Definite (5)	**Medium (55)**	Irreversible	Low	Yes
		With Mitigation	Site only (1)	Permanent (5)	Minor (2)	Definite (5)	**Medium (40)**	Barely	None	Yes
	Erosion & sedimentation	Without Mitigation	Local (2)	Permanent (5)	Moderate (6)	Highly Likely (4)	**Medium (52)**	Partly	Medium	Yes
		With Mitigation	Site only (1)	Permanent (5)	Low (4)	Probable (3)	**Medium (30)**	Barely	Low	No
	Water Pollution	Without Mitigation	Local (2)	Permanent (5)	Low (4)	Highly Likely (4)	**Medium (44)**	Partly	High	Yes
		With Mitigation	Site only (1)	Permanent (5)	Minor (2)	Probable (3)	**Low (24)**	Barely	Low	No
	Flow modification	Without Mitigation	Local (2)	Permanent (5)	Moderate (6)	Definite (5)	**High (65)**	Irreversible	Low	Yes
		With Mitigation	Local (2)	Permanent (5)	Low (4)	Definite (5)	**Medium (55)**	Barely	None	Yes

Table 10: Evaluation of potential impacts of Alternative B: Amended Layout 2 on aquatic habitat

	Impact	Mitigation	Extent	Duration	Magnitude	Probability	Significance	Reversibility	Mitigation Potential	Irreplaceable Resource Loss
Construction Phase	Loss and disturbance of aquatic vegetation & habitat	Without Mitigation	Local (2)	Permanent (5)	Low (4)	Highly likely (4)	**Medium (44)**	Irreversible	Low	Yes
		With Mitigation	Site only (1)	Medium (3)	Minor (2)	Probable (3)	**Low (18)**	Barely	None	Yes
	Erosion & sedimentation	Without Mitigation	Local (2)	Short (2)	Moderate (6)	Highly likely (4)	**Medium (40)**	Partly	Medium	Yes
		With Mitigation	Site only (1)	Short (2)	Low (4)	Probable (3)	**Low (21)**	Barely	Low	No
	Water Pollution	Without Mitigation	Local (2)	Medium (3)	Low (4)	Definite (5)	**Medium (45)**	Partly	High	No
		With Mitigation	Site only (1)	Short (2)	Minor (2)	Probable (3)	**Low (15)**	Barely	Low	No
	Flow modification	Without Mitigation	Local (2)	Medium (3)	Moderate (6)	Highly likely (4)	**Medium (44)**	Partly	Medium	Yes
		With Mitigation	Local (2)	Medium (3)	Low (4)	Probable (3)	**Low (27)**	Barely	Low	Yes

	Impact	Mitigation	Extent	Duration	Magnitude	Probability	Significance	Reversibility	Mitigation Potential	Irreplaceable Resource Loss
Operational Phase	Loss and disturbance of aquatic vegetation & habitat	Without Mitigation	Local (2)	Permanent (5)	Low (4)	Probable (3)	**Medium (33)**	Irreversible	Low	Yes
		With Mitigation	Site only (1)	Permanent (5)	Minor (2)	Probable (3)	**Low (24)**	Barely	None	Yes
	Erosion & sedimentation	Without Mitigation	Local (2)	Permanent (5)	Low (4)	Probable (3)	**Medium (33)**	Partly	Medium	Yes
		With Mitigation	Site only (1)	Permanent (5)	Minor (2)	Improbable (2)	**Low (16)**	Barely	Low	No
	Water Pollution	Without Mitigation	Local (2)	Permanent (5)	Low (4)	Probable (3)	**Medium (33)**	Partly	High	Yes
		With Mitigation	Site only (1)	Permanent (5)	Minor (2)	Probable (3)	**Low (24)**	Barely	Low	No
	Flow modification	Without Mitigation	Local (2)	Permanent (5)	Moderate (6)	Highly likely (4)	**Medium (52)**	Irreversible	Low	Yes
		With Mitigation	Site only (1)	Permanent (5)	Minor (2)	Probable (3)	**Low (24)**	Barely	None	Yes

Table 11: Evaluation of potential impacts of Alternative C: No-Go on aquatic habitat

	Impact	Mitigation	Extent	Duration	Magnitude	Probability	Significance	Reversibility	Mitigation Potential	Irreplaceable Resource Loss
No development	Loss and disturbance of aquatic vegetation & habitat	Without Mitigation	Local (2)	Short (2)	Low (4)	Improbable (2)	**Low (16)**	Irreversible	Medium	Yes
		With Mitigation	Site only (1)	Short (2)	Minor (2)	Improbable (2)	**Low (10)**	Barely	None	Yes
	Erosion & sedimentation	Without Mitigation	Local (2)	Short (2)	Low (4)	Improbable (2)	**Low (16)**	Partly	Medium	Yes
		With Mitigation	Site only (1)	Short (2)	Minor (2)	Improbable (2)	**Low (10)**	Barely	Low	No
	Water Pollution	Without Mitigation	Local (2)	Short (2)	Low (4)	Probable (3)	**Low (24)**	Partly	Medium	No
		With Mitigation	Local (2)	Short (2)	Minor (2)	Improbable (2)	**Low (12)**	Barely	Low	No
	Flow modification	Without Mitigation	Local (2)	Medium (3)	Low (4)	Improbable (2)	**Low (18)**	Partly	Medium	Yes
		With Mitigation	Local (2)	Short (2)	Minor (2)	Improbable (2)	**Low (12)**	Barely	Low	Yes

8 CUMULATIVE IMPACTS

Cumulative impacts on the environment can result from broader, long term changes and not only as a result of a single activity or development. They are rather from the combined effects of many activities overtime. Rivers and certain wetlands are longitudinal systems where different reaches interact in a continuum along the length of the watercourse. This is vitally important to understand in the context of cumulative impacts from developments. Activities in the upper reaches influence the processes of the lower reaches and it must therefore be viewed as a whole. This is not always within the scope of studies such as this.

The impacts of the proposed development, when assessed on their own, are found to largely range between Medium to Low significance (after mitigation). The aquatic habitat is already degraded due to impacts in the catchment such as from forestry and agriculture. These impacts cause hydrological and geomorphological changes which influences aquatic ecosystem functioning and leads to reduced wetland habitat. The town of Wittedrift is growing and therefore urban development pressures on the Bosfontein River, such as from this development, are likely to increase in future. The cumulative impact of this development and future development within the catchment will likely cause drastic resource loss, habitat degradation, pollution, flow modification, etc. Figure 22 below show the effect of urban development on wetland habitat downslope.

Small-scale aquatic assessments of individual properties are unlikely to obtain conservation objectives. The most effective and proactive solution is sustainable development planning with a broader spatial and temporal focus. The identification and protection of sensitive aquatic habitat should be done on a catchment scale and will aid sustainable development planning whilst minimising negative cumulative impacts.

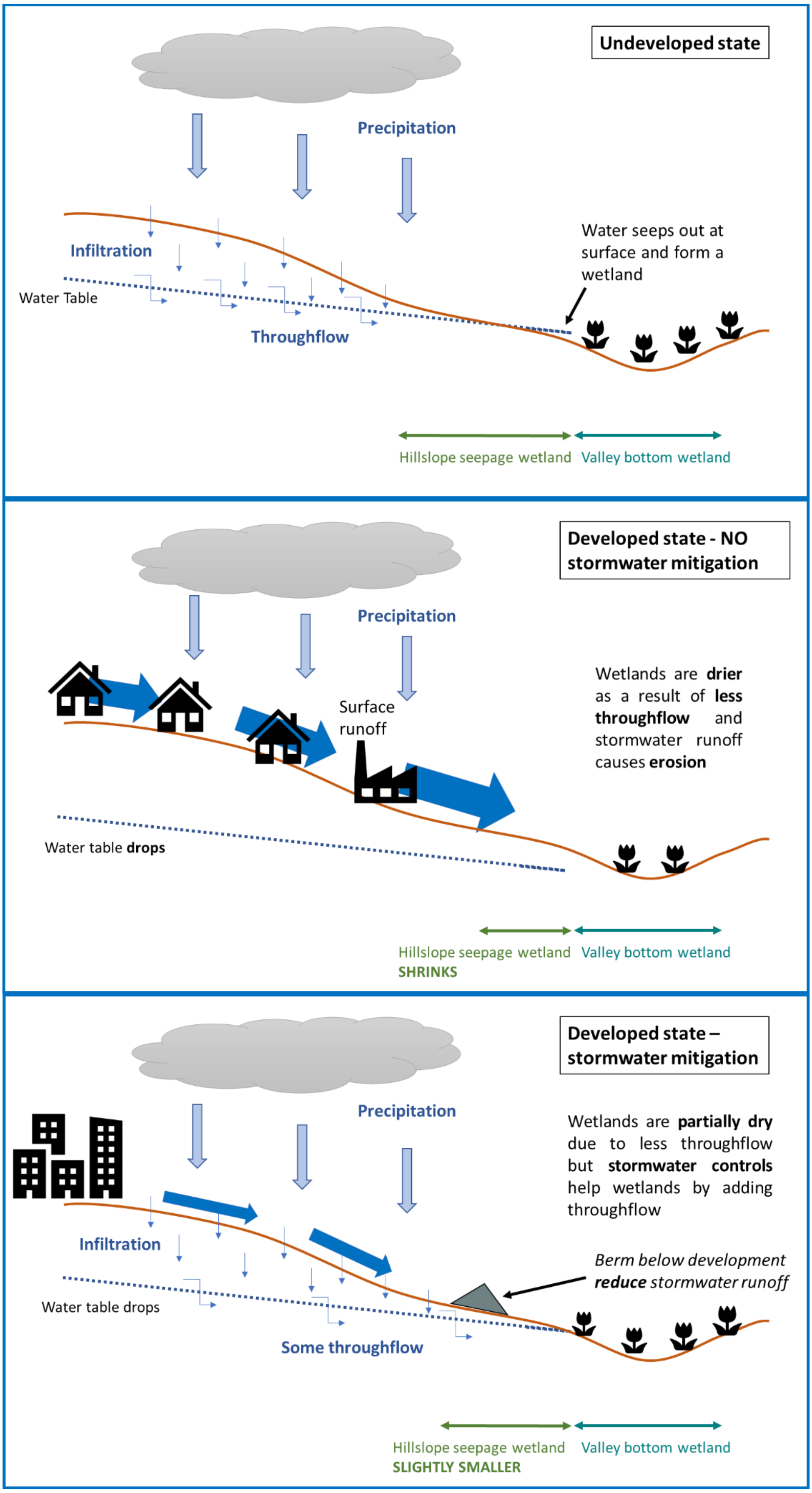

Figure 22: Diagrams indicating the characteristics influencing wetlands that are affected by development

9 MITIGATION MEASURES

The mitigation of negative impacts on biodiversity and ecosystem goods and services is a legal requirement for authorisation purposes and must take on different forms depending on the significance of the impact and the specific area being affected. Mitigation requires the adoption of the precautionary principle and proactive planning that is enabled through a mitigation hierarchy. Its application is intended to strive to first avoid disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided altogether, to minimise, rehabilitate, and then finally offset any remaining significant residual negative impacts on biodiversity (DEA 2013).

The mitigation measures detailed within this report must be taken into consideration during financial planning of the construction phase of the development. This is to ensure that sufficient funds are available to implement all the measures required to maintain the current PES score of the watercourses impacted upon. Any potential risks must be managed and mitigated to ensure that no deterioration to the water resource takes place. Standard management measures should be implemented to ensure that any on-going activities do not result in a decline in water resource quality. Consideration should also be given to the rehabilitation of the watercourse where feasible. Mitigation measures related to the impacts associated with the construction activities are intended to augment standard/generic mitigation measures included in the project-specific Environmental Management Programme (EMPr).

The monitoring of the development activities is essential to ensure the mitigation measures are implemented. Therefore, compliance with the mitigation recommendations must be audited by a suitably qualified independent Environmental Control Officer with an appropriately timed audit report. In the case where there is extensive damage to any aquatic system, where rehabilitation is required, a suitably qualified aquatic specialist must audit the site. Monitoring for non-compliance must be done on a daily basis by the contractors. Photographic records of all incidents and non-compliances must be retained. This is to ensure that the impacts on the aquatic habitat are adequately managed and mitigated against and the successful rehabilitation of any disturbed areas within any system occurs. Monitoring should especially focus on preventing water pollution, avoiding wetland habitat, and introducing runoff from the development responsibly into the receiving environment. The following mitigation measures must be adhered to and monitored:

9.1 Design Phase and Buffer Area

Aquatic buffer zones are designed to act as barriers between human activities and sensitive water resources in order to protect them from adverse negative impacts. Buffer zones associated with water resources have been shown to perform a wide range of functions and have therefore been adopted as a standard measure to protect water resources and associated biodiversity. An aquatic impact buffer zone is defined as a zone of vegetated land designed and managed so that sediment and pollutant transport carried from source areas via diffuse surface runoff is reduced to acceptable levels (Macfarlane and Bredin 2016).

Regarding any proposed housing development on the property, a buffer area from the boundary of the wetland habitat must be adopted and demarcated. The specific size of the buffer zone was informed by a tool developed by Macfarlane and Bredin (2016) called *Buffer zone guidelines for rivers, wetlands and estuaries*. The aquatic buffer tool developed by Macfarlane *et al.* (2016) was used to determine the aquatic buffer width requirements for the development. The result was a recommended aquatic buffer area (to be considered a No-Go zone) of 10 m from the boundary of the delineated aquatic habitat. This width is sufficient to maintain the aquatic habitat in the current state.

The aquatic assessment and buffer zone determination was conducted after a layout (Alternative A) was already proposed for the development. Alternative A included a community centre on the north eastern side with a swimming pool and stormwater outlet within wetland habitat. This layout would have also required infilling. After the determination of the buffer area the layout was amended to reduce infrastructure. The amended layout was assessed as Alternative B. In this layout the community centre was redesigned to adhere to the buffer. However, as can be seen in Figure 23, part of the development is still proposed within the buffer on the eastern side of the development. However, the aquatic habitat in this area is artificial in nature and likely occur due to a outlet that is located upstream of the wetland habitat in this region. Therefore, the buffer on this piece of wetland was reduced. Alternative B largely complies with the final buffer zone as shown in Figure 23. The little infrastructure that remains within the buffer is unlikely to cause high impacts to the aquatic habitat, but it is still recommended that it be set back to be completely outside the buffer.

The open space proposed below the terrace in the development should serve as adequate to protect aquatic habitat. It is important that the buffer area, as shown in Figure 24 below, be considered as a No-Go zone in order to ensure adequate protection of aquatic resources. No infrastructure should be developed within this area, including stormwater outlets.

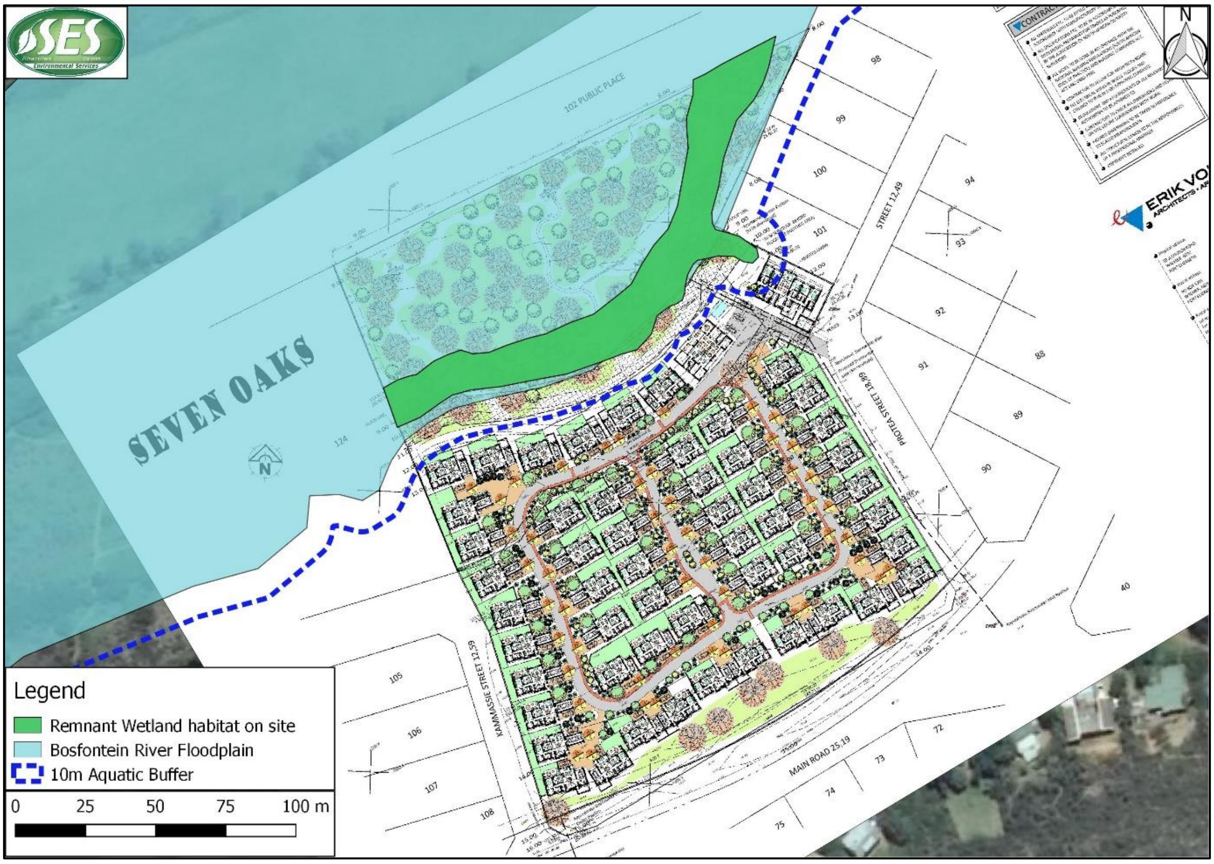

Figure 23: A map showing the recommended 10m buffer from aquatic habitat overlaid on the amended proposed layout: Alternative B

Figure 24: Final 10 m aquatic buffer in relation to the preferred layout: Alternative B

9.2 Construction Phase

- No construction, including workers and vehicles, must be allowed within the buffer area.
- The mitigation of impacts must focus on managing the runoff generated by the development and introducing it responsibly into the receiving environment. The stormwater flows must enter the wetland areas in a diffuse flow pattern without pollutants. Figure 25 and 26 show examples of measures that can be put in place on the terrace to restrict erosion and sedimentation caused by construction activities.

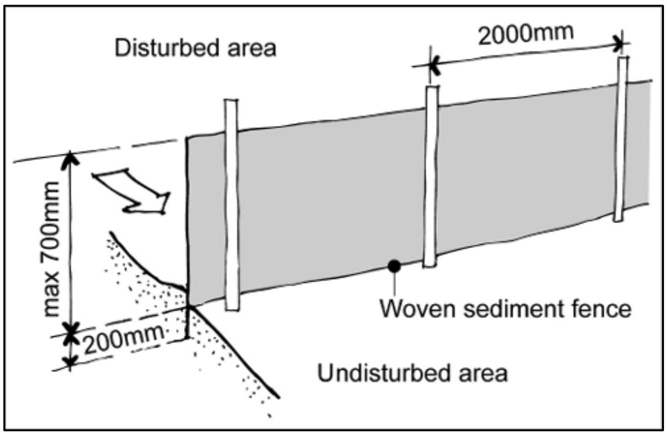

Figure 25: An example of a silt fence, which is a structure that could be put in place to restrict disturbance to the upslope area and it could potentially be used to delineate the buffer area.

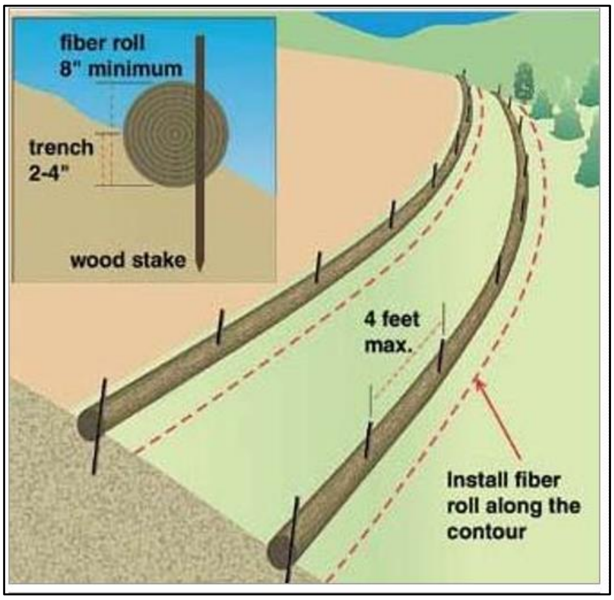

Figure 26: An example of a construction and/or rehabilitation methods to prevent erosion on the hillslope due to any soil disturbance and vegetation clearance

- Soft infrastructure must be considered where practical. For example, permeable surfaces can be done via permeable concrete block pavers (such as Amorflex), brick pavers, stone chip, and gravel and may contribute to slowing surface flows (especially if maintained). Stormwater managed by the development could be discharged into porous channels / swales ('infiltration channels or basins') running near parallel or parallel to contours within and along the edge of the development (Figure 27). This will provide for some filtration and removal of urban pollutants (e.g. oils and hydrocarbons), provide some attenuation by increasing the time runoff takes to reach low points, and reduce the energy of storm water flows within the stormwater system through increased roughness when compared with pipes and concrete V-drains.

Figure 27: Examples of soft infrastructure incorporated into the stormwater management design

- Frequent stormwater outlets must be designed to prevent erosion at discharge points. All erosion protection measures (e.g. Reno-mattresses) must be established to reflect the natural slope of the surface and located at the natural ground level. Structures such as these must be located within the layout footprint and not encroach into the buffer areas. Otherwise the assessment must be amended after the stormwater management plan, location of structures, and designs become available, to incorporate the impact of this encroachment.
- Stormwater exit points must include a best management practice approach to trap any additional suspended solids and pollutants originating from the proposed development. Also include the placement of stormwater grates (or similar). The use of grease traps/oil separators to prevent pollutants from entering the environment from stormwater is recommended. To ensure the efficiency of these, they must be regularly maintained. Key maintenance will include litter and sediment clearing and the servicing and maintenance of key collection points like catch pits, detention tanks etc. Such maintenance should be the responsibility of either the local municipality or, where possible, the relevant owners/estate associations, and budgeted for.
- Stockpiles must not be located within 50 metres of the wetland. The furthest threshold must be adhered to. They should not be placed in vegetated areas that will not be cleared. Erosion control measures including silt fences, low soil berms and/or shutter boards must be put in

place around the stockpiles to limit sediment runoff from stockpiles. Alternatively, the exposed slopes must drain into small temporary stormwater and silt traps/ponds.

- Regular inspections during the operational phase should also be undertaken to ensure that functions are not undermined by inappropriate activities.

9.3 Post-construction/ Rehabilitation Phase

Although it is recommended that no construction should be allowed to occur within or impact upon watercourses under the current proposal, there is always potential for accidental disturbance therefore guidelines for rehabilitation of aquatic habitats are provided. The aim of the rehabilitation is to ensure the necessary procedures are appropriately implemented in the natural environment that may be negatively affected by the development. The plan will promote the re-establishment of the ecological functioning of any area disturbed by construction activities. Also consult WET-RehabEvaluate, WET-RehabMethods (Cowden and Kotze, 2009), and the river rehabilitation manual developed by Day *et al.* 2016, for further information. Important guidelines for rehabilitation are:

- A rehabilitation plan must be compiled with the assistance of a botanist to ensure that the buffer area is revegetated with indigenous plant species in the correct manner. The area must be maintained through alien invasive plant species removal (which is the landowner's responsibility regardless of mitigation associated with this project) and the establishment of indigenous vegetation cover to filter run-off before it enters the freshwater habitat. Please see the Annexure for control options for likely alien invasive plants species.
- The solid domestic waste must be removed and disposed of offsite. All post-construction building material and waste must be cleared in accordance with the EMPr.
- Removal of vegetation must only be when essential for the continuation of the project. Do not allow any disturbance to the adjoining natural vegetation cover or soils. Care must especially be taken near the wetland not to damage the vegetation.
- Erosion features that have developed due to construction within the aquatic habitat due to the project are required to be stabilised. This may also include the need to deactivate any erosion headcuts/rills/gullies that may have developed.
- It is the contractor's responsibility to continuously monitor the area for newly established alien species during the contract and establishment period, which if present must be removed. Removal of these species shall be undertaken in a way which prevents any damage to the remaining indigenous species and inhibits the re-infestation of the cleaned areas.
- Alien/ invasive species shall not be stockpiled. It should be removed from site and dumped at an approved site.

- Any use of herbicides in removing alien plant species is required to be investigated by the ECO before use, for the necessity, type proposed to be used, effectiveness and impacts of the product on aquatic biota.
- A monitoring programme shall be in place, not only to ensure compliance with the EMPr throughout the construction phase, but also to monitor any post-construction environmental issues and impacts such as increased surface runoff. The monitoring should be regular and additional visits must be taken when there is potential risk to the aquatic habitat.

9.4 Operational Phase

- It must be noted that a formal stormwater management plan has not been undertaken. When developing a stormwater management plan for the site, it will be critical that due consideration is given to the collection and treatment of stormwater prior to discharge into the natural environment. It is therefore recommended that the stormwater management plan be developed with appropriate ecological input and be developed based on Sustainable Drainage Systems (SUDS).
- The stormwater management infrastructure must be designed to ensure the runoff from the development is not highly concentrated before entering the buffer area. The volume and velocity of water must be reduced through discharging the surface flow at multiple locations surrounding the development, preventing erosion.
- Any evidence of erosion from this stormwater system must be rehabilitated and the volume/velocity of the water reduced through further structures and/or energy dissipaters. These structures must be incorporated within the layout area and not in the buffer.
- The use and maintenance of grease traps/oil separators to prevent pollutants from entering the environment from stormwater is recommended.
- Appropriate waste water infrastructure must be designed to prevent any such water from entering the surrounding environment.
- Maintenance of the buffer area must be implemented for it to remain effective. Apart from erosion control and alien invasive plant eradication, the encroachment of any further infrastructure or vehicles must be prevented.
- Constructing water tanks to catch rainwater runoff from roofs for watering gardens will reduce stormwater runoff and possible erosion associated therewith. Tanks can also be installed at the communal buildings.
- The local authority should prevent illegal dumping in this area by providing suitable waste disposal facilities where waste can be recycled and disposed of in a controlled manner.
- Engage with the community and Home Owners Association to explain the reasons why the buffer and the water resources are protected and what human activities are allowed. The landowners and community could be involved in the monitoring of the aquatic habitat.

- Placement of signage near the boundary of the buffer zone should also be considered to help mark the boundary and educate the community about the purpose and value of protecting buffer zones. Information can include a description and visual of alien invasive plant species as well as plant name signage for indigenous species. Promoting a sense of ownership from the residents of their open space area will benefit them as well as the environment.

With this specific proposal it could be reasoned that there is potential for enhancing the value of the development through incorporating the buffer areas and wetland conservation. The natural area can be used as a multi-purpose area but activities must be limited to low impact activities, such as pathways and benches. It promotes the use of the open space area that contains freshwater habitat for recreational activities and advocates the adoption and maintenance of a buffer zone. Walkways, such as the proposed boardwalk and bird hides near the wetland for bird viewing are potential uses that are unlikely to impact upon the freshwater habitat.

10 CONCLUSION

The proposed development of Erf 103 and 104, Wittedrift will impact on the Bosfontein River wetland that is situated north of the proposed development area. The wetland habitat is degraded due to various impacts within the catchment such as from agriculture, forestry and urban development. The wetland received a ‘D’ PES score, indicating a Poor system. However, this is an indication of the health of the whole reach of natural wetland adjacent to the development. The fragment of wetland habitat remaining is in better health with dense vegetation cover and no signs of erosion. The wetland’s functional importance is highlighted in its ability to attenuate floods, trap sediment and control erosion. It is recommended that the wetland be maintained in its current state which will allow it to perform valuable ecosystem services.

There are two proposed development layouts, Alternative A and Alternative B, that were assessed in this report. Alternative A is the original layout where development encroaches significantly into aquatic habitat on the eastern side of the development. Alternative B is the amended layout that considers the 10m aquatic buffer. Although some infrastructure still slightly encroaches into the buffer, it is unlikely to cause high impacts to the aquatic habitat. It is however still recommended that infrastructure be set back to be completely outside the buffer.

The proposed development activities will trigger a water use licence in terms of Section 21 (c) and (i) of the National Water Act (Act 36 of 1998). It is recommended that a water use application for this proposed development be submitted to the Breede Gouritz Catchment Management Agency.

11 REFERENCES

ARMITAGE, N., VICE, M., FISHER-JEFFES, L., WINTER, K., SPIEGEL, A., & DUNSTAN, J. 2013. Alternative Technology for Stormwater Management: *The South African Guidelines for Sustainable Drainage Systems.* Report to the Water Research Commission. Pretoria

BITOU LOCAL MUNICIPALITY: SPATIAL DEVELOPMENT FRAMEWORK. 2018.

BROMILOW, C. 2001. Problem Plants of South Africa: a Guide to the Identification and Control of more than 300 invasive plants and other weeds. Briza Publications, Pretoria.

COWDEN, C. & Kotze, D.C. 2009. WETRehabEvaluate: Guidelines for monitoring and evaluating wetland rehabilitation projects. WRC Report No TT 342/09, Water Research Commission, Pretoria.

CSIR (Council for Scientific and Industrial Research). 2010. National Aquatic Ecosystem Priority Areas (NFEPA). Council for Scientific and Industrial Research, Pretoria, South Africa.

DAY, L., ROWNTREE, M., & KING, H. 2016. The Development of a Comprehensive Manual for River Rehabilitation. WRC Report No TT 646/15. Water Research Commission, Pretoria.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, 1999a. Resource Directed Measures for Protection of Water Resources. Volume 4. Wetland Ecosystems Version 1.0, Pretoria.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, 2005. A Practical Field Procedure for Identification and Delineation of Wetland and Riparian areas. Edition 1, September 2005. DWAF, Pretoria.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, 2007. Internal Guideline: Generic Water Use Authorisation Application Process

Department of Water Affairs (DWA), 2014. *Reserve Determination Studies for Surface Water, Groundwater, Estuaries and Wetlands in the Gouritz Water Management Area:* Desktop EcoClassification Report. Prepared by Scherman Colloty & Associates. Report no. RDM/WMA16/00/CON/0213.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY. 2009. DWAF Training Manual: National Water Act Section 21(c) and (i) Water Uses. Version: November 2009.

DRIVER, A., NEL, J.L., SNADDON, K., MURRAY, K., ROUX, D.J., HILL, L., SWARTZ, E.R., MANUEL, J. AND FUNKE, N. 2011. *Implementation Manual for Aquatic Ecosystem Priority Areas. Report to the Water Research Commission*. Pretoria

DWAF. 2008. Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas, prepared by M. Rountree, A. L. Batchelor, J. MacKenzie and D. Hoare. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa

Fraser Consulting Civil Engineers cc. 2019. Proposed development on Erven 103 and 104, Wittedrift, Plettenberg Bay: Floodline Information.

KLEYNHANS, C.J., 1996. Index of Habitat Integrity (IHI).

KOTZE, D.C., MARNEWECK, G.C., BATCHELOR, A.L., LINDLEY, D.S. AND COLLINS, N.B. 2009. WET-Ecoservices: A technique for rapidly assessing ecosystem services supplied by wetlands.

LAWRENCE, D.P., 2007. Impact significance determination - Designing an approach. Environmental Impact Assessment Review 27: 730 - 754.

MACFARLANE, D.M. and Bredin, I.P. 2016. Buffer zone guidelines for rivers, wetlands and estuaries. Part 2: Practical Guide. WRC Report No (tbc), Water Research Commission, Pretoria.

MACFARLANE, D.M., KOTZE, D.C., ELLERY, W.N., WALTERS, D., KOOPMAN, V., GOODMAN, P. & GOGE, C. 2008. WET-Health: A technique for rapidly assessing wetland health, Version 2.

MUCINA, L. AND RUTHERFORD, M. C. (EDS) 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

NAIMAN, R.J., AND H. DECAMPS. 1997. The ecology of interfaces -- riparian zones. Annual Review of Ecology and Systematics 28:621-658

OLLIS, D.J., SNADDON, C.D., JOB, N.M. & MBONA, N. 2013. Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems. *SANBI Biodiversity Series* 22. South African National Biodiversity Institute, Pretoria.

ROGERS KH. 1995. Riparian Wetlands. In: Wetlands of South Africa, Cowan GI (ed). Department of Environmental Affairs and Tourism: Pretoria.

SOUTH AFRICAN NATIONAL PARKS. 2014. Outeniqua National Park: State of Knowledge. South African National Parks unpublished report.

TURPIE J; Taljaard S; van Niekerk L; Adams J; Wooldridge T; Cyrus D; Clark B; & Forbes N. 2013. The Estuary Health Index: A standardised metric for use in estuary management and the determination of ecological water requirements. WRC Report No 1930/1/12.

VAN GINKEL, C.E., GLEN, R.P., GORDAN-GRAY, K.D., CILLIERS, C.J., MUASYA AND VAN DEVENTER, P.P., 2011. Easy identification of some South African Wetland Plants (Grasses, Resticios, Sedges, Rushes, Bulrushes, Eriocaulons and Yellow-eyed grasses). WRC Report No. TT 459/10.

12 ANNEXURE (METHODOLOGIES)

12.1 Wetland delineation and HGM type identification

Wetland delineation includes the confirmation of the occurrence of wetland and a determination of the outermost edge of the wetland. The outer boundary of wetlands was identified and delineated according to the Department of Water Affairs wetland delineation manual 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005a). Wetland indicators were used in the field delineation of the wetlands: position in landscape, vegetation and soil wetness (determined through soil sampling with a soil auger and the examining the degree of mottling).

Four specific wetland indicators were used in the detailed field delineation of wetlands, which include:

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur.
- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation.
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

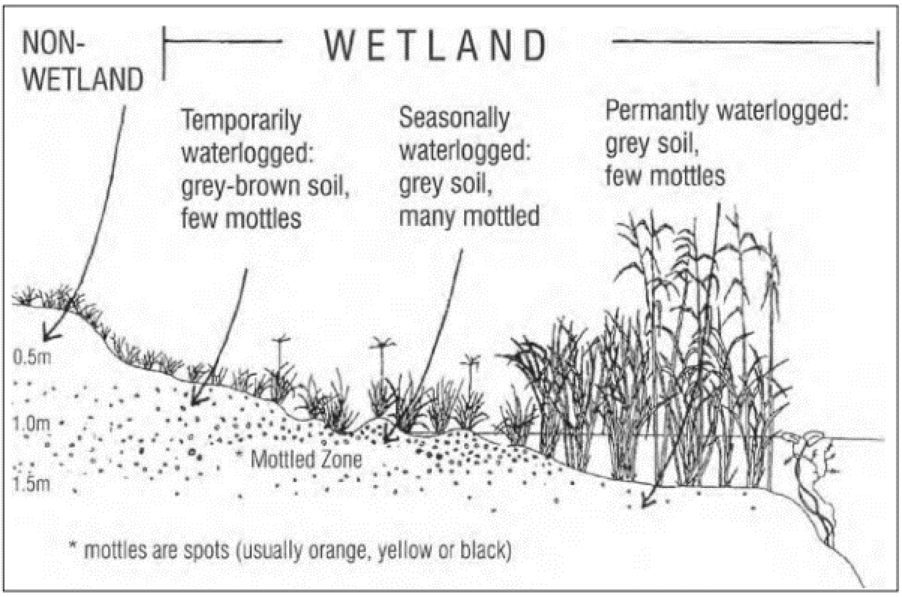

Figure A11.1a: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change as one moves along a gradient of decreasing wetness, from the middle to the edge of the wetland. Source: Donovan Kotze, University of KwaZulu-Natal.

According to the wetland definition used in the National Water Act, vegetation is the primary indicator, which must be present under normal circumstances. However, in practise the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role. The reason is that vegetation responds relatively quickly to changes in soil moisture regime or management and may be transformed; whereas the morphological indicators in the soil are far more permanent and will hold the signs of frequent saturation long after a wetland has been drained (perhaps for several centuries).

The permanent, seasonal and temporary wetness zones can be characterised to some extent by the soil wetness indicators that they display (Table A11.1a)

A11.1a: Soil Wetness Indicators in the various wetland zones

TEMPORARY ZONE	SEASONAL ZONE	PERMANENT ZONE
Minimal grey matrix (<10%)	Grey matrix (<10%)	Prominent grey matrix
Few high chroma mottles	Many low chroma mottles present	Few to no high chroma mottles
Short periods of saturation (less than three months per annum)	Significant periods of wetness (at least three months per annum)	Wetness all year round (possible sulphuric odour)

Table A11.1b: Relationship between wetness zones and vegetation types and classification of plants according to occurrence in wetlands

VEGETATION	TEMPORARY WETNESS ZONE	SEASONAL WETNESS ZONE	PERMANENT WETNESS ZONE
Herbaceous	Predominantly grass species; mixture of species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas	Hydrophilic sedges and grasses restricted to wetland areas	Dominated by: (1) emergent plants, including reeds (*Phragmites australis*), a mixture of sedges and bulrushes (Typha capensis), usually >1m tall; or (2) floating or submerged aquatic plants.
Woody	Mixture of woody species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas.	Hydrophilic woody species restricted to wetland areas	Hydrophilic woody species, which are restricted to wetland areas. Morphological adaptations to prolonged wetness (e.g. prop roots).
SYMBOL	**HYDRIC STATUS**	**DESCRIPTION/OCCURRENCE**	
Ow	Obligate wetland species	Almost always grow in wetlands (>90% occurrence)	
Fw/F+	Facultative wetland species	Usually grow in wetlands (67-99% occurrence) but occasionally found in non-wetland areas	

F	Facultative species	Equally likely to grow in wetlands (34-66% occurrence) and non-wetland areas
Fd/F-	Facultative dryland species	Usually grow in non-wetland areas but sometimes grow in wetlands (1-34% occurrence)
D	Dryland species	Almost always grow in drylands

In order to identify the wetland types, using Kotze *et al.* (2009) and Ollie *et al*. (2013), a characterisation of hydrogeomorphic (HGM) types was conducted. These have been defined based on the geomorphic setting of the wetland in the landscape (e.g. hillslope or valley bottom, whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated), how water flows through the wetland (diffusely or channelled) and how water exits the wetland (Figure A11.1b).

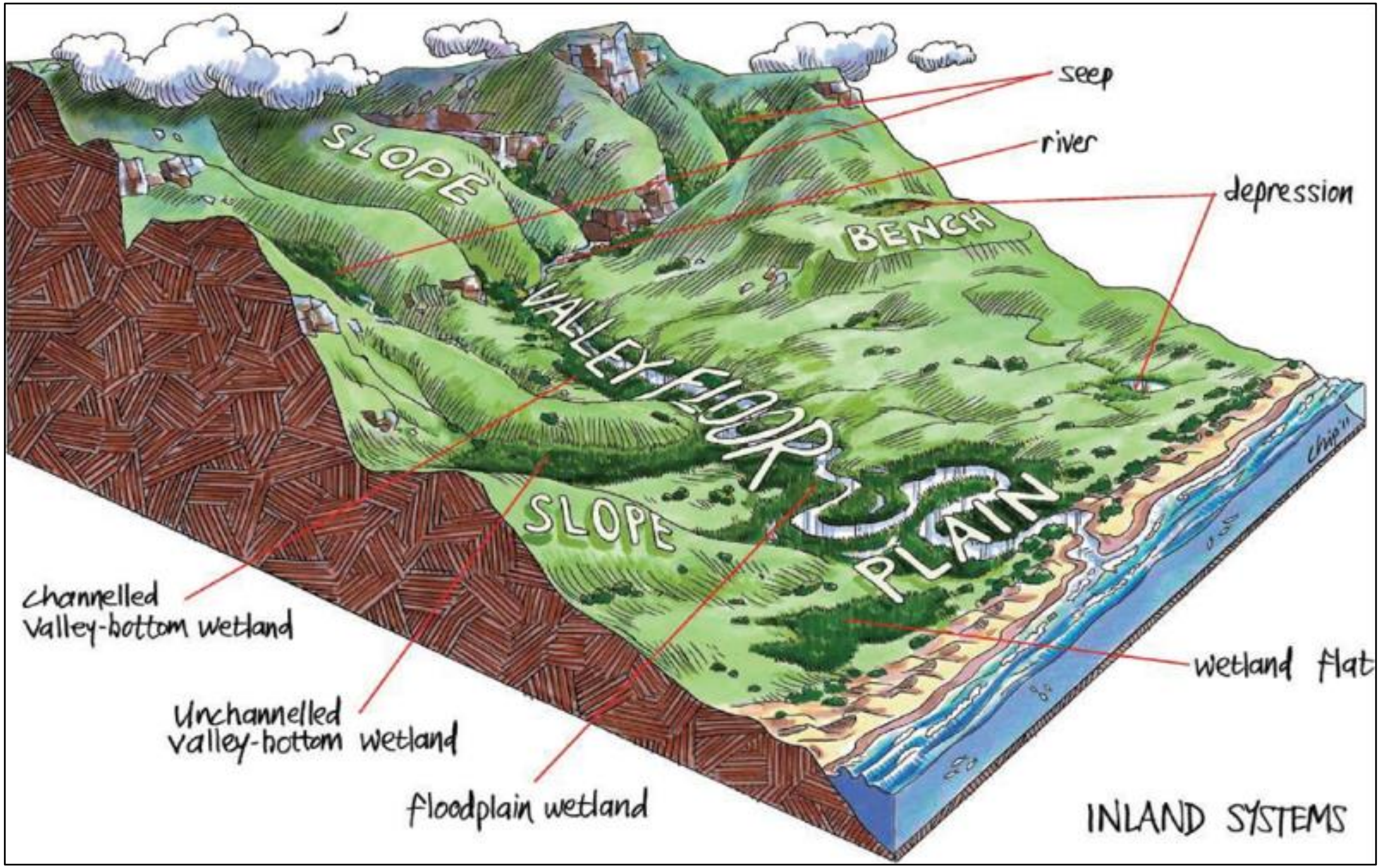

Figure A11.1b: Illustration of wetland types and their typical landscape setting (From Ollie <u>et al.</u> 2013)

12.2 Delineation of Riparian Areas

Riparian zones are described as "the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas" i , Riparian zones can be thus be distinguished from adjacent terrestrial areas through their association with the physical structure (banks) of the river or stream, as well as the distinctive structural and compositional vegetation zones between the riparian and upland terrestrial areas. Unlike wetland areas, riparian zones are usually not saturated for a long enough duration for redoxymorphic features to develop. Riparian zones instead develop in response to (and are adapted to) the physical disturbances caused by frequent overbank flooding from the associated river or stream channel.

Like wetlands, riparian areas can be identified using a set of indicators. The indicators for riparian areas are:

- **Landscape position**;
- **Alluvial soils** and recently deposited material;
- **Topography** associated with riparian areas; and
- **Vegetation** associated with riparian areas.

Landscape Position

A typical landscape can be divided into 5 main units, namely the:

- Crest (hilltop);
- Scarp (cliff);
- Midslope (often a convex slope);
- Footslope (often a concave slope); and
- Valley bottom.

Amongst these landscape units, riparian areas are only likely to develop on the valley bottom landscape units (i.e. adjacent to the river or stream channels; along the banks comprised of the sediment deposited by the channel). Alluvial soils are soils derived from material deposited by flowing water, especially in the valleys of large rivers. Riparian areas often, but not always, have alluvial soils. Whilst the presence of alluvial soils cannot always be used as a primary indicator to accurately delineate riparian areas, it can be used to confirm the topographical and vegetative indicators.

Quaternary **alluvial soil** deposits are often indicated on geological maps, and whilst the extent of these quaternary alluvial deposits usually far exceeds the extent of the contemporary riparian zone; such indicators are useful in identifying areas of the landscape where wider riparian zones may be expected to occur.

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

As with the delineation approach for wetlands, the field delineation method for riparian areas focuses on two main indicators of riparian zones:

- **Vegetation Indicators**, and
- **Topography** of the banks of the river or stream.

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

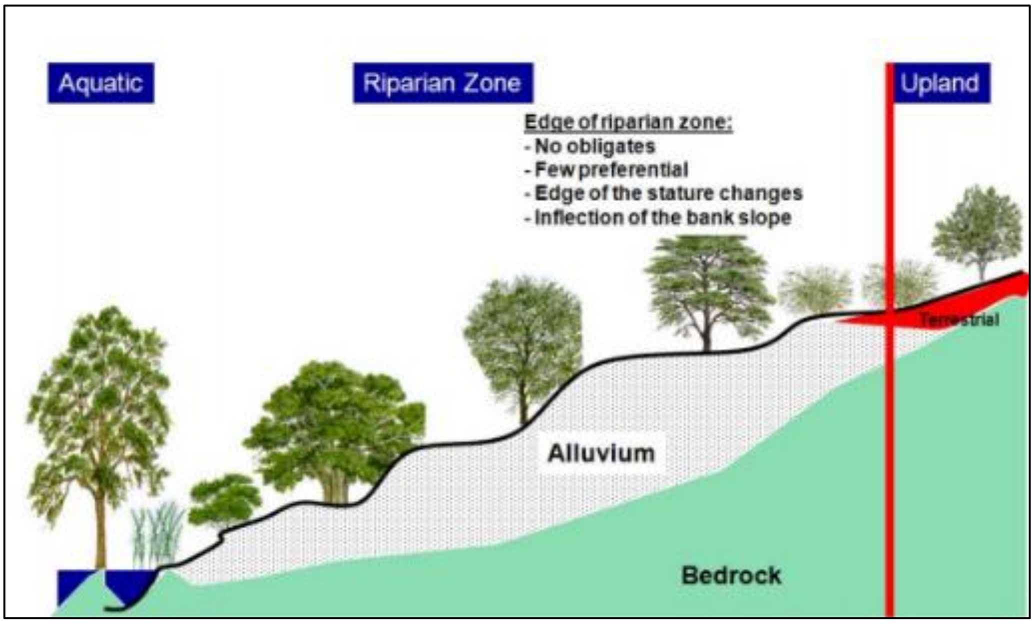

Figure A11.2a: A schematic diagram illustrating the edge of the riparian zone on one bank of a large river. Note the coincidence of the inflection (in slope) on the bank with the change in vegetation structure and composition. The edge of the riparian zone coincides with an inflection point on the bank; where there are not obligates upslope; few preferential. The boundary also coincides with the outer edge of the stature differences (DWAF 2008).

12.3 Present Ecological State (PES) – Wetlands

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

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

- **Hydrology** is defined in this context as the distribution and movement of water through a wetland and its soils. This module focuses on changes in water inputs as a result of changes in catchment activities and characteristics that affect water supply and its timing, as well as on modifications within the wetland that alter the water distribution and retention patterns within the wetland.
- **Geomorphology** is defined in this context as the distribution and retention patterns of sediment within the wetland. This module focuses on evaluating current geomorphic health through the presence of indicators of excessive sediment inputs and/or losses for clastic (minerogenic) and organic sediment (peat).
- **Vegetation** is defined in this context as the vegetation structural and compositional state. This module evaluates changes in vegetation composition and structure as a consequence of current and historic onsite transformation and/or disturbance.

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. The tool attempts to standardise the way that impacts are calculated and presented across each of the modules. This takes the form of assessing the spatial extent of impact of individual activities and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact (Table A11.2a).

Table A11.2a: Guideline for interpreting the magnitude of impacts on integrity (Macfarlane et al., 2008).

Impact Category	Description	Score
None	No discernible modification or the modification is such that it has no impact on this component of wetland integrity.	0 – 0.9
Small	Although identifiable, the impact of this modification on this component of wetland integrity is small.	1 – 1.9
Moderate	The impact of this modification on this component of wetland integrity is clearly identifiable, but limited.	2 – 3.9
Large	The modification has a clearly detrimental impact on this component of wetland integrity. Approximately 50% of wetland integrity has been lost.	4 – 5.9
Serious	The modification has a highly detrimental effect on this component of wetland integrity. Much of the wetland integrity has been lost but remaining integrity is still clearly identifiable.	6 – 7.9
Critical	The modification is so great that the ecosystem processes of this component of wetland integrity are almost totally destroyed, and 80% or more of the integrity has been lost.	8 – 10

Impact scores obtained for each of the modules reflect the degree of change from natural reference conditions. Resultant health scores fall into one of six health categories (A-F) on a gradient from "unmodified/natural" (Category A) to "severe/complete deviation from natural" (Category F) as depicted in Table A11.2b, below. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic systems.

Table A11.2b. Health categories used by WET-Health for describing the integrity of wetlands (after Macfarlane et al., 2008).

Impact Category	Description	Range	PES 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	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**

An overall wetland health score was calculated by weighting the scores obtained for each module and combining them to give an overall combined score using the following formula:

Overall health rating = [(Hydrology*3) + (Geomorphology*2) + (Vegetation*2)] / 7

This overall score assists in providing an overall indication of wetland health/functionality which can in turn be used for recommending appropriate management measures.

12.4 Wetland Functional Importance (Goods and Services)

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

The overall goal of WET-EcoServices is to assist decision makers, government officials, planners, consultants and educators in undertaking quick assessments of wetlands, specifically in order to reveal the ecosystem services that they supply. This allows for more informed planning and decision making. WET-EcoServices includes the assessment of several ecosystem services (listed in Table A11.4a) - that is, the benefits provided to people by the ecosystem.

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

Table A11.4a: Ecosystem services assessed by WET-Ecoservices

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

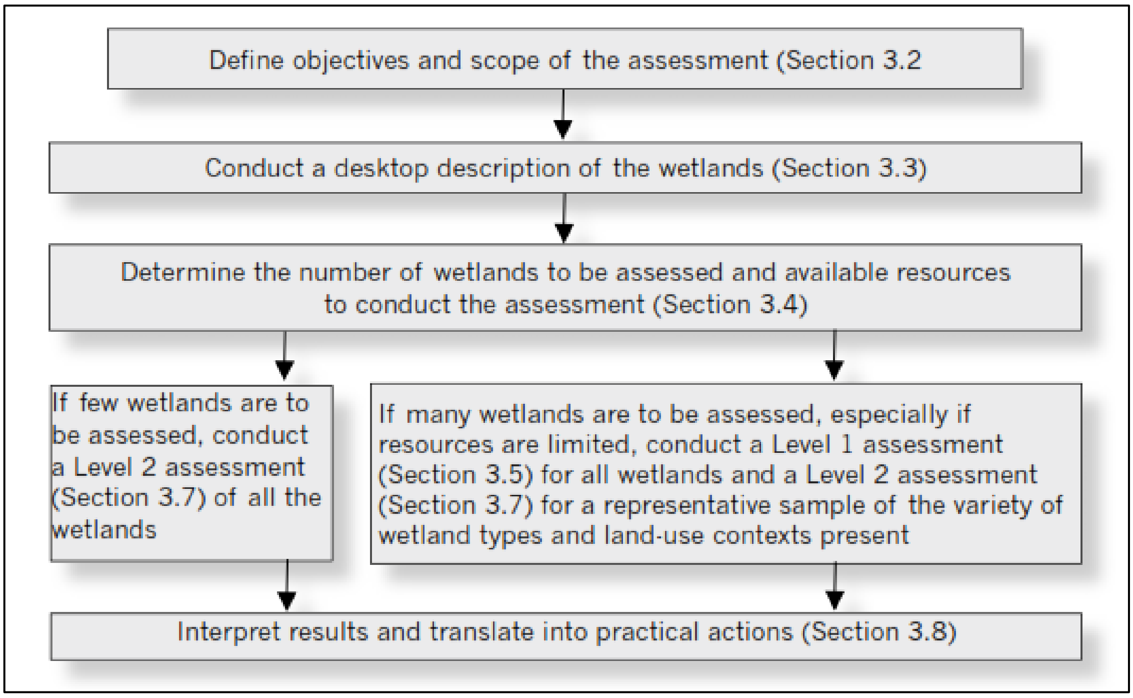

Figure A11.4a: Steps required for Wet-EcoServices. The sections referred to within this figure relate back to the Wetland Management Series: Wet-Ecoservices. WRC Report TT 339/08

12.5 Ecological Importance & Sensitivity (EIS) - Wetlands

The Ecological Importance and Sensitivity was determined by utilising a rapid scoring system. The system has been developed to provide a scoring approach for assessing the Ecological, Hydrological Functions; and Direct Human Benefits of importance and sensitivity of wetlands. These scoring assessments for these three aspects of wetland importance and sensitivity have been based on the requirements of the NWA, the original Ecological Importance and Sensitivity assessments developed for riverine assessments (DWAF, 1999), and the work conducted by Kotze et al (2008) on the assessment of wetland ecological goods and services from the WET-EcoServices tool (Rountree, 2010). An example of the scoring sheet is attached as Table A11.5a. The scores are then placed into a category of very low, low, moderate, high and very high as shown in Table 14.5b.

Table A11.5a: Example of scoring sheet for Ecological Importance and sensitivity

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

Table A11.5b: Category of score for the Ecological Importance and Sensitivity

RATING	EXPLANATION
None, Rating = 0	Rarely sensitive to changes in water quality/hydrological regime
Low, Rating =1	One or a few elements sensitive to changes in water quality/hydrological regime
Moderate, Rating =2	Some elements sensitive to changes in water quality/hydrological regime
High, Rating =3	Many elements sensitive to changes in water quality/ hydrological regime
Very high, Rating =4	Very many elements sensitive to changes in water quality/ hydrological regime

12.6 Present Ecological State (PES) – Riparian

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

DWAF have developed a modified IHI, designed to accommodate the time constraints associated with desktop assessments or for instances where a rapid assessment of river conditions is required. The protocol does not distinguish between instream and riparian habitat and addresses six simple metrics to obtain an indication of Present Ecological State (PES). Each of the criteria are rated on a scale of 0 (close to natural) to 5 (critically modified) (Table A11.6a) according to the following metrics:

- Bed modification
- Flow modification
- Inundation
- Bank condition
- Riparian zone condition
- Water quality modification

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

Table A11.6a: The rating scale for each of the various metrics in the assessment

Rating Score	Impact Class	Description
0	**None**	*No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.*
0.5 - 1.0	**Low**	*The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.*
1.5 - 2.0	**Moderate**	*The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.*
2.5 - 3.0	**Large**	*The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.*
3.5 - 4.0	**Serious**	*The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.*
4.5 - 5.0	**Critical**	*The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.*

The six metric ratings of the HGM under assessment are then averaged, resulting in one value. This value determines the Habitat Integrity PES category for the HGM (Table A11.6b).

Table A11.6b: The habitat integrity PES categories

Habitat Integrity PES Category	Description
A: Natural	Unmodified, natural.
B: Good	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: Fair	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D: Poor	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E: Seriously modified	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F: Critically modified	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.

12.7 Ecological Importance & Sensitivity – Riparian

The ecological importance of a wetland/river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Kleynhans & Louw, 2007; Resh et al., 1988; Milner, 1994). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity (Table A11.7a).

Table A11.7a: Components considered for the assessment of the ecological importance and sensitivity of a riparian system. An example of the scoring has also been provided.

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

The scores assigned to the criteria in Table A11.7a were used to rate the overall EIS of each mapped unit according to Table A11.7b, below, which was based on the criteria used by DWS for river eco-classification (Kleynhans & Louw, 2007) and the WET-Health wetland integrity assessment method (Macfarlane et al., 2008).

Table A11.7b: The ratings associated with the assessment of the EIA for riparian areas

Rating	Explanation
None, Rating = 0	Rarely sensitive to changes in water quality/hydrological regime
Low, Rating =1	One or a few elements sensitive to changes in water quality/hydrological regime
Moderate, Rating =2	Some elements sensitive to changes in water quality/hydrological regime
High, Rating =3	Many elements sensitive to changes in water quality/ hydrological regime
Very high, Rating =4	Very many elements sensitive to changes in water quality/ hydrological regime

12.8 Direct, Indirect and Cumulative Impacts Methodology

Direct, indirect and cumulative impacts should be assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high).
- The **duration**, wherein it will be indicated whether:
    - The lifetime of the impact will be of a very short duration (0-1 years) – assigned a score of 1.
    - The lifetime of the impact will be of short duration (2-5 years) – assigned a score of 2;
    - Medium term (5-15 years) – assigned a score of 3;
    - Long-term (> 15 years) – assigned a score of 4; or
    - Permanent – assigned a score of 5.

- The **magnitude**, quantified on a scale of 0-10, where:
    - 0 is small and will have no effect on the environment,
    - 2 is minor and will not result in an impact on processes,
    - 4 is low and will cause a slight impact on processes,
    - 6 is moderate and will result in processes continuing but in a modified way,
    - 8 is high (processes are altered to the extent that they temporarily cease), and
    - 10 is very high and results in complete destruction of patterns and permanent cessation of processes.

- The **probability** of occurrence, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1-5, where:
    - 1 is very improbable (probably will not happen),
    - 2 is improbable (some possibility, but low likelihood),
    - 3 is probable (distinct possibility),
    - 4 is highly likely (most likely) and;
    - 5 is definite (impact will occur regardless of any prevention measures).

- The **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high;

- The degree to which the impact can be reversed.
- The degree to which the impact may cause irreplaceable loss of resources; and
- The degree to which the impact can be mitigated.
- The significance is calculated by combining the criteria in the following formula, **S = (E+D+M) P**, where:
    - S = significance weighting
    - E = extent
    - D = duration
    - M = magnitude
    - P = probability

- The significance weightings for each potential impact are as follows:
    - <30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop the area),
    - 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
    - >60 points: High (i.e. where the impact must have an influence on the decision process to develop the area).

13 ANNEXURE: ALIEN INVASIVE PLANT CONTROL

Table showing control options for likely alien invasive plants species (Adapted from Day et al. 2016)

Acacia cyclops (Rooikrans)		**Manual:** Hand pulling or hoeing of seedlings or saplings. Grubbing, hoeing and digging out of immature stage up to 2 m. Felling and cutting of stump to the ground for larger mature trees. **Bio-Control:** Indigenous field mice eat the seeds. Rooikrans seed weevil. Flower galler (*Dasineura dielsi* Rubsaamen). Seed feeder (*Melanterius servulus*).
Acacia mearnsii *(Black Wattle)*		**Manual:** Hand pulling of seedlings or saplings <40 cm. Grubbing. Hoeing. Digging of immature trees up to 2 m. Felling used for large mature trees. Ringing, ring of 10 cm width in large plants. **Chemical:** Seedlings – Mamba, Garlon 4, Viroaxe. Tree stumps – Timbrel 3A. **Bio Control:** Stump fungus *(Cylindrobasidium laeve)* applied to freshly cut stumps. Seed weevil (*Melanterius maculates*).

Arundo donax (Spanish Reed)		**Manual:** Repeated removal. Cutting of stalks. However, cut stalks can re-root and manual methods generally unsustainable. **Chemical:** 3Apply MAMBA or Nexus GLYPHOSATE 360 Reg. NO L7113: Act /Wet no 36/ 1947. This is a broad spectrum herbicide so applicable in dense monospecific stands. Ideally use as foliar spray, just before winter (as this is the time that translocation in plant nutrients to the root-mass takes place in preparation for winter dormancy and toxin transfer to roots is most effective. If stands too dense for good foliar application, cut stems and then apply as foliar to resprouting material – but note that cut material may resprout and transfer to roots less effective as cutting stimulates stem growth. If mixed stands, use GLYPHOSATE 360, on cut stems, but note less effective.
Lantana camara		**Manual:** Hand pulling of seedlings or saplings. Grubbing or hoeing of small patches. Cutting is ineffective as plant coppices use of herbicides needed. Large infestation should be crushed or rolled with brush cutters then stumps treated with herbicides. **Chemical:** Seedlings/ saplings – Mamba/Kilo Touchdown / Access. Mature tree stumps – Chopper / Access/ Timbrel 3A. **Bio Control:** Flower galler (Aceria *lantanae* Cook). Leaf miner (*Calycomyza lantanae*). Leaf sucker (Falconia intermedia). Leaf feeder (*Hypena laceratalis* Walker). Leaf miner (*Octotoma scabripennis* Guerin-Meneville). Leaf miner (*Ophiomyia camarae* Spencer). Seed miner (*Ophiomyia lantanae*). Leaf & flower sucker (*Teleonemia scrupulosa* Stal). Leaf miner (*Uroplata girardi* Pic).
Pennisetum clandestinum (Kikuyu grass)		**Manual:** hand pull by roots; kikuyu often associated with raised fill / disturbed areas – removal will reduce invasion opportunities; Inclusion of hard paths on upland edge of river, buffer or wetland provides hard management edge from which to manage invasion and also reduces to some extent root spread **Chemical:** Spray with Roundup ® while grass is actively growing (not when dormant) and follow up spray any regrowth after 4 months.

Rubus spp (Bramble)		**Chemical:** Mamba max – most effective in autumn when downward sap movement.
Cirsium vulgare (Scottish Thistle)		**Manual:** hand pull
Hedychium gardnerianum (Kahili ginger lily)		**Manual:** hand pull