Aquatic Specialist Impact Assessment for the Section 24G and Water Use License Applications required for the proposed Village Ridge housing development on Erven 21028 and 21029, George

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DECLARATION OF CONSULTANTS INDEPENDANCE

I consider myself bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP);

• At the time of conducting the study and compiling this report I did not have any interest, hidden or otherwise, in the proposed development that this study has reference to, except for financial compensation for work done in a professional capacity;

• Work performed for this study was done in an objective manner. Even if this study results in views and findings that are not favourable to the client/applicant, I will not be affected in any manner by the outcome of any environmental process of which this report may form a part, other than being members of the general public;

• I declare that there are no circumstances that may compromise my objectivity in performing this specialist investigation. I do not necessarily object to or endorse any proposed developments, but aim to present facts, findings and recommendations based on relevant professional experience and scientific data;

• I do not have any influence over decisions made by the governing authorities;

• I undertake to disclose all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by a competent authority to such a relevant authority and the applicant;

• I have the necessary qualifications and guidance from professional experts in conducting specialist reports relevant to this application, including knowledge of the relevant Act, regulations and any guidelines that have relevance to the proposed activity;

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• All the particulars furnished by me in this document are true and correct.

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Expertise: > 10 years' experience working on aquatic ecosystems across South Africa, with a focus on the Southern Cape in the last 3 years. Includes research and consulting expertise, having published > 10 water-related research articles and compiled > 80 aquatic specialist reports. Research and consulting have been in a range of sectors including agriculture, urban developments, linear structures, renewable energy, conservation, and mining.

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1. ABBREVIATIONS AND GLOSSARY

BGCMA	Breede-Gouritz Catchment Management Agency
DEADP	Department of Environmental Affairs and Development Planning
Endangered	According to the IUCN Red List: species that possess a very high risk of extinction as a result of rapid population declines of 50 to more than 70 percent over the previous 10 years; a current population size of fewer than 250 individuals, or other factors.
Endemic	(or organisms or disease) having a distribution limited to a particular geographical area such as an island.
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
SCC	Species of Conservation Concern
WULA	Water Use License Application

2. INTRODUCTION

2.1 Background

Confluent Environmental (Pty) Ltd were appointed by Power Construction (Pty) Ltd to conduct an aquatic specialist impact assessment of a proposed high density housing settlement proposed for development on Erven 21028 and 21029 in George, Western Cape. The site is in the suburb of King George Park.

In May 2021 the developer commenced with clearing the site for construction prior to obtaining environmental authorisations required due to the presence of wetlands in close proximity, and within the footprint of the development. A wetland on Erf 21028 was excavated and partially infilled during the initial clearing activities. Clearing of riparian vegetation along a steep slope adjacent to the Camphersdrift Wetland had also been undertaken. Upon receipt of a directive from the Department of Environmental Affairs and Development Planning (DEA&DP) Power Construction appointed Confluent Environmental to delineate wetland and buffer areas on the site which were to be treated as no-go areas while construction could continue around these areas. Subsequently, the Breede-Gouritz Catchment Management Agency (BGCMA) issued a directive instructing the developer to cease all construction within the regulated area (500 m) of the wetlands, which in effect covered the entire site. Construction activities therefore ceased towards the end of August 2021 pending authorisations from both regulating authorities. This report provides the necessary aquatic specialist inputs to both the Section 24G application in terms of the National Environmental Management Act and the Water Use License Application (WULA) in terms of the National Water Act (Act No. 36 of 1998).

The original development layout was approved by the George Municipality Planning and Development Directorate in September 2020 and included closure and consolidation of a public road (Loch Lomondry Avenue) which dissected Erf 21028 and 21029; rezoning of the consolidated property from General Residential Zone II to a sub-divisional area consisting of multiple units (explained further) and a departure of the land-use planning by-law which resulted in a reduced requirement for parking bays. Options for fundamentally revising the entire development are therefore limited.

2.2 Terms of Reference

- Conduct site visits to verify the presence of wetlands;
- Conduct a desktop study that considers the site within the catchment context including the management and conservation of water resources;
- Determine the Present Ecological State (PES), Ecological Importance and Sensitivity (EIS) and conservation significance of identified wetlands;
- Compile an aquatic specialist report that assesses alternative layout options for the development in terms of their impacts during the construction and operational phases, and recommend mitigation measures to address the impacts.

2.3 Assumptions and Limitations

- Every effort has been made to pre-empt and foresee the impacts associated with all anticipated phases of the proposed development. Nonetheless, it is possible that unanticipated impacts may occur. The exclusion of these impacts from this report does

not lessen their relevance, and the developer must exercise a duty of care to mitigate negative impacts throughout all phases of the development.

- This assessment has benefitted from numerous site visits conducted over at least 8 months covering a range of seasons and weather events. However, it is still feasible that additional sensitive species or habitats were missed due to disturbance of the site, or seasonal variation in their presence / absence. The emphasis on protecting wetland habitat and buffers aims to address this limitation.

3. DESCRIPTION OF THE DEVELOPMENT

3.1 Current state of the site

As stated, construction work commenced on the site until a compliance notice was received from DEA&DP which restricted work to areas outside of wetlands and their buffers. Construction works therefore continued outside of the No-Go areas until the directive from the BGCMA instructed Power Construction to cease work in the regulated area of the wetlands (the entire development site). Construction had already progressed to a substantial degree when the site was closed pending environmental authorisations. The delineated wetland areas and 19m buffers indicated in Figure 1 were determined in the early phases of Confluent Environmental's appointment and were used to determine where the No-Go areas for construction would be. These are explained in more detail in this report.

Figure 1. Development site overview indicating before and after construction work commenced.

An area of riparian vegetation measuring 1 928 m^2 was cleared down a steep slope towards the Camphersdrift Wetland on Erf 21029. The potential for soil erosion was immediately mitigated through the installation of soil protection measures including seeding with Oats, laying of soil mats, and installation of silt fences (Erosion control on slope in Figure 1; Confluent Environmental, Immediate Mitigation V3; Figure 2). Unfortunately, heavy rainfall on 22 November 2021 resulted in a soil slippage at the base of the slope which will need to be reinforced and rehabilitated.

Figure 2. Photo of the area where riparian vegetation was cleared (left) subsequently stabilised with soil erosion control measures (right), and where a slip occurred following heavy rainfall on 22 November 2021 (below).

The wetland flat area on Erf 21028 was cleared of vegetation and excavated, and a large quantity of soil was placed over approximately one third of the area. Following the initial delineation and demarcation of the No Go area, most of the fill was removed. Over the course of 6-8 months of good rainfall, wetland vegetation started to regenerate, and there is frequently standing water on the surface which attracts waterfowl such as Egyptian Geese and Yellow-billed Ducks (Figure 3).

During repeated site visits it was apparent that numerous frogs were inhabiting the wetland flat area due to obvious calling and tadpoles present in the standing water. Therefore, an amphibian specialist was appointed (Ferdi De Lange) in October 2021 to conduct a survey of frogs at the site and to confirm whether any Species of Conservation Concern (SCC) are present at the site. The results of this study confirmed the presence of a significant population of Knysna Leaf-folding frogs (*Afrixalus knysnae*; tadpoles, adults, and eggs). The IUCN (International Union for the Conservation of Nature) lists *A. knysnae* as an Endangered species. An additional 7 to 8 amphibian species were identified in the wetland which significantly elevates its conservation status (Ekologik, Phase 1 Assessment, Nov. 2021).

Good water quality with high clarity is an important requirement for *A. knysnae*. Events such as increased turbidity following heavy rainfall on 22 November therefore need to be considered and mitigated in future construction and operational phase activities (Figure 3). The

environmental requirements for *A. knysnae* are discussed in more detail in the Ekologic report (F. De Lange, 2022).

Figure 3. Photo of the wetland flat immediately after it was excavated, partially infilled and delineated (top left), approximately 3 months following removal of the infill material and cessation of work in the area (top right), water quality following heavy rainfall on 22/11/21 (bottom left), and following extensive regrowth of vegetation and good rains (bottom right).

As indicated in Figure 1, the site currently has large areas of exposed soil with no vegetated cover and is therefore vulnerable to significant soil erosion which could result in sedimentation of the Camphersdrift Wetland. Therefore, prior to closing the site, several soil erosion prevention measures were implemented at various points across the site. These include the installation of hay bale check dams, sandbag dams, silt fencing and seeding soil stockpiles with Oats and Ryegrass.

3.2 Proposed development alternatives

The approved development plan was approved in September 2020 by the George Municipality and is the first development option considered in this assessment (See Appendix 1 for the complete plan). After extensive site investigations and the amphibian survey, the alternative development plan was revised based on specialist (aquatic and amphibian) inputs and is referred to as the preferred development plan (Appendix 2). A summary of the sub-divisional zones in the approved versus the preferred plans is provided in Table 1.

The preferred plan has incorporated a total area of 7 598 m2 of Open Space Zone 3 which was not included in the approved plan. This consists of the wetland flat and 19 m buffer area,

as well as the green corridor linking the wetland flat to the Camphersdrift Wetland. The preferred plan also has a slight increase in Open Space Zone 1 which includes an area of land adjacent to the wetland flat buffer, as well as the 19 m buffer along the Camphersdrift Wetland. This is a substantial increase in open space dedicated to the conservation and protection of wetlands and associated flora and fauna.

Table 1. Summary of sub-divisional zones in the approved and proposed alternative layout for Village Ridge.

Sub-divisional zones	Approved plan	Area (m^2)	Preferred plan	Area (m^2)
Single residential zone 1	99	16 849	95	16 577
General residential zone 3	86	5 995	60	4 035
Business zone 3	3	298	3	304
Community zone 1	1	1 005	0	0
Utility zone (cell phone tower)	1	44	1	69
Open space zone 1	11	5 545	8	6 175
Open space zone 3	0	0	2	7 598
Transport Zone 2	-	15 473	-	10 453
Total area		45 211 m^2		45 210 m^2

4. CATCHMENT CONTEXT

The site is in quaternary catchment **K30B** and drains in a south-easterly direction to the Camphersdrift Wetland (Figure 4). The Camphersdrift Wetland adjacent to the site is an extensive Channelled Valley Bottom Wetland and originates from the Camphersdrift River which drains a portion of the southern slopes of the Outeniqua Mountains above the suburb of Glen Barrie. The Camphersdrift system is a tributary of the Gwaing River, which drains to the sea approximately 12 km to the south.

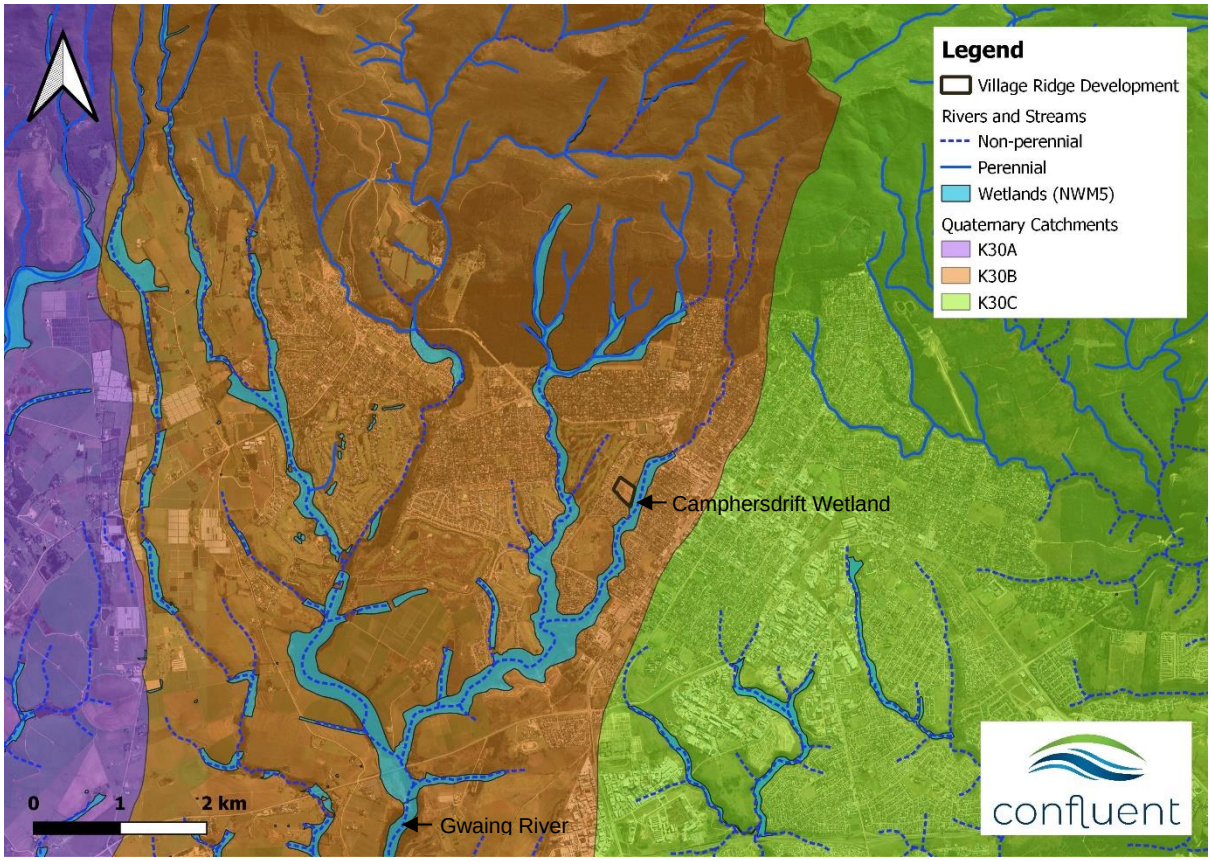


Figure 4. The site in the City of George in relation to quaternary catchments and mapped watercourses.

The mean annual rainfall is approximately 787 mm and the mean annual runoff is 300 mm. Rainfall seasons are bimodal with peaks in Autumn (March) and Spring (October; Figure 5).

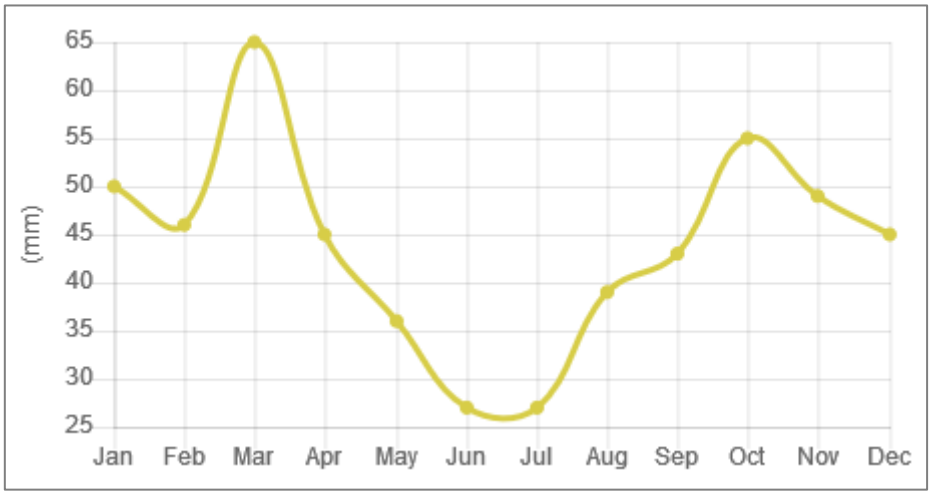


Figure 5. Monthly mean rainfall in George.

4.1 Conservation

4.1.1 Western Cape Biodiversity Spatial Plan

Most of the site is mapped as Critical Biodiversity Area 2; Terrestrial (CBA2), with a small area of Critical Biodiversity Area 1: Aquatic (CBA1; Figure 6). As the site slopes towards the Camphersdrift Wetland which is mapped as a CBA1 it is relevant to consider the land use in this context as it could influence this area. Relevant definitions and management objectives are listed below.

CBA1: Definition
Areas in a natural condition that are required to meet biodiversity targets for species, ecosystems or ecological processes and infrastructure.
CBA2: Definition
Areas in a degraded or secondary condition that are required to meet biodiversity targets, for species, ecosystems or ecological processes and infrastructure.
CBA1 & 2: Objectives
Maintain in a natural or near-natural state, with no further loss of natural habitat. Only low-impact, biodiversity-sensitive land uses are appropriate.

While the definitions of CBA1 and 2 differ, their management objectives are the same. The respective definitions of areas on the site are a fair indication of the vegetation present. The area indicated as CBA1 is mostly indigenous plants with a few alien invader species. While the CBA2 is in areas previously disturbed and vegetated mostly with kikuyu grass. The wetland flat present on Erf 21028 was not identified in the WCBSP highlighting the importance of ground-truthing to verify the presence / absence of sensitive biodiversity features.

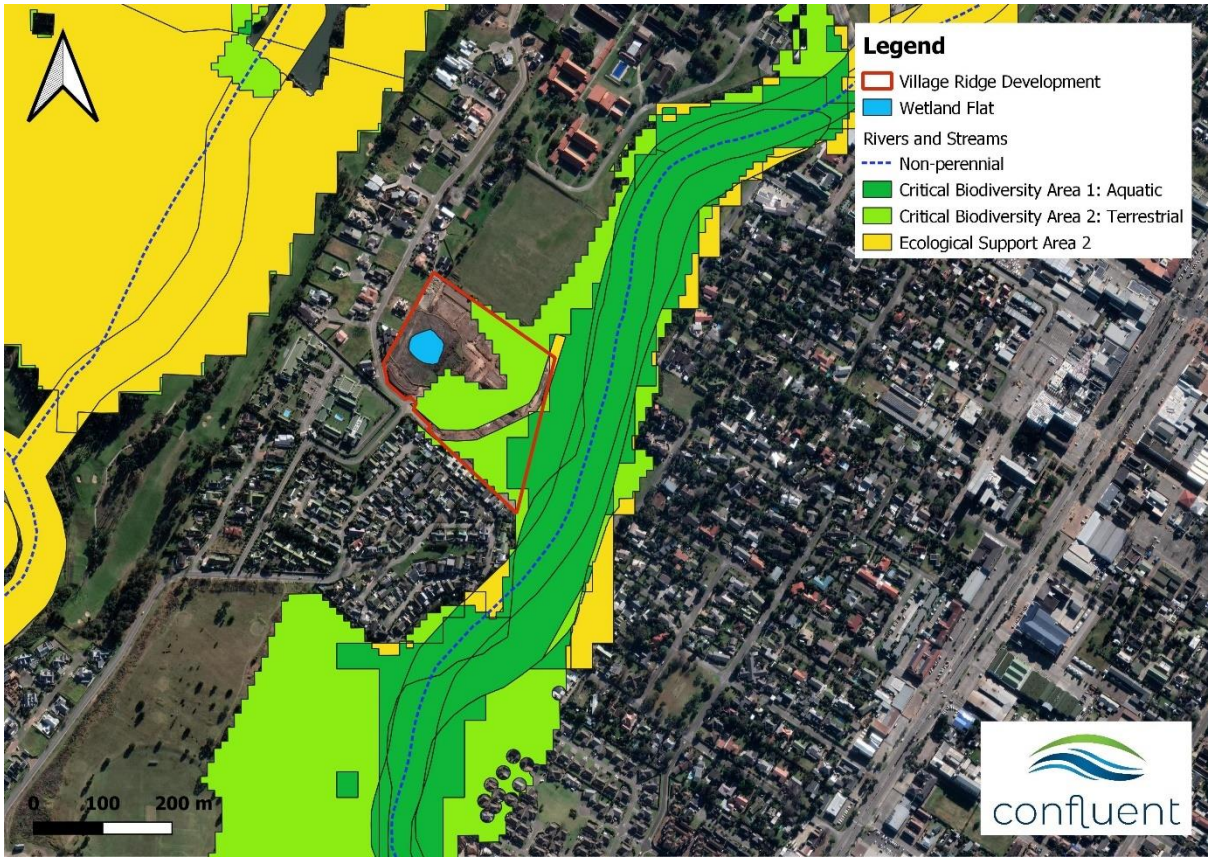


Figure 6. Map of the site in relation to areas mapped in the Western Cape Biodiversity Spatial Plan.

4.1.2 National Freshwater Ecosystem Priority Area (NFEPAs)

The sub-quaternary reach (SQR) 9115 is classified as a Fish Support Area (Figure 7). According to Nel *et al.* (2011) the management objective for fish support areas is: "Sub-quaternary catchments that are required to meet biodiversity targets for threatened and near threatened fish species indigenous to South Africa. Fish support areas also include SQRs that are important for migration of threatened and near threatened fish species. River reaches in Fish Support Areas need to be maintained in a condition that supports the associated populations of threatened fish species."

The fish species present in the catchment are 2 Western Cape endemics, *Galaxius zebratus* and *Sandelia capensis* (Cape kurper). Both species occur in flowing rivers and streams and are unlikely to be in isolated or unchanneled wetlands. However, two invaluable and relevant ecosystem services provided by wetlands is the maintenance of base flows supported by interflow through soil during periods of low rainfall, and the removal of pollutants from urban areas which results in cleaner water delivered to flowing streams and rivers. It is important that these functions be preserved within the SQR. As one of the largest wetlands in the catchment, the Camphersdrift Wetland is important in this regard.

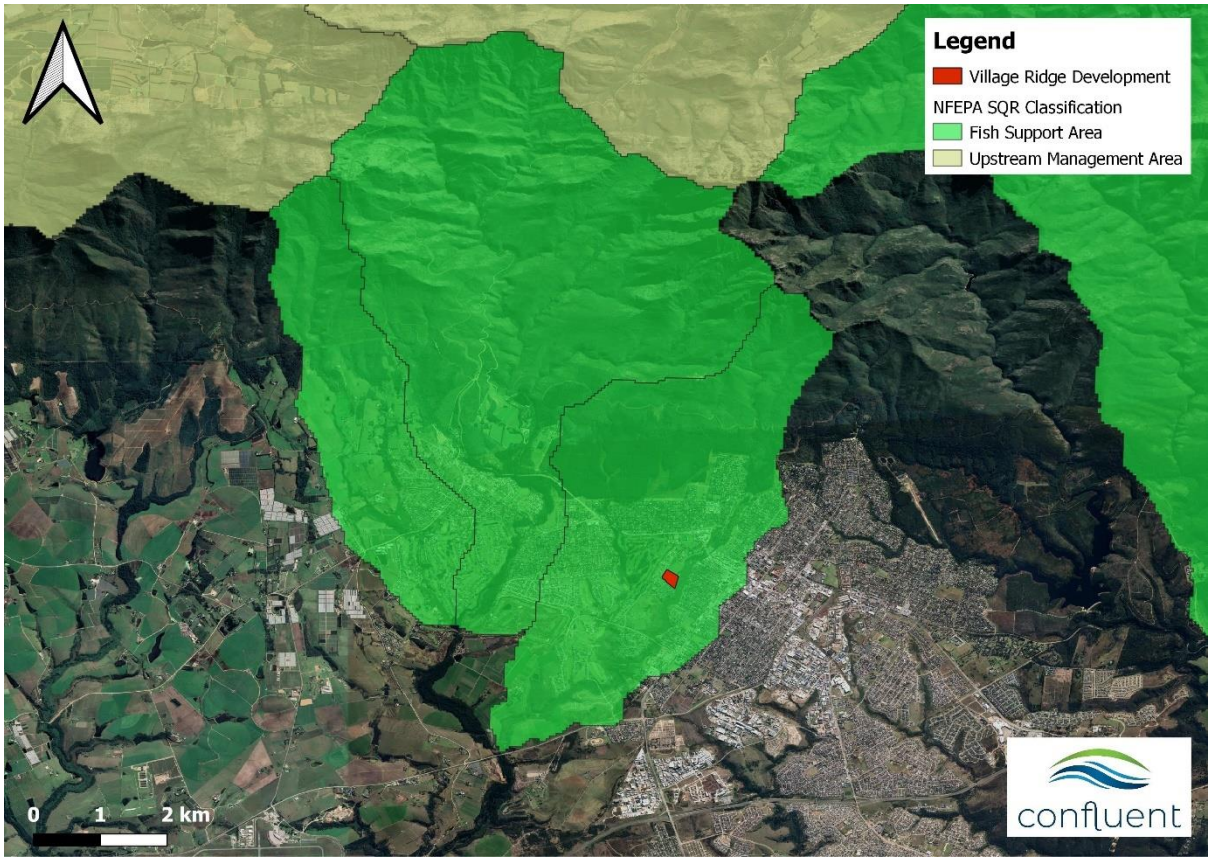


Figure 7. Map of the site within the NFEPA sub-quaternary reach classified as a Fish Support Area.

4.1.3 Resource Quality Objectives (RQOs)

Resource Quality Objectives (RQOs) are defined as clear goals (numerical or descriptive statements) relating to the quality of a water resource and are set in accordance to the management class for the resource to ensure the water resource is protected. The purpose of RQOs is to set clear objectives for the resource against which water use licenses and the related impacts can be evaluated and managed to achieve a balance between the need to protect and utilise the resource.

The Breede-Gouritz Catchment Management Agency (BGCMA) recently concluded an assessment of major rivers in the Water Management Area (DWS, 2018). The Camphersdrift Wetland (River) was not assessed in this report, but the Present Ecological State (PES) for the Gwaing River was determined to be E (Seriously Modified), and the Recommended Ecological Category is to improve the PES to D (Largely Modified). The main issues for improvement are to reduce wastewater inflows and clear alien vegetation. The Gwaing River is in a poor state, but the maintenance of inflowing tributaries such as the Camphersdrift Wetland system are critical to maintaining the river's resilience.

4.2 Vegetation

The mapped vegetation type at the site is at the boundary of the two dominant vegetation types in George: Garden Route Granite Fynbos and Garden Route Shale Fynbos. The former is listed as *Critically Endangered,* and the latter is listed as *Vulnerable*. While there may be elements of both vegetation types in the riparian vegetation along the Camphersdrift Wetland

on Erf 21029, most of the development area was highly transformed, consisting of kikuyu grass (*Pennisetum clandestinum*).

In a study conducted by the botanical specialist, Jan Vlok (2014), the wetland flat on Erf 21028 was described as having typical wetland vegetation dominated by *Typha capensis* and species in the Cyperaceae and Juncaceae families. The author also noted the presence of wetland fauna such as Vlei Rat, clicking stream frogs, damselflies and dragonflies in this area. The botanical specialist has subsequently updated the report and has identified a threatened plant species growing in the disturbed areas of the steep slopes towards the Camphersdrift Wetland, *Nemesia elata*.

4.3 Historical Overview

Most of the development area has been disturbed for many decades. The earliest aerial photo of the site is from 1939, where both the circular wetland flat is clearly visible as distinct vegetation, as well as the Camphersdrift Wetland. At this time the development area was used as agricultural land. Possibly grazing for livestock. In a few subsequent aerial photos, such as 1974, the wetland flat is not discernable, and may have been partially drained or mowed during a dry phase. Dense fringing vegetation, possibly alien, is visible along the Camphersdrift Wetland. From 2000 onwards the site was further disturbed with construction of Loch Lormondry Road. The road was built up with soil and fill material within its footprint, and there is still infill material such as broken bricks evident on the slope above the Camphersdrift Wetland (observed during site visits).

Figure 8. Historical aerial and satellite images showing the development site including the wetland flat area when it is visible (blue circle).

5. SITE ASSESSMENT

5.1 Site visit

The site was visited on numerous occasions between May 2021 and January 2022. This covers seasonal variation between winter and spring. Site visits were conducted during dry weather and following heavy rainfall events to assess and provide mitigation measures to prevent / reduce soil erosion and to monitor changes to the wetland flat in terms of vegetation cover, extent, and ecological classification.

5.2 Wetland classification

Classification of wetlands on, and downslope of the development site followed methods developed by Ollis *et al*. (2013) to classify wetlands and other aquatic ecosystems. The classification system accounts for diagnostic features such as the topographic setting and hydrology (depending on the wetland type). The Camphersdrift Wetland is classified as a channelled valley-bottom wetland at this location as it has an incised channel flowing along the eastern portion of the wetland (Table 2). It is supported by interflow through soil on the western slope which is more confined (steeper) than the eastern slope (Figure 9 and Figure 10). The western slope could potentially be classified separately as a hillslope seep, but as the unit is continuous with the valley-bottom wetland, they were considered as a single hydrogeomorphic (HGM) unit.

The wetland on Erf 21028 is classified as a wetland flat due to its location on a flat bench with no inflowing or outflowing water from the system, and no significant contours surrounding it. It is supported by both groundwater as well as rainfall (Figure 9). Evidence for this is further explained in the assessment of Present Ecological State (PES).

Table 2. Summary of wetland hydrogeomorphic units at the development site.

Wetland	**Level 1**	**Level 2**		**Level 3**	**Level 4: HGM Unit**	
Unit	System	DWS Ecoregion	Vegetation	Landscape unit	4A	5A,B
Camphersdrift Wetland	**Inland**	Level 2 ecoregion 20.02 **South Eastern Coastal Belt**	SANBI Vegmap (2018): **Garden Route Granite Fynbos** (Critically Endangered)	**Valley floor** Western slope for 500m = 3.6% (max. 13%) Eastern slope for 500m = 2.8% (max. 9%).	**Channelled valley-bottom wetland** – a valley bottom wetland with a river channel running through it.	Inundation periodicity: **Intermittently Inundated** Saturation periodicity: **Permanent**
Wetland on Erf 21028	**Inland**	Level 2 ecoregion 20.02 **South Eastern Coastal Belt**	SANBI Vegmap (2018): **Garden Route Granite Fynbos** (Critically Endangered)	**Bench located on a shelf** gentle upslope to one side and downslope the other side.	**Wetland flat – a near-**level wetland not fed water by a river channel which is typically on a bench or plain.	N/A

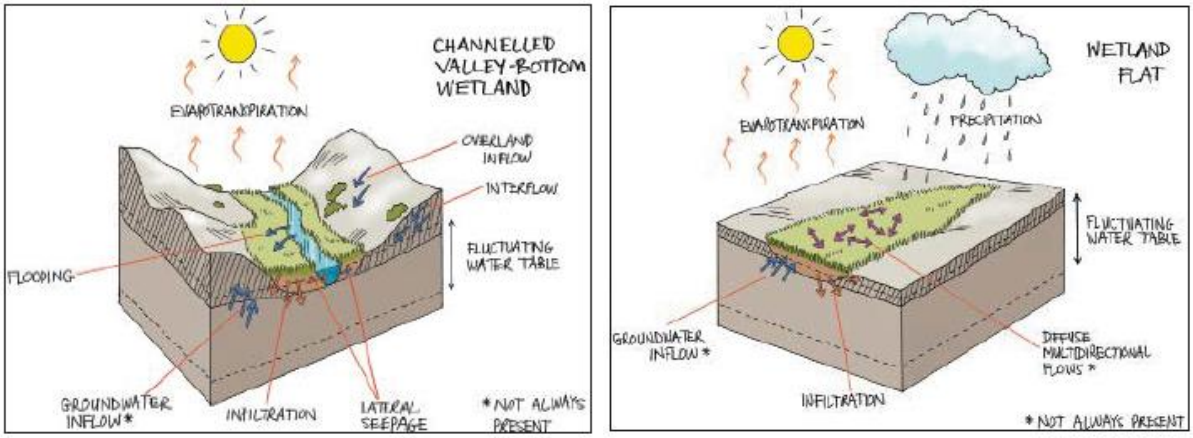


Figure 9. Conceptual illustration of the two wetland types present at the site (from Ollis *et al*., 2013).

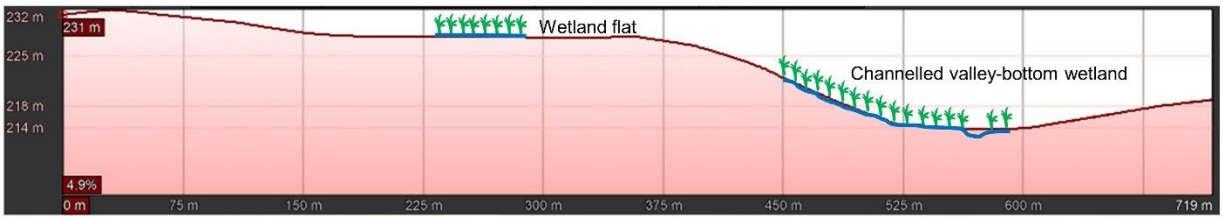
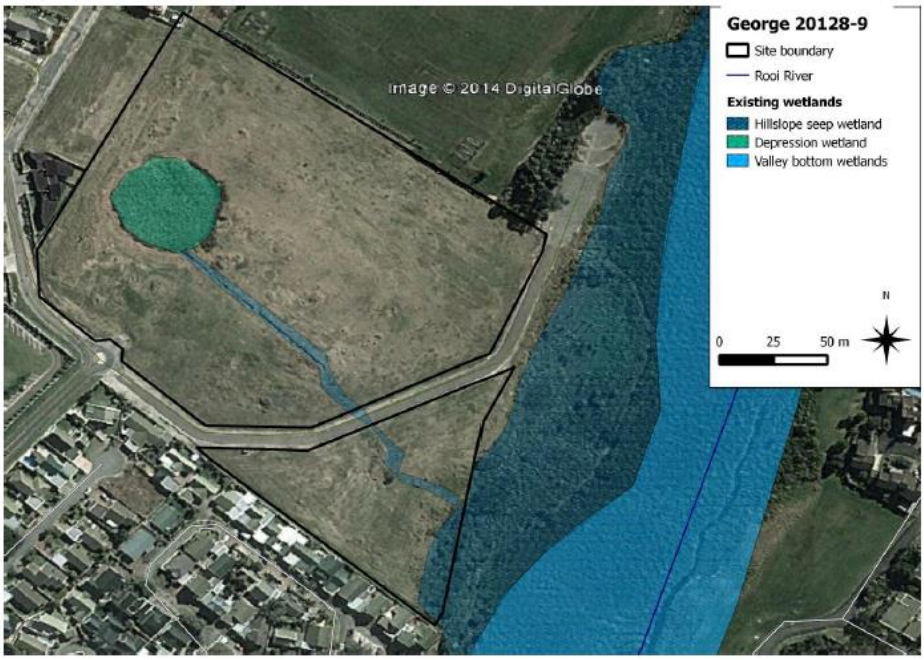


Figure 10. Wetland unit settings based on elevation profile (Google Earth).

5.3 Wetland Buffers

Sensitive vegetation and wetlands on Erven 21028 and 21029 have been previously assessed. Ractliffe (2014) and Vlok (2014) provided specialist inputs on aquatic and botanical aspects of the site respectively. Ractliffe (2014) identified the wetland flat (depression wetland), a connecting channel, and hillslope seep adjacent to the Camphersdrift wetland. Buffers were recommended for these areas as indicated in Figure 11. Wetland buffers were 30 m and the interconnecting channel was 25 m.



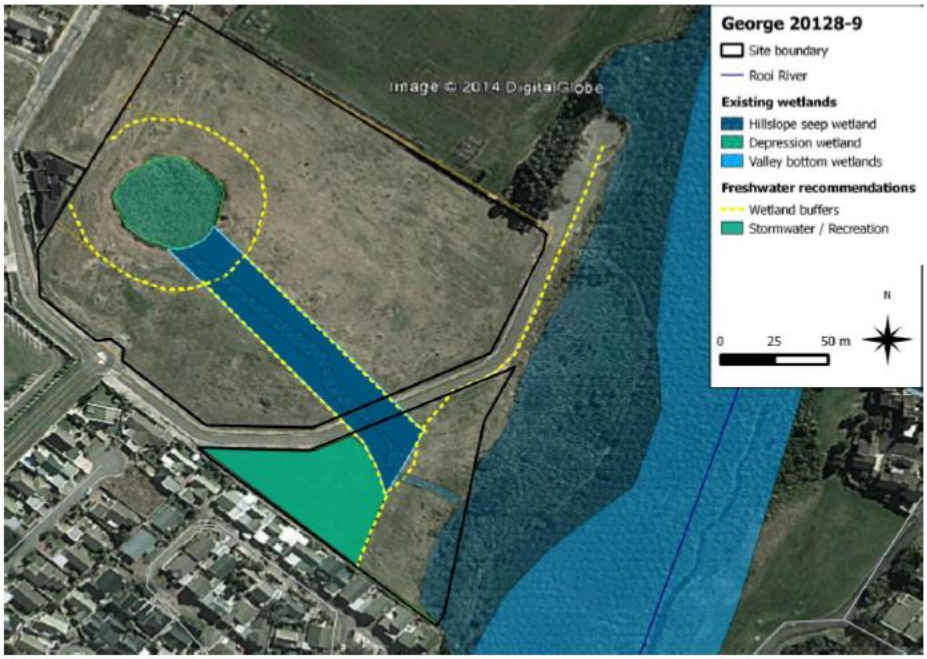


Figure 11. Wetlands identified on Erven 21028 and 21029 (above) and buffer recommendations (below) from Ractliffe (2014).

Through discussion with Ractliffe (*pers. comm.* 21/06/2021) the following issues pertaining to the buffers identified in Figure 11 were identified:

1. The Ractliffe assessment was meant as a scan of sensitive aquatic habitat on the site, and not a complete and thorough assessment.
2. The recommended buffers were based on commonly applied distances at the time, and were not established using the subsequently developed tool for determining buffers for wetlands and rivers (Macfarlane & Bredin, 2017).
3. Both wetland areas were not delineated in detail using methods developed for this purpose (DWAF, 2005). Soil augering was conducted in the middle of each wetland to confirm wetland conditions only.
4. The linear channel leading from the wetland flat (depression) visible in various historical images is entirely artificial and had no features of a watercourse. It appears to have been dug at some point in an unsuccessful attempt to drain water from the wetland.

As a result of the above points, it was proposed that the buffer areas for the wetland flat and Camphersdrift Wetland be revised using the detailed site-based model developed by Macfarlane & Bredin (2017). The buffers are then mapped from the edge of the delineated wetland area (DWAF, 2005). It is furthermore proposed that the linear channel be discarded from buffered areas as it is not a natural watercourse and has no function as such.

Recommended buffer zones for both wetland areas were determined using the site-based buffer zone tool developed by Macfarlane and Bredin for rivers and wetlands (2017), which is the more detailed of the two available models. The recommended buffers were determined as follows:

Wetland Flat Buffer: 19 m

Camphersdrift Wetland Buffer: 19 m

A point worth noting about watercourse buffers is that they primarily protect watercourses from diffuse sources of pollution, as opposed to point sources. Housing developments do not produce large amounts of diffuse pollution, unlike other land uses such as a feedlot for example. Greater risks are posed by point sources such as stormwater outlets, which buffers are not able to mitigate. Buffers are also meant to conserve biodiversity, migration corridors, and reduce collective risks to the watercourse. These factors were accounted for in the buffer calculation.

5.4 Wetland delineation

The wetland flat was easily delineated using historical aerial and satellite imagery and by referring to Ractliffe (2014) and Vlok (2014) reports on vegetation and wetland characteristics. It is roughly circular and is defined by wetland vegetation which distinctly differs from the surrounding kikuyu grass. Soil augering in the wetland and across other areas of the site indicates the following horizons:

A – Orthic

B1-Neocutanic

B2-Soft plinthic

This is a Tukulu soil form. Plinthic soils have characteristic accumulations of iron and manganese oxides and hydroxies. that form localised high-chroma (coloured) mottles and concretions. These features develop in zones of periodic water saturation at the limits of a fluctuating water table. The soft plinthic layer is underlain by hard plinthite which is also known as laterite. The gleyed layer shown in soil auger samples from the wetland flat indicate a layer of permanent saturation at approximately 40 cm depth at this location (Figure 12). These soil features indicate that groundwater inflow from a fluctuating water table interacts with rainfall which accumulates above the clay later. Soil features were also confirmed on site with Professor Josua Louw, a lecturer in soil science at the Nelson Mandela University.

Figure 12. Soil auger sample from the wetland flat showing gleyed (grey) material >40 cm depth.

As vegetation was recently cleared on the slope above the Camphersdrift wetland, soil indicators were used to delineate the wetland in this area. A series of four transects perpendicular to the Camphersdrift wetland were augered up the slope where vegetation was cleared. Augering was conducted approximately every 2 – 3 m along the transect. Soils were augered to a depth of 50 cm to search for evidence of permanent, seasonal or temporary wetness. The delineated edge of the wetland was determined as the line between auger points indicating temporary wetness and no wetness (Figure 13). Delineated wetland areas in the vicinity of the two erven to be developed are presented along with the revised buffer recommendation in Figure 14.

Figure 13. Example of augered soil down the slope towards Camphersdrift wetland showing soil with no wetland indicators (left) compared to soils with indicators of temporary wetness (right).

Figure 14. Delineated wetland areas and recommended buffers for Erven 21028 and 21029. Red line indicates the edge of erven in the Approved Development Plan.

The revised aquatic buffers of 19 m have been considered by the amphibian specialist (F. de Lange) and were determined as adequate for the purpose of protecting *A. knysnae* in the wetland flat. The 19 m buffers were therefore incorporated into the Preferred Development Plan and development of housing removed from these areas.

5.5 Present Ecological State (PES)

5.5.1 Methods of Assessment

Methods for the assessment of both wetlands are provided in detail in Appendix 3. The wetland flat was assessed using the RDM-99 developed by DWAF (1999) and the channelled valley bottom wetland was assessed using the WET-Health methods developed by Macfarlane *et al.* (2008).

5.5.2 Camphersdrift Wetland PES

The Camphersdrift Wetland is an extensive valley-bottom wetland which extends through a large area of George. Only the section of wetland directly adjacent to Erven 21028 and 21029 was considered in determining the PES of this system. Vegetation that was unlawfully cleared on the slope was fairly limited in extent relative to the wetland area with the result that the overall PES was not altered due to this activity. While there are various additional negative impacts in other areas of the Camphersdrift wetland, the section adjacent to the development area was classified as a PES of C, Moderately Modified (Table 3).

Heavy rainfall on 22 November 2021 exposed vulnerabilities in the wetland where, due to very high stormwater flows combined with natural runoff, an enlarged channel was incised through the wetland (Figure 15). The associated increase in exposed soil renders the wetland vulnerable to extensive alien plant invasions which are difficult to control in this location. The channel also increases a degree of downcutting and detachment from surrounding wetland areas which can start to dry out. This emphasises the need to carefully manage stormwater flows in new developments to ensure that they don't exacerbate this situation.

Isolated areas of dense alien vegetation are present within the outer limits of the wetland and include species such as *Lantana camara*, *Solanum mauritianum* (bugweed), *Rubus* sp. (bramble) and *Acacia mearnsii* (black wattle). However, vegetation is predominantly indigenous and typical of obligate and facultative wetland plant species found in the region.

Some minor infilling has occurred due to historical construction of the municipal bulk sewer which runs adjacent to the wetland and along the property boundary. Stormwater discharge points have been constructed within the wetland area resulting in localised downcutting and pollution of the wetland with potentially contaminated water containing litter.

Table 3. Summary of factors considered in the PES determination for the Camphersdrift Wetland using the Level 1WET-Health index (Macfarlane *et al*., 2008).

Present Ecological State
HYDROLOGY
Major increase in flood peaks due to hardened surfaces and stormwater discharge into the wetland
Minor increase in inputs due to discharge from various urban sources
Reduced surface roughness in catchment areas
Hydrology PES Category: C, Moderately Modified
GEOMORPHOLOGY
Infilling associated with the bulk municipal sewer line and historical road construction on Erf 21029
Increased runoff resulting in more extensive channelling of the wetland and channel incision
Downcutting / erosion of the channel occurring due to stormwater flows
Geomorphology PES Category: B, Largely Natural
VEGETATION
Infilling / infrastructure has replaced / disturbed natural vegetation in areas (e.g. sewer line)
Isolated dense patches of aliens, especially Lantana, are present
Lawn / parkland has replaced wetland vegetation on the opposite bank
Downcutting of the wetland channel has removed extensive wetland vegetation exposing the wetland to increased risk of alien encroachment.
Hydrology PES Category: C, Moderately Modified
OVERALL PES: C, Moderately Modified

Figure 15. Camphersdrift wetland showing various impacts considered in the PES assessment.

5.5.3 Wetland Flat PES

Immediately following the excavation and infilling of the wetland flat, the PES would have been significantly worse than the current PES determined (Refer to photo sequence in Figure 3). The DEA&DP directive to cease work in the wetland and delineate it as a no-go area, along with recommendations to remove the infill partially covering the wetland (Confluent Environmental, 2021) have resulted in prevention of further damage and a remarkable recovery of the wetland over an 8-month period (May 2021 to January 2022).

Results of the PES assessment are presented in Table 4. The pre-construction PES was determined to be **A, Natural**. This was in spite of fairly minor impacts to the wetland including being surrounded by extensive kikuyu grass, periodic mowing of vegetation, an unsuccessful attempt to drain it through a channel, and domestic cats and dogs with free access to it.

The post-construction PES was evaluated in January 2022, and resulted in a slightly downgraded PES of **B, Largely Natural**. Most ecological functions were restored due to heavy rainfall and no further disturbance in the wetland. Vegetation in the buffer zone adjacent to the wetland has increased in species diversity with an influx of additional alien vegetation or weedy species due to the disturbance. There is still a small area of infilling associated with a large mound of soil that remains to be removed from the wetland area and buffer to the south-east of the wetland, which has moderately affected the wetland's topography and hydrology. Extensive earthworks with exposed soil in the areas surrounding the delineated buffer area result in sediment-laden water entering the wetland through surface runoff. This impact has only been observed once following an exceptionally high rainfall event (22 Nov. 2022) and does not occur on a regular basis. Footprints of dogs and cats have been frequently observed around the wetland indicating that free-roaming domestic animals enter the wetland area and potentially cause disturbance to fauna. However, this impact was present prior to construction and has therefore been scored at the same level in both scenarios.

Table 4. Summarised scores for the Present Ecological State of the Wetland flat Pre- and Post-Construction (assessed January 2022).

Criteria	Pre-Construction Score & Comments (1-5)	Confidence (1-4)	Post-Excavation Score & Comments (1-5)	Confidence (1-4)
Hydrological				
Flow modification	4: Minimal reduction in groundwater recharge due to increased hard surfaces	3	3: Slight reduction in groundwater recharge due to infilling	3
Permanent inundation	5: No evidence of modifications resulting in permanent inundation	4	5: No evidence of modifications resulting in permanent inundation	4
Water quality				
Water quality modification	4: Minimal impacts mainly related to occasional solid waste (litter)	3	3: During periods of very high volumes / intensity rainfall sediment laden runoff increases turbidity	4

Sediment load modification	4: Minimal increase in sediment following disturbance such as mowing	3	3: Turbid runoff during high rainfall causes sedimentation of wetland habitat	4
Geomorphology				
Canalisation	5: Channel excavated for drainage but not effective	4	5: Canal subsequently covered by infilling	4
Topographic alteration	4: History of minor disturbance (earthworks) over preceding decades	3	3: Topography of the wetland moderately altered by excavation and infilling	4
Biota				
Terrestrial encroachment	4: Periods of mowing may have encouraged growth of kikuyu and other spp.	3	3.5: Small area of remaining infill has terrestrial vegetation (weeds and kikuyu)	4
Indigenous vegetation removal	4: Mowing may have impacted more sensitive species	2	4: Although initially removed, indigenous vegetation has fully re-established	4
Invasive plant encroachment	4: Mowing would have selected for resilient species (e.g. *Typha*) which can become invasive	3	3.5: None in the wetland, but diverse alien species in buffer area	3
Alien fauna	3: Domestic cats and dogs impact on wetland associated fauna	3	3: Domestic cats and dogs impact on wetland associated fauna	3
Overutilisation of biota	5: None likely	3	5: None likely	3
Overall PES Category	**(84%) A, Natural**	3	**(75%) B, Largely Natural**	3

Table 5. List of wetland plants identified from the Wetland Flat

Plant species	Common name	Wetland type	
Potamogeton nodosus	Pondweed	Obligate wetland plant	
Ranunculus pinnatus[A]	Buttercup	Obligate wetland plant	
Schoenoplectus decipiens	Sedge	Obligate wetland plant	
Typha capensis	Bulrush	Obligate wetland plant	
Persicaria decipiens[A]	Knotweed	Obligate wetland plant	
Eleocharis dregeana	Finger sedge	Obligate wetland plant	
Alisma plantago-aquatico[A]	Mud plantain	Obligate wetland plant	

Chara sp.	Stonewort	Aquatic	
Hydrocotyle bonariensis[A]	Varkoortjies	Obligate wetland plant	
Nymphoides thunbergiana	Yellow floating heart	Obligate wetland plant	
Juncus dregeanus		Obligate wetland plant	

5.6 Ecological Importance and Sensitivity (EIS)

5.6.1 Method of Assessment

Both the wetland flat and Camphersdrift wetlands were assessed in terms of their Ecological Importance and Sensitivity (EIS) using the method developed by Rountree *et al.* (2013) which is explained in detail in Appendix 6.4.

5.6.2 Camphersdrift Wetland EIS

The EIS for the Camphersdrift Wetland was determined to be **'High'** (Table 6). Factors that contribute to this result is the importance of the wetland as a corridor for the movement of wildlife in an urban setting. As one of the largest remaining green belts in George, the importance of this function is elevated.

The wetland functions effectively to mitigate the impacts of flooding during heavy rainfall events, protecting infrastructure and preserving the integrity of downstream aquatic ecosystems. Should the function of flood attenuation be overwhelmed by increasing stormwater inputs the result will be gradual downcutting and incision of the channel and draining of adjacent wetland areas.

Table 6. Ecological Importance and Sensitivity of the Camphersdrift Wetland adjacent to the Village Ridge development site.

Ecological importance and sensitivity	Score 0-4	Confidence 1-5	Motivation
Biodiversity support	**2.6**		
Presence of Red Data species	0	3	None known
Populations of unique species	4	4	2 Western Cape endemics, *Galaxius zebratus* and *Sandelia capensis;* and 5 amphibian species
Migration/feeding/breeding sites	4	5	Bushbuck, mongoose, otters, and extensive birdlife as an example.
Landscape scale	**2.8**		
Protection status of wetland	2	4	Municipal land
Protection status of vegetation type	3	4	Critically Endangered and Vulnerable
Regional context of the ecological integrity	3	4	Assessed section in good condition relative to other urban wetlands in George
Size and rarity of the wetland types present	3	4	The extent of wetland area is significant
Diversity of habitat types	3	4	Relatively diverse with unchannelled, channelled, areas with a range of inundation
Sensitivity of the wetland	**3**		
Sensitivity to changes in floods	3	5	Increased flood volumes cause channel incision
Sensitivity to changes in low flows	3	4	Areas of the wetland may dry out
Sensitivity to changes in water quality	3	4	Historically good water quality, but steadily deteriorating
Hydrofunctional Importance	**3**		
Flood attenuation	4	**5**	Of critical importance as shown in recent floods
Streamflow regulation	4	**5**	Extensive area which slowly releases water through interflow
Sediment trapping	4	**5**	Important function observed in recent flooding
Phosphate assimilation	2	**4**	Possible, but no obvious sources
Nitrate assimilation	2	**4**	Possible, but no obvious sources
Toxicant assimilation	2	**4**	Possible, but probably limited to stormwater and urban runoff
Erosion control	3	**5**	Erosion control due to flood attenuation
Carbon storage	3	**5**	Large area of fast-growing vegetation with a rapid turnover. Carbon retained in functional wetland soils.
Direct human benefits	1.5		
Water for human use	2	**3**	None known
Harvestable resources	2	**3**	None known
Cultivated foods	0	**4**	None known
Cultural heritage	2	**3**	Central part of George known to many residents
Tourism and recreation	2	**4**	Limited opportunities in terms of access, but visually important
Education and research	2	**4**	None active, but has good potential value
ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS)	**3.0**	**HIGH**	

5.6.3 Wetland Flat EIS

The Ecological Importance and Sensitivity of the Wetland Flat was determined to be **'Very High'** (Table 7). The importance of the wetland has been significantly elevated due to the presence of *A. knysnae*, and the six other frog species present at the site. This makes it and important breeding location. While small, the type of wetland is not very common in the region, further increasing the importance. The main area of sensitivity is to poor water quality due to the high-quality water requirements by *A. knysnae*. In terms of direct human benefits, the potential for research and education is considered of high importance. As the wetland flat is located on a bench at the top of a gently sloping area with no major surface inflows it has a relatively low hydrofunctional importance.

Table 7. Ecological Importance and Sensitivity of the Wetland Flat in the Village Ridge development site

Ecological importance and sensitivity	Score 0-4	Confidence 1-5	Motivation
Biodiversity support	**4**		
Presence of Red Data species	4	5	*Afrixalus Knysnae*
Populations of unique species	4	5	6 additional amphibian species
Migration/feeding/breeding sites	4	5	Confirmed breeding location for above
Landscape scale	**2.8**		
Protection status of wetland	2	4	Municipal, will be zoned P.O.S. III
Protection status of vegetation type	3	4	Critically Endangered and Vulnerable
Regional context of the ecological integrity	3	4	Good considering it's in an urban area
Size and rarity of the wetland types present	4	5	One of the only known natural wetland flats in George
Diversity of habitat types	2	5	Relatively low: standing water, aquatic and emergent wetland vegetation
Sensitivity of the wetland	**2**		
Sensitivity to changes in floods	1	5	Topography of the site means that flood waters drain away from the wetland
Sensitivity to changes in low flows	1	5	Relatively low, as undergoes dry periods when the water table is low
Sensitivity to changes in water quality	4	5	High because breeding requirements of *A. Knysnae* are for clear water of a good quality.
Hydrofunctional Importance	**1.5**		
Flood attenuation	2	4	Limited importance due to site topography but still spreads and attenuates some floodwaters
Streamflow regulation	1	4	Very little connection to Camphersdrift wetland, but may contribute to downslope interflow
Sediment trapping	2	4	Limited due to wetland's location
Phosphate assimilation	0	4	No impacted runoff or effluent in wetland
Nitrate assimilation	0	4	No impacted runoff or effluent in wetland
Toxicant assimilation	1	4	No impacted runoff or effluent in wetland
Erosion control	2	4	Retention of wetland reduces area of hard surfaces leading to less runoff and erosion
Carbon storage	1	4	Small area, so minimal C storage
Direct human benefits	1.1		
Water for human use	0	4	None known
Harvestable resources	0	3	None known
Cultivated foods	0	4	None known
Cultural heritage	1	4	Appreciated by local residents, contributes to sense of place

Tourism and recreation	2	3	Minimal, but sustains a sense of green, open areas within George
Education and research	4	4	Given the amphibian diversity, species of conservation concern, and rarity of the wetland type it has good potential
ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS)	**4.0**	**VERY HIGH**	

6. REHABILITATION PLAN

The rehabilitation plan is applicable to the Preferred Layout option, as wetlands and buffers are retained in this option. The approach to rehabilitation has been divided between pre-and post-construction activities. Pre-construction activities are actions required before construction on the remainder of the site may commence. These measures aim to reduce disturbance to habitat, water quality, fauna and flora in wetland areas during the construction phase. The purpose of rehabilitation prior to construction is to ensure that the work is prioritised and that any follow up work required can be attended to while the developer is on site.

6.1 Pre-construction rehabilitation of the Wetland Flat

- Work in the wetland flat may only commence outside of the typical amphibian breeding season which is from April to August. On this point, if construction recommences on the site during the breeding season (outside the above timeframe), then work at the site will need to be conducted entirely outside of the delineated buffer until rehabilitation of the wetland flat can commence. In this scenario the rehabilitation would only commence during construction as opposed to pre-construction, but must be implemented as soon as the seasons allow.
- Survey and peg the delineated Wetland Flat area and 19 m buffer.
- The first step will be to remove the large pile of soil that was stockpiled in the buffer south-east of the Wetland Flat. This must be done working in a south-easterly direction, with the minimal footprint of disturbance.
- All soil removed from the site must be stockpiled outside of the buffer zone, making an effort to separate and preserve topsoil.
- Plant rescue should be undertaken for any wetland vegetation (e.g. *Typha*) where possible. This can be used for rehabilitation of disturbed areas in the wetland.
- Using as small an excavator / bobcat as possible, working from the inside out, the second step will be to gently remove the remaining infill in the wetland. This must be done under supervision of an aquatic ecologist using the delineated areas indicated in Figure 16 as a guide. The depth of fill removed must approximate the other side of the wetland so that it isn't significantly deeper or higher by comparison.
- If standing water is present in the wetland during this exercise, it must be protected from excess silt by placing a line of sandbags along the area of infill to be removed. This will reduce the amount of silted water entering clean areas of the wetland. The sandbags can remain in situ for one month while the site stabilises.
- Water quality must be monitored for clarity during this process, and to ensure that the Electrical Conductivity remains within 10% of the reference range of 180 – 220 µS/cm.
- Remove any other significant soil stockpiles in the buffer area using the methods described.

- Reshape the disturbed area to smooth contours.
- Replant disturbed areas in the wetland with any suitable wetland vegetation disturbed during the clearing.
- Use topsoil from the site to build a continuous, gently sloping soil berm approximately 60 cm high which runs along the inside edge of the 19 m buffer. This is in line with recommendations from the amphibian specialist study and aims to ensure stormwater runoff doesn't enter the Wetland Flat during both the construction and operational phases.
- The soil berm should be lightly seeded with Teff grass seed to provide rapid cover during the construction phase.
- Plant rescue of regenerating indigenous terrestrial plants must be undertaken across the remaining site (excluding buffer areas) and plants should be replanted in the buffer and soil berm of the Wetland Flat.
- Finally, temporary fencing must be erected around the outer limit of the soil berm. This will be replaced with permanent fencing during the construction phase.
- Revegetation of disturbed areas of the wetland must be monitored carefully to ensure adequate cover with suitable plants is occurring. Given the site's historical recovery from earthworks, it is anticipated that wetland vegetation will establish rapidly.
- Alien vegetation in the Wetland Flat buffer zone must be cleared by hand, preferably without the use of any herbicides, at least once prior to construction.

Figure 16. Map showing Step 1 and Step 2 soil to be removed from the Wetland Flat and buffer area.

6.2 Post-construction rehabilitation

6.2.1 Wetland Flat

- The condition of the Wetland Flat must be re-assessed by an aquatic specialist toward the end of the construction phase to determine the percentage cover and species composition of vegetation in the wetland area and buffer. Based on these findings, the following actions must be taken:
- Actively replant any bare areas in the wetland or buffer area with suitable vegetation. Appropriate species are listed in Table 5 and Table 8 respectively.
- The soil berm parallel to the buffer zone must be vegetated with a mix of plants from Table 8.
- A fence must be erected around the entire perimeter of the wetland buffer with the following specifications:
  - 1.8 m high
  - Mesh size that prevents access by dogs and cats (Max. 900 mm)
  - Dug into the ground approximately 10 cm to prevent animals digging beneath it.
  - Fix a solid barrier 0.6m high from the soil (e.g. irrigation plastic) to the base of the fence to 'funnel' frogs within the wetland to and opening in the barrier aligned to the green corridor. This will encourage frogs to migrate through the fence in this area, reducing their risk of being run over.
  - Single pedestrian entry gate that can be locked
  - Suggested construction should be similar to that indicated in Figure 17. The wetland should be clearly visible beyond the fence, and diamond mesh is recommended on the inside.
  - A continuous border of *Carissa bispinosa* (Forest num num) must be planted along the outside edge of the fence. This thorny but attractive shrub will reduce contact with people and pets, providing protection for the fence.

Figure 17. Suggested fencing showing wood latte for aesthetic appeal, approximate spacing so the wetland is visible, and diamond mesh which must be on the inside of wooden latte.

- All alien vegetation must be removed from the buffer area by hand, with no use of herbicides. While there are some alien species present in the wetland, these must not be disturbed as they form part of the habitat for *A. knysnae*.
- 5 trees can be planted at random within the buffer to provide some local shade and habitat for birds (Table 8).

- Signage must be erected on wooden poles inside the fence at the entrance gate explaining the significance of the wetland flat and the reason for restricted access.

6.2.2 Camphersdrift Wetland Buffers

Rehabilitation of the Camphersdrift Wetland buffer will need to be undertaken towards the end of the construction phase. Part of the buffer on the northern portion will be needed for access to upgrade the sewerline and construct the stormwater attenuation dam, and can therefore only be rehabilitated once this work is complete.

- Topsoil must be replaced to a depth of at least 50 cm and shaped to natural contours where soil was previously excavated (e.g. old road).
- Topsoil must be obtained on site and must not be mixed with ferricrete.
- The same approach to revegetation in these areas must be followed as per the report compiled for Immediate Mitigation Measures (Confluent Environmental, V3, Jun 2021). In contrast, the area should be lightly seeded with *Eragrostis curvula* and *Teff* as opposed to oats. Active replanting should also be undertaken as the seedbank may be depleted. Suitable species are listed in Table 8. Soil saver matting and silt fencing must be used to reduce the risk of erosion on sloped areas. Planting must take place following the placement of soil saver matting so that holes can be cut into it to accommodate plants.
- Revegetation of the buffer area must aim to achieve 90% cover with vegetation.

6.2.3 Green Corridor

Rehabilitation of the Green Corridor will need to take place midway or towards the end of the construction phase. Once the corridor area is established with structures such as boundary walls and services, and there is no further need for construction vehicles to cross the area, the following steps must be implemented:

- Ensure there is a layer of topsoil along the length of the corridor at least 50 cm deep. This must tie into the buffer adjacent to the Camphersdrift Wetland.
- Profile the corridor with a few very gentle terraces on sloped areas to encourage the pooling of surface runoff during rainfall events.
- Plan replanting of the corridor so that denser more bushy vegetation is staggered and meanders along the corridor, as opposed to being in a straight line along the edges (See below).

- Grassy areas must be seeded with *Cynodon dactylon* (kweek) and shrubby areas must be actively planted with appropriate species listed in Table 8. The aim is for minimal maintenance required with no mowing of grass necessary.

Table 8. Plant species recommended for active planting in areas requiring rehabilitation

Plant species	Common name	Wetland Flat Buffer	Camphersdrift Wetland Buffer	Green Corridor	Sound damping
Aristea pusilla	-	✓	✓	✓	
Eragrostis curvula	Weeping love grass	✓	✓	✓	
Erica gracilis	Pink bell heather	✓	✓	✓	
Helichrysum petiolare	Licorice plant	✓	✓	✓	
Selago corymbosa	Stiff bitterbush	✓	✓	✓	
Osteospermum moniliferum	Bietou		✓	✓	✓
Gymnosporia buxifolia	Common spikethorn		✓		
Halleria lucida	Tree fuschia	2	✓	✓	✓
Tarconanthus littoralis	Coastal camphor tree	1	✓	✓	✓
Passerina corymbosa	Common cluster-flower gonna	✓	✓	✓	
Rapanea melanophloeos	Cape Beech		✓	✓	✓
Virgilia oroboides	Keurboom			✓	✓
Buddleja salvifolia	Sagewood	2		✓	✓
Afrocarpus falcatus	Outeniqua yellowwood				✓

7. IMPACT ASSESSMENT

The impact assessment considers the impacts of the two proposed alternative development layouts on aquatic ecosystems associated with the site, namely the wetland flat and Camphersdrift wetland. The historically approved layout and subsequently preferred layout are in Appendix 1 and 2 respectively. Methods used for the impact assessment are provided in Appendix 5. Depending on the numerical result, the impact would fall into a significance category as **negligible, minor, moderate or major**, and the type would be either positive or negative.

7.1 Design and layout phase

The approved layout resulted in complete loss of the Wetland Flat and made no allowance for a buffer alongside the Camphersdrift Wetland. Houses were planned to the very edge of the erf including areas of steeply sloping land (Appendix 1).

Once the need for environmental authorisations was highlighted through directives received from both DEA&DP and the BGCMA, specialist studies confirmed the Very High EIS of the Wetland Flat and the need for a buffer along the Camphersdrift Wetland. Following these findings, the development team made significant efforts to rework the layout to conserve the Wetland Flat and include buffers around both wetland areas (indicated in this report). The preferred layout also incorporates a green corridor linking the two wetland areas to retain a

degree of connectivity between these habitats (Appendix 2). The preferred layout was modified using recommendations from the aquatic, amphibian and botanical specialist reports.

7.1.1 IMPACT: Loss of Wetland Flat

This impact was considered for the approved layout only, as the Wetland Flat and buffer are preserved in the preferred layout. Continuing with the approved development would result in permanent loss of the Wetland Flat. This impact cannot be mitigated and is only permissible if a suitable wetland offset is identified. After being assessed as having a Very High Ecological Importance and Sensitivity (EIS) due to the presence of a Species of Conservation Concern (SCC; *A. knysnae*), a wetland offset was not considered feasible. With the currently available knowledge of the PES and EIS of the Wetland Flat, its loss was rated as a **Major Negative** impact (Table 9).

Table 9. Design and layout phase impact: Loss of wetland flat in approved layout.

Impact	**Loss of Wetland Flat**			
Description of impact	**Loss of significant A. knysnae breeding location; loss of one of few known wetland flats in George area; loss of significant habitat for amphibians in general.**			
Mitigatability	Low	Mitigation does not exist; or mitigation will slightly reduce the significance of impacts		
Potential mitigation	**This impact cannot be mitigated if the approved layout were to be go ahead**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Permanent	Impact may be permanent, or in excess of 20 years	Permanent	Impact may be permanent, or in excess of 20 years
Extent	Limited	Limited to the site and its immediate surroundings	Limited	Limited to the site and its immediate surroundings
Intensity	Extremely high	Natural and/ or social functions and/ or processes are severely altered	Extremely high	Natural and/ or social functions and/ or processes are severely altered
Probability	Certain / definite	There are sound scientific reasons to expect that the impact will definitely occur	Certain / definite	There are sound scientific reasons to expect that the impact will definitely occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Major - negative**		**Major - negative**	
Comment on significance	The Very High EIS of the Wetland Flat is why the permanent loss of the wetland is considered a Major Negative impact.			
Cumulative impacts	Increasing wetland losses and disturbance throughout George due to development are putting water resources and biodivesity under pressure. This wetland is small, but important, showing how the cumulative impacts affecting even smaller wetlands can have significant consequences.			

7.1.2 IMPACT: Development in the Camphersdrift Wetland buffer

This impact was considered for the approved layout only, as the buffer area is preserved and rehabilitated in the preferred layout. The approved layout would result in the permanent loss of riparian vegetation and transformation to harder surfaces and built infrastructure to support steep slopes adjacent to the wetland. The erosion slip that occurred at the base of the slope following heavy rains in November 2021 demonstrates how vulnerable the slope is to erosion without dense vegetation to protect it, along with effective stormwater management at the site.

Prior to clearance in May 2021, the vegetation was mostly indigenous with isolated alien plants. Moderate mitigation of impacts is possible but would require significant interventions to ensure the stability of the slope. Construction of a retaining wall at the base of the slope would probably be necessary to stabilise the area. However, the base of the slope is almost in alignment with the 1:50 and 1:100-year floodlines which increases the risk of damage to infrastructure and pollution of the wetland (Appendix 6). When considering the cumulative impacts of such development, this approach sets a poor precedent for ongoing development along wetlands in George due to the loss of ecosystem services and associated risk to infrastructure both at the site and further downstream through deflected energy during flooding. The impacts in their mitigated state were rated as a **Moderate Negative**.

Table 10: Design and layout phase impact: Development in the Camphersdrift Wetland buffer.

Impact	**Development in the Camphersdrift Wetland buffer**			
Description of impact	**Riparian & wetland vegetation loss, erosion, infilling required for stability**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• Construct a retaining wall along the base of the slope and back-fill with compacted soil layers to protect the slope and infrastructure above. • Revegetate any exposed areas of soil with a complex mix of indigenous grasses, forbs, shrubs and trees to reinforce stability of the slope. Revegetation must commence during the construction phase and must include soil saver matting and silt fencing.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Permanent	Impact may be permanent, or in excess of 20 years	Permanent	Impact may be permanent, or in excess of 20 years
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	Very high	Natural and/ or social functions and/ or processes are majorly altered	High	Natural and/ or social functions and/ or processes are notably altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Almost certain / Highly probable	It is most likely that the impact will occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Moderate - negative**		**Moderate - negative**	
Comment on significance	See below			
Cumulative impacts	While the intensity of the impacts are considered moderate in their mitigated state, the extent of the impact is very limited. However, should other developments follow this approach, the cumulative impacts would result in extensive degradation of wetland habitat and function.			

7.1.3 IMPACT: Wetland loss and degradation

This impact provides a comparison between the Approved and Preferred Layout options. Extensive consultation between the development team and aquatic and amphibian specialists during the planning and design phase have helped ensure that anticipated impacts during the operational phase have been considered and mitigated to a large extent in revising the Preferred Layout. The 'without mitigation' assessment scenario considers the inevitable wetland and buffer loss if the Approved Layout went ahead, and the 'with mitigation' scenario considers all the layout modifications to include the wetlands, buffers, and green corridor. Impacts in their mitigated state were considered as a **Minor Positive**. There is a degree of

uncertainty associated with the sustained function of wetlands and the green corridor, despite improvements in the Preferred Layout.

Table 11. Design and layout phase impact: Wetland loss and degradation.

Impact	**Wetland loss and degradation**			
Description of impact	**Approved layout results in loss of ecologically sensitive and important wetland habitat, reduced connectivity and greater risks to the Camphersdrift Wetland through removal of riparian vegetation.**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Incorporate the Wetland Flat and 19 m buffer into the development and fence the wetland to protect it from domestic animals and human disturbance. • Remove houses and roads from the 19 m buffer adjacent to the Camphersdrift Wetland. • Establish a green corridor providing a link between the Camphersdrift Wetland and the Wetland Flat.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Positive	
Duration	Permanent	Impact may be permanent, or in excess of 20 years	On-going	Impact will last between 15 and 20 years
Extent	Limited	Limited to the site and its immediate surroundings	Limited	Limited to the site and its immediate surroundings
Intensity	Extremely high	Natural and/ or social functions and/ or processes are severely altered	Moderate	Natural and/ or social functions and/ or processes are moderately altered
Probability	Certain / definite	There are sound scientific reasons to expect that the impact will definitely occur	Almost certain / Highly probable	It is most likely that the impact will occur
Confidence	High	Substantive supportive data exists to verify the assessment	Medium	Determination is based on common sense and general knowledge
Reversibility	Low	The affected environment will not be able to recover from the impact - permanently modified	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Low	The resource is not damaged irreparably or is not scarce
Significance	**Major - negative**		**Minor - positive**	
Comment on significance				
Cumulative impacts	The Preferred Layout option sets a better precedent for development and wetlands in George.			

7.1.4 Design and Layout Phase Conclusion

Loss of the Wetland Flat in the Approved Layout is unacceptable from an aquatic ecology perspective. The presence and local abundance of *A. knysnae* in this habitat elevates its conservation status significantly. The Preferred Layout which retains the Wetland Flat and provides buffers for all wetland areas is the recommended alternative.

7.2 Construction Phase

An Environmental Control Officer (ECO) must be appointed for the duration of the construction phase and should check on the site at least once per week as well as after rainfall. Generic impacts associated with both the Approved and Preferred Layouts are considered in the following section. These are impacts applicable for both layout scenarios.

7.2.1 IMPACT: Construction vehicles may pollute or damage wetlands

The potential impacts of operating heavy construction vehicles in the vicinity of sensitive wetland habitats are fairly easy to mitigate. In their mitigated state, the impacts are considered **Negligible** (Table 12).

Table 12. Construction phase impact: Construction vehicles may pollute or damage wetlands

Project phase	**Construction**			
Impact	**Construction vehicles may pollute or damage wetlands**			
Description of impact	**Pollution of water with petro-chemicals and destruction of plants**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Before construction begins, clearly fence off buffer areas with high visibility, durable material such as posts with orange shade-cloth supported by wire. Shade-cloth must be hammered into the ground with wooden pegs at the ground level. Signs must be erected indicating these as 'No-Go' areas. • Construction work must be stopped during and immediately following rainfall. • Vehicle refuelling must take place at the site offices in an area with sandbags immediately available to contain spills should they occur. • All construction vehicles must be checked daily for leaks. Should leaks be detected, the vehicle must be removed from the site until it has been repaired.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Short term	Impact will last between 1 and 5 years	Brief	Impact will not last longer than 1 year
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Likely	The impact may occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance				
Cumulative impacts				

7.2.2 IMPACT: Construction staff on site

These impacts generally arise due to staff ignorance of site sensitivities, lack of communication, clear boundaries and poor sanitation facilities. They are therefore easily mitigated with effective planning, clear communication and follow up by site management. These impacts are considered as **Negligible** in their mitigated state (Table 13).

Table 13. Construction phase impact: Construction staff on site

Project phase	**Construction**			
Impact	**Construction staff on site**			
Description of impact	**Litter, accidental damage, human waste disposal**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Clean and adquate toilet facilities (at least 1 toilet per 10 workers) must be provided for all staff working on site, and must be emptied on a regular basis. • Rest areas to be designated for break and lunch times and must include waste disposal (bins) to be cleaned out regularly. • All staff to be informed that no waster disposal of litter or construction materials is permitted on the site. • All staff to be briefed about designated 'no-go' areas within the wetland flat, Camphersdrift Wetland and associated buffer zones. • Staff operating heavy earth moving equipment must be informed that vehicles may not enter 'no-go' areas under any circumstances (other than for specific actions required for rehabilitation purposes). • New / casual staff must be briefed as above.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Short term	Impact will last between 1 and 5 years	Brief	Impact will not last longer than 1 year
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Rare / improbable	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	High	The affected environment will be able to recover from the impact	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance	These impacts can be easily mitigated through effective communication and regular follow ups from the construction team and foreman on site.			
Cumulative impacts	Not applicable.			

7.2.3 IMPACT: Management of materials

Effective management of materials stockpiled on site will result in a **Negligible** impact provided all mitigation measures are implemented (Table 14).

Table 14. Construction phase impact: Management of materials.

Project phase	**Construction**			
Impact	**Management of materials**			
Description of impact	**Erosion of stockpiled materials and pollution of stormwater**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Equipment and material laydown areas must be designated before construction works begin. Preferably a level location near the site offices. • Concrete or cement mixing is not permitted at or in the vicinity of wetlands or buffer areas. Any cement mixing cannot take place on bare ground. An impermeable or bunded area must be established in a way that cement slurry will not run off with stormwater into the surrounding environment. • No waste material from construction must be dumped into wetland or buffer areas, or the surrounding environment. All waste materials must be responsibly disposed of at an appropriate waste disposal facility. • Any soil or material stockpiles must be covered with a geotextile or plastic and bunded (e.g. with sand bags) to prevent erosion of the material down slopes into wetland areas.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Short term	Impact will last between 1 and 5 years	Short term	Impact will last between 1 and 5 years
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Likely	The impact may occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance	These impacts can be easily mitigated through effective managemnet of materials on site.			
Cumulative impacts	Not applicable			

7.2.4 IMPACT: Installation and upgrade of sewage connections

This section relied on information from the Civil Engineering Services report for both the Approved and Preferred Layouts (Zutari, 2018 & 2022). The installation and upgrades of sewer connections in the vicinity of delineated wetland and buffer areas are very similar with the resulting impact assessment being applicable to both layouts. Any difference between the layouts was largely related to the internal arrangement of individual residences.

No upgrades to the existing bulk sewerage reticulation system are envisaged. An existing sewerage line between the northern part of the erf connection manhole and the bulk line must be upgraded from a 110 mm diameter pipe to a 160 mm diameter pipe (Figure 18). The bulk line runs along the base of the slope immediately adjacent to the Camphersdrift Wetland, and therefore any work undertaken to connect to the bulk line will involve working on a significant slope through indigenous riparian vegetation (Figure 18). However, this area was historically cleared and maintained by the municipality to provide access to the bulk sewer line. An existing pipeline already crosses the riparian buffer connecting to the main line on the southern portion of the property.

Along with standard expected methods for installing sewer pipelines and manholes, a method statement provided by Power Construction for the upgrade of the northern sewer line was used as the basis for the impact assessment and is provided in Appendix 7. Mitigation measures provided in Table 15 are applicable to the installation of sewer lines in proximity to wetland areas or buffers as indicated in Figure 18.

The feasibility of reducing the depth and resulting disturbance footprint for the sewer line connection to be upgraded may only be determined during construction, as the contractors were not able to locate the actual position of the manhole prior to receiving the directive to cease work on the site. However, assuming all mitigation measures can be implemented, the impacts are considered **Negligible** (Table 15).

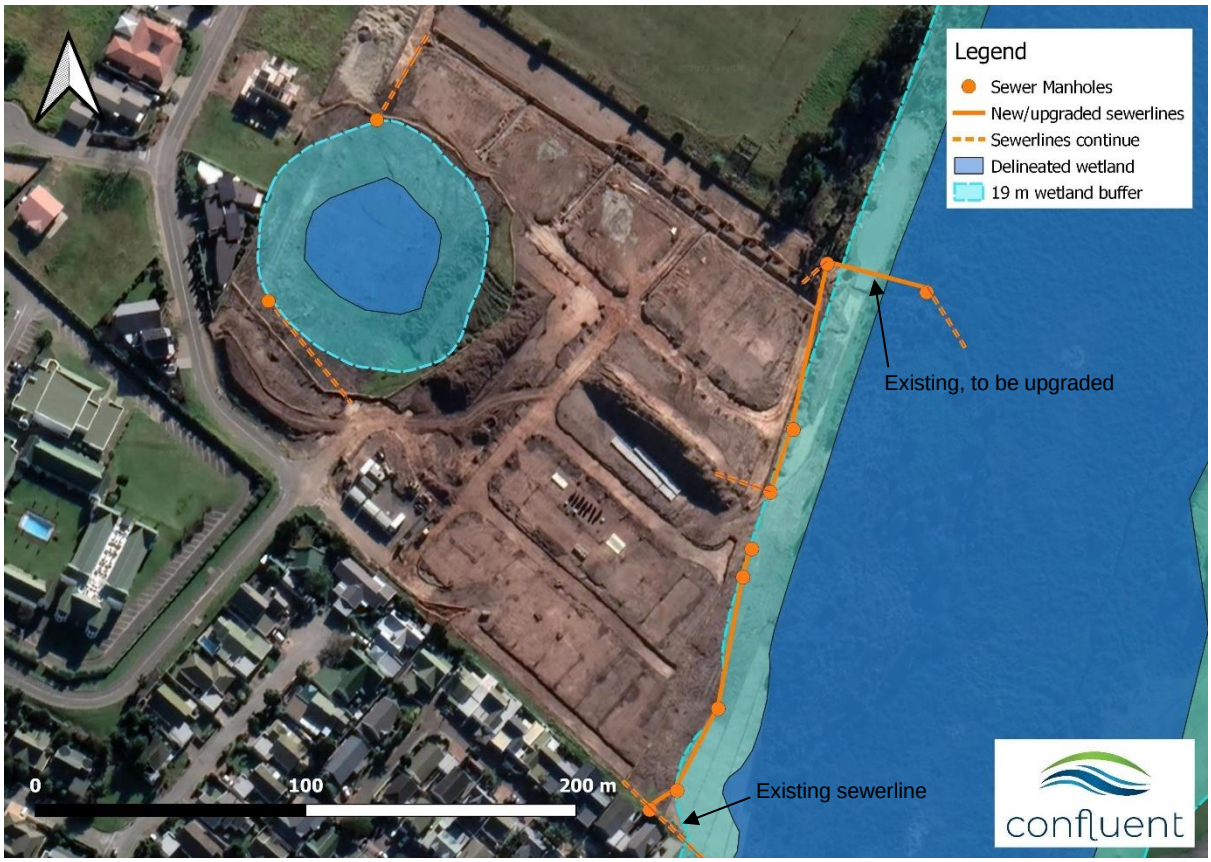


Figure 18. Mapped sewerlines and manholes for the Preferred Layout in direct proximity to wetland and buffer areas (Refer to Zutari Engineering Services report, 2022).

Table 15. Construction phase impact: Sewer line connection in Camphersdrift Wetland and buffer.

Impact	**Sewer line connections in Camphersdrift Wetland and buffer**			
Description of impact	**Disturbance to riparian vegetation and soil causing possible erosion and sedimentation in the Camphersdrift Wetland**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• Check the weather report for the proposed duration of work. As far as possible there should be no heavy rainfall predicted to occur during installation of the upgraded / new sewer lines. • The footprint of disturbance must be demarcated with temporary fencing to indicate the limit of disturbance. • Prior to commencing with excavations, a search and rescue for plants suitable for rehabilitating the slope post-works must be undertaken from within the demarcated area (above). • Identify suitable soil stockpiling and sand laydown areas on a level area near the excavation site. • Stockpiled materials need to be bunded with sandbags to prevent downslope erosion. • Attempt to replace the old pipe (110 mm) with the new pipe (160 mm) by closing off the old pipe and placing the new one at a higher level above the old decommissioned pipe. This could possibly be achieved with installation of a backdrop structure in the connection manhole. The purpose of this is to reduce the need to dig such a large, deep trench (3 m deep x 16 m wide) thus reducing the footprint of disturbance. • Minimise the footprint of disturbance from heavy machinery by excavating the trench with the excavator from one elevated position as far as possible. • Once the new pipe has been connected and the trench refilled with soil, the slope will need to be rehabilitated to ensure it does not erode. Topsoil on exposed slopes must be lightly seeded with Teff grass and a light mulch. Soil saver matting must be pegged over the soil and seed mix, followed by establishment of 3 to 4 horizontal silt fences along the slope. Rescued vegetation as well as bought plants suitable for the site must be actively re planted in small holes in the soil saver matting.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Short term	Impact will last between 1 and 5 years	Brief	Impact will not last longer than 1 year
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	High	Natural and/ or social functions and/ or processes are notably altered	Moderate	Natural and/ or social functions and/ or processes are moderately altered
Probability	Certain / definite	There are sound scientific reasons to expect that the impact will definitely occur	Likely	The impact may occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance	These impacts and mitigation measures apply in the case of both proposed layouts			
Cumulative impacts	Not applicable			

7.2.5 IMPACT: Construction of stormwater infrastructure

This assessment used the Stormwater Management and Engineering Services plan compiled by Zutari (2018 and 2022) for both the Approved and Preferred Layouts as reference. These plans were compiled as draft plans with final layout and design deferred once the development layout had been finalised. The plan includes stormwater management methods during the construction phase. In both plans, post-development runoff was approximately 5 times higher than pre-development. Both plans make use of one existing stormwater outlet draining the northern part of the development into the Camphersdrift wetland (Figure 19), and propose construction of an additional outflow to the south of the development. The new outflow would

include energy dissipation structures such as a gabion box followed by reno mattress. The impacts in their mitigated state are considered Minor (Table 16).

The difference with the Preferred Plan is the inclusion of a stormwater attenuation dam on an old, paved parking area at the end of the recently de-proclaimed Loch Lomond Avenue. Approximately 60% of the development's stormwater runoff would be diverted to the attenuation dam, which would drain more slowly into the Camphersdrift Wetland through a morning glory spillway via the existing stormwater drain (Figure 19). The attenuation dam is seen as a significant improvement to mitigating negative impacts of discharging large volumes of stormwater in the Camphersdrift Wetland. It also creates additional wetland habitat, a scenic feature, and will trap litter where it can be more easily disposed of. The remaining 40% of the development's runoff would be diverted to the new proposed outlet in the Camphersdrift Wetland to the south (Figure 19).

The more controlled release of water through the attenuation dam would also reduce the likelihood that the existing stormwater outflow point would need to be upgraded. It is currently in good condition, and if further work can be avoided in the wetland that would be preferable.

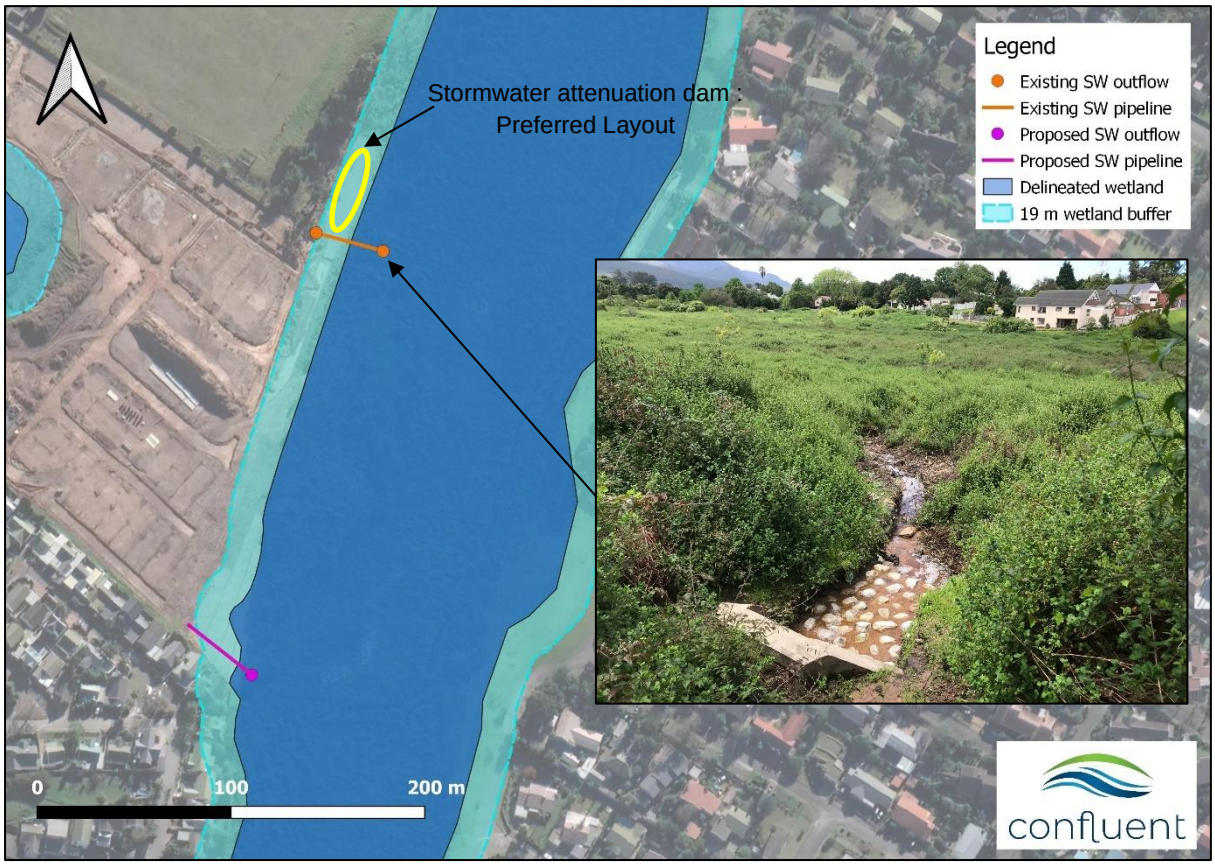


Figure 19. Location of existing and proposed stormwater outflows into the Camphersdrift Wetland indicated for both layouts, with the proposed stormwater attenuation dam for the Preferred Layout. Photographic insert indicates the existing outflow.

Table 16. Construction phase impact: Construction of stormwater infrastructure in wetland and riparian areas (both layouts)

Project phase	**Construction**			
Impact	**Approved & Preferred Layout: Construction of stormwater infrastructure in wetland and riparian areas.**			
Description of impact	**Disturbance to wetland plants and soil resulting in erosion and increased alien vegetation**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• Check the weather report for the proposed duration of work. As far as possible there should be no heavy rainfall predicted to occur during installation of the upgraded / new sewer lines. • The footprint of disturbance must be demarcated with temporary fencing to indicate the limit of disturbance. • Prior to commencing with excavations, a search and rescue for plants suitable for rehabilitating the slope post-works must be undertaken from within the demarcated area (above). • Remove topsoil first and store separately from subsoils for replacement at conclusion of the works. • Paving removed from the road to build the attenuation dam must be disposed of at a suitable facillity, or reused on the site. No construction rubble or soil may be disposed of down the slope • Identify suitable soil stockpiling and sand laydown areas on a level area near the excavation site. • Stockpiled materials need to be bunded with sandbags to prevent downslope erosion. • Construction of new outflow structure must be kept as close to the wetland 'edge' as possible to limit disturbance by heavy machinery. • At conclusion of construction, all exposed areas of wetland soil must be rehabilitated by revegetation with suitable wetland plants. • Soil on the sloped area must be replaced with a final layer of topsoil into which a light cover of grass seed (e.g. Teff) and mulch must be added. Soil saver matting must be pegged over the soil and seed mix, followed by establishment of 3 to 4 horizontal silt fences along the slope. Rescued vegetation as well as bought plants suitable for the site must be actively re planted in small holes in the soil saver matting.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Short term	Impact will last between 1 and 5 years	Short term	Impact will last between 1 and 5 years
Extent	Limited	Limited to the site and its immediate surroundings	Limited	Limited to the site and its immediate surroundings
Intensity	High	Natural and/ or social functions and/ or processes are notably altered	Moderate	Natural and/ or social functions and/ or processes are moderately altered
Probability	Likely	The impact may occur	Probable	The impact has occurred here or elsewhere and could therefore occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Minor - negative**	
Comment on significance	There is little difference in the pre- and post-mitigation significance of impact as it is not easy to mitigate impacts given the slope and difficult access to the site.			
Cumulative impacts	Not applicable			

7.2.6 IMPACT: Disruption of the wetland flat hydrology

A geohydrology study (DHS Groundwater, 2022) investigated the potential impact that the proposed development (Preferred Layout) would have on the wetland hydrology. The finding was that provided no sub-surface drainage was implemented and the foundations were no deeper than 60 cm then the Wetland Flat's hydrology should not be affected (Table 17).

Table 17. Construction phase impact: Disruption of the wetland flat hydrology

Project phase	**Construction**			
Impact	**Disruption of the wetland flat hydrology**			
Description of impact	**Reducing water in the wetland due to sub-surface drainage structures associated with the development**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Foundations must be no deeper than 1 mbgl. • No artificial groundwater table lowering is allowed. • No sub-surface drainage structures may be constructed in association with the development.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Positive	
Duration	Long term	Impact will last between 10 and 15 years	Brief	Impact will not last longer than 1 year
Extent	Very limited	Limited to specific isolated parts of the site	Very limited	Limited to specific isolated parts of the site
Intensity	Negligible	Natural and/ or social functions and/ or processes are negligibly altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur	Highly unlikely / none	Expected never to happen
Confidence	Low	Judgement is based on intuition	High	Substantive supportive data exists
Reversibility	Low	The affected environment will not be able to recover from the impact - permanently modified	High	The affected environment will be able to recover from the impact
Resource irreplaceability	High	The resource is irreparably damaged and is not represented elsewhere	High	The resource is irreparably damaged and is not represented elsewhere
Significance	**Negligible - negative**		**Negligible - positive**	
Comment on significance				
Cumulative impacts				

7.2.7 IMPACT: Stormwater management during construction

This impact is applicable to both layouts and is considered Negligible in its mitigated state.

Table 18. Construction phase impact: Soil erosion and sedimentation due to stormwater runoff during construction.

Project phase	**Construction**			
Impact	**Soil erosion and sedimentation due to stormwater runoff during construction**			
Description of impact	**Deposition of soil in wetland and riparian areas as well as potential slips**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Where concentrated flows are likely to occur, proactively install any combination of runoff protection utilising silt fencing, hay bale check dams, or sand bag. Silt fencing and hay bales are preferred. Several cutoff channels and berms have failed at the site, and should not be relied upon. • Erosion protection must beinitiated priort to commencement of construction, and be concentrated along the buffer with the Camphersdrift Wetland to protect the slope from futher slippage. • The Environmental Control Officer (ECO) appointed for the construction phase must monitor the condition of runoff reducing interventions at regular intervals, and especially after rainfall events.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Short term	Impact will last between 1 and 5 years	Brief	Impact will not last longer than 1 year
Extent	Local	Extending across the site and to nearby settlements	Limited	Limited to the site and its immediate surroundings
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Probable	The impact has occurred here or elsewhere and could therefore occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance	The impacts and mitigation measures are considered the same for both proposed layouts.			
Cumulative impacts				

7.2.8 IMPACT: Conclusion of construction

Impacts of site closure primarily relate to the site clean-up and ensuring that erosion will not occur due to poorly shaped landforms or blocked stormwater infrastructure. Following the mitigation measures provided in Table 19 will result in a **Negligible** impact to the site (Table 19). This impact relates to both the Approved and Preferred Layouts.

Table 19. Construction phase impact: Conclusion of construction

Project phase	**Construction**			
Impact	**Conclusion of construction**			
Description of impact	**Pollution of water resources and the natural environment**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• The site must be cleared of all waste materials, rubble, and debris associated with the construction phase. • Alien vegetation must all be cleared from residential, wetland and buffer areas within the site footprint prior to site closure. • All drainage structures must be checked to ensure they are free flowing with no blockages. • All landforms outside of wetland and buffer areas must be reshaped to ensure they are free draining and do not create concentrated flow paths. • There should be no exposed areas of soil. All areas should be revegetated according to the rehabilitation plan.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Short term	Impact will last between 1 and 5 years	Brief	Impact will not last longer than 1 year
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Probable	The impact has occurred here or elsewhere and could therefore occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	High	The affected environment will be able to recover from the impact	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance	These impacts can be easily mitigated through effective managemnet of site closure.			
Cumulative impacts	Not applicable			

7.2.9 Construction phase conclusions

Most of the impacts considered for the construction phase were similar whether the Approved or Preferred Layouts were adopted. The major difference between the two layouts is that continued construction in the Wetland Flat and Camphersdrift Buffer extends the footprint of disturbance into these sensitive areas. For that reason, the Preferred Layout is supported.

7.3 Operational Phase

While some responsibilities for the landowner remain for a stipulated time period post-construction (e.g. alien clearing for 1 year), the Wetland Flat will require an ongoing commitment in terms of management and maintenance. The inputs are not expected to be too onerous, mainly alien clearing, litter clean-ups, and arranging access for education, monitoring and research. At the time of writing, no firm commitment had been obtained as yet, but it was envisaged that Cape Nature could shoulder some of this responsibility. This is an important, and unconfirmed aspect of conserving the *A. knysnae* population on site.

7.3.1 Frog noise

This impact is only relevant to the Preferred Layout as it's the result of preserving the Wetland Flat that frog noise could be an issue for residents. Frog noise during site visits in the breeding season was loud. The amphibian specialist highlighted that this impact could potentially result in aggression from residents towards the wetland and frogs. Implementation of mitigation measures recommended in Table 20 will reduce this impact to an extent. But it cannot be eliminated. While this impact is considered negative for the purpose of this assessment, there may well be residents who are not affected, or even find the noise enjoyable.

Table 20. Operational phase impact: Frog noise

Project phase	**Operation**			
Impact	**Frog noise**			
Description of impact	**Residents may try to kill frogs or damage the wetland deliberately**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• Plant as many trees and shrubs as possible in areas of Public Open Space, along roads, and at parking areas in proximity to the buffer of the Wetland Flat. Use species indicated in Table 8. • Inform and educate new residents of the likelihood of significant frog noise during the breeding season, and ensure they are aware that any disruption of the wetland or its inhabitants is unlawful. • Include a section entitled 'frog noise' on the sign to be erected at the entrance to the Wetland Flat. Ensure the information is informative and encourages tolerance from residents.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Brief	Impact will not last longer than 1 year	Brief	Impact will not last longer than 1 year
Extent	Very limited	Limited to specific isolated parts of the site	Very limited	Limited to specific isolated parts of the site
Intensity	High	Natural and/ or social functions and/ or processes are notably altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Likely	The impact may occur
Confidence	High	Substantive supportive data exists to verify the assessment	Medium	Determination is based on common sense and general knowledge
Reversibility	Low	The affected environment will not be able to recover from the impact - permanently modified	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	High	The resource is irreparably damaged and is not represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance				
Cumulative impacts				

7.3.2 Frog deaths due to cars

This impact is primarily related to the Preferred Layout as there would be no habitat from which frogs could migrate and get run over in the Approved Layout. Permeability of the fence for the Wetland Flat ensures that frogs and toads can migrate into and out of the wetland. However, they run the significant risk of being run over by cars once outside of this protected area. Modifications to the fence can improve the odds that amphibians migrate out of the wetland flat and directly into the 'frog tunnel' which leads beneath the road to the green corridor (Table 21).

Table 21. Operational phase impact: Frog deaths due to cars.

Project phase	**Operation**			
Impact	**Frog deaths due to cars**			
Description of impact	**Frogs migrating from the Wetland Flat being run over by vehicles**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• Install a solid barrier along the bottom of the fence approximately 0.6 m high. This could be in the form of green plastic irrigation sheeting secured with cable ties. The barrier should 'funnel' frogs towards a gap in the barrier at the green corridor. • Ensure the 'frog tunnel' indicated on the Preferred Layout plan has been installed on the road. Culverts should be sunk approximately 20 cm below the soil ensuring seamless vegetation cover through the tunnels as frogs travel through. • Install a sign at the entrance warning drivers to reduce speeds and look out for frogs / toads. • Install speed humps either side of the frog crossing, including signage, to slow traffic.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Brief	Impact will not last longer than 1 year	Brief	Impact will not last longer than 1 year
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Likely	The impact may occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance				
Cumulative impacts				

7.3.3 Litter

Litter may be washed, thrown, or blown into both the Camphersdrift Wetland and the Wetland Flat. Litter in the stormwater attenuation dam would be easier to collect and clean up than in the Camphersdrift Wetland below, where access can be difficult. For this reason, as much of the development's stormwater as possible should be diverted to the attenuation dam as indicated in the Preferred Layout option. Cleanups of litter within the Wetland Flat would need to be undertaken by the managing body, taking care not to trample the wetland or overwhelm the site with too many people. There are minimal opportunities to mitigate this impact.

Table 22. Operational phase impact: Litter

Project phase	**Operation**			
Impact	**Litter**			
Description of impact	**Litter may be thrown, blown, or washed into the Camphersdrift Wetland and the Wetland Flat**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• Divert as much stormwater to the attenuation dam as possible as litter is easier to clean up at this point. • There are no stormwater inflows permitted to the Wetland Flat, therefore litter would either be blown or thrown into this area. Ensure sufficient public bins are installed and serviced in the Public Open Space areas where they can be easily cleared out on a regular basis by the Municipality. • The municipality must undertake routine maintenance of stormwater outflows in the Camphersdrift Wetland which should include clearing litter from the outflow points and ensuring the free flow of water.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Short term	Impact will last between 1 and 5 years	Short term	Impact will last between 1 and 5 years
Extent	Limited	Limited to the site and its immediate surroundings	Limited	Limited to the site and its immediate surroundings
Intensity	Low	Natural and/ or social functions and/ or processes are somewhat altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Likely	The impact may occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	High	The affected environment will be able to recover from the impact	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance				
Cumulative impacts				

7.3.4 Alien vegetation and maintenance of green spaces

This impact would be applicable to both the Preferred and Approved Layouts. However, there would be much less green space to manage in the Approved Layout which only had a central square of lawn. The Preferred Layout has the green corridor and buffer areas which would need ongoing removal of alien vegetation and careful maintenance to ensure frogs are protected (Table 23).

Table 23. Operational phase impact: Alien vegetation and maintenance of green spaces

Project phase	**Operation**			
Impact	**Alien vegetation and maintenance of green spaces**			
Description of impact	**Habitat degradation due to aliens and reduced amphibian survival due to practices like mowing**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• Alien vegetation clearing must be undertaken in recently planted areas such as the green corridor, Camphersdrift wetland and attenuation dam. Recent disturbance of soil will render these areas highly susceptible to alien encroachment. Follow up clearing should be conducted every 6 months for at least 2 years.** **• Mowing must be restriced to areas designated as public open space within the development only. No mowing must take place within the green corridor or along the buffer adjacent to the Camphersdrift Wetland. Mowing suppresses the growth of new plants and reduces the interception of surface runoff by plants.** **• Unmowed grass and vegetation should be continuous between the Wetland Flat, green corridor, and Camphersdrift buffer so that migrating frogs are not exposed to predation or extreme temperatures.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Long term	Impact will last between 10 and 15 years	Brief	Impact will not last longer than 1 year
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Probable	The impact has occurred here or elsewhere and could therefore occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance				
Cumulative impacts				

7.3.5 Operational phase conclusions

Many of the potential impacts associated with the operational phase would only be relevant to the Preferred Layout option. This is because the conserved habitat would require ongoing protection and maintenance until vegetation has established and stabilised the site. In contrast, there would be minimal habitat remaining to protect should the Approved Layout be implemented. Therefore, the Preferred Layout is recommended.

7.4 Cumulative Impacts

The development site is located within a densely urbanised suburb with extensive hard surfaces and a history of encroachment into wetland areas. The Preferred Layout was adapted to accommodate a significantly larger buffer along the Camphersdrift Wetland compared to neighbouring properties. The inclusion of a stormwater attenuation dam reduces the volumes and velocity of stormwater, as well as litter entering the Camphersdrift Wetland, mitigating this impact to an extent which has not been considered or implemented in other areas. These measures represent a diversion from the 'development as usual approach' in this area and

reduce the cumulative impact of the development if the Preferred Layout is adopted. Preservation of the Wetland Flat aims to ensure that A. knysnae is protected in this now somewhat isolated population. There may have been similar habitats previously located in the area where populations were eliminated, but if the Preferred Alternative is implemented the cumulative impact of biodiversity loss in the area will be reduced.

7.5 No-Go Alternative

Should the development not be permitted to proceed, the implication is that the site in its entirety would need to be rehabilitated. Extensive earthworks including the construction of platforms and road cuttings were made, and the rehabilitation effort would be significant. Many of the recommendations in the rehabilitation plan in this report would be applicable, from a wide-scale perspective. While complete rehabilitation would always be the most attractive option from an environmental perspective, the pressure for development in well-located urban areas is a reality. As many alterations to the original Approved Layout have been made with specialist inputs in a significant attempt to mitigate as many impacts as possible, it is recommended that the Preferred Alternative be adopted as opposed to the No-Go option.

7.6 Mitigation Measures Checklist

A checklist of all the mitigation measures recommended at each phase of the development is listed below for ease of implementation by the developer and monitoring by the ECO.

7.6.1 Design and Layout Phase (Layout specific)

The Preferred Layout was put together using feedback from specialist studies of the site. The Approved Layout did not take any site sensitivities into account. Therefore, the Preferred Layout is the alternative supported from an aquatic specialist perspective. The Approved Layout would not be supported.

7.6.2 Construction Phase (Applicable to both layouts)

- ✓ An Environmental Control Officer (ECO) must be appointed for the duration of the construction phase and should check on the site at least once per week as well as after rainfall.

<u>Construction vehicles</u>

- ✓ Before construction begins, clearly fence off buffer areas with high visibility, durable material such as posts with orange shade-cloth supported by wire. Shade-cloth must be hammered into the ground with wooden pegs at ground level. Signs must be erected indicating these as 'No-Go' areas.
- ✓ Construction work must be stopped during and immediately following rainfall.
- ✓ Vehicle refuelling must take place at the site offices in an area with sandbags immediately available to contain spills should they occur.
- ✓ All construction vehicles must be checked daily for leaks. Should leaks be detected, the vehicle must be removed from the site until it has been repaired.

Construction staff on site

- ✓ Clean and adequate toilet facilities (at least 1 toilet per 10 workers) must be provided for all staff working on site and must be emptied on a regular basis.
- ✓ Rest areas to be designated for break and lunch times and must include waste disposal (bins) to be cleaned out regularly.
- ✓ All staff to be informed that no waste disposal of litter or construction materials is permitted on the site.
- ✓ All staff to be briefed about designated 'no-go' areas within the wetland flat, Camphersdrift Wetland and associated buffer zones.
- ✓ Staff operating heavy earth moving equipment must be informed that vehicles may not enter 'no-go' areas under any circumstances (other than for specific actions required for rehabilitation purposes).
- ✓ New / casual staff must be briefed as above.

Management of materials

- ✓ Equipment and material laydown areas must be designated before construction works begin. Preferably a level location near the site offices.
- ✓ Concrete or cement mixing is not permitted at or in the vicinity of wetlands or buffer areas. Any cement mixing cannot take place on bare ground. An impermeable or bunded area must be established in a way that cement slurry will not run off with stormwater into the surrounding environment.
- ✓ No waste material from construction must be dumped into wetland or buffer areas, or the surrounding environment. All waste materials must be responsibly disposed of at an appropriate waste disposal facility.
- ✓ Any soil or material stockpiles must be covered with a geotextile or plastic and bunded (e.g. with sand bags) to prevent erosion of the material down slopes into wetland areas.

Sewer line connections in Camphersdrift wetland and buffers

- ✓ Check the weather report for the proposed duration of work. As far as possible there should be no heavy rainfall predicted to occur during installation of the upgraded / new sewer lines.
- ✓ The footprint of disturbance must be demarcated with temporary fencing to indicate the limit of disturbance.
- ✓ Prior to commencing with excavations, a search and rescue for plants suitable for rehabilitating the slope post-works must be undertaken from within the demarcated area (above).
- ✓ Identify suitable soil stockpiling and sand laydown areas on a level area near the excavation site.
- ✓ Stockpiled materials need to be bunded with sandbags to prevent downslope erosion.
- ✓ Attempt to replace the old pipe (110 mm) with the new pipe (160 mm) by closing off the old pipe and placing the new one at a higher level above the old, decommissioned pipe. This could possibly be achieved with installation of a backdrop structure in the connection manhole. The purpose of this is to reduce the need to dig such a large, deep trench (3 m deep x 16 m wide) thus reducing the footprint of disturbance.
- ✓ Minimise the footprint of disturbance from heavy machinery by excavating the trench with the excavator from one elevated position as far as possible.

- ✓ Once the new pipe has been connected and the trench refilled with soil, the slope will need to be rehabilitated to ensure it does not erode. Topsoil on exposed slopes must be lightly seeded with Teff grass and a light mulch. Soil saver matting must be pegged over the soil and seed mix, followed by establishment of 3 to 4 horizontal silt fences along the slope. Rescued vegetation as well as bought plants suitable for the site must be actively re planted in small holes in the soil saver matting.

Stormwater management during construction

- ✓ Where concentrated flows are likely to occur, proactively install any combination of runoff protection utilising silt fencing, hay bale check dams, or sandbags. Silt fencing and hay bales are preferred. Several cutoff channels and berms have failed at the site and should not be relied upon.
- ✓ Erosion protection must be initiated prior to commencement of construction and be concentrated along the buffer with the Camphersdrift Wetland to protect the slope from further slippage.
- ✓ The Environmental Control Officer (ECO) appointed for the construction phase must monitor the condition of runoff reducing interventions at regular intervals, and especially after rainfall events.

Construction of stormwater infrastructure

- ✓ Check the weather report for the proposed duration of work. As far as possible there should be no heavy rainfall predicted to occur during installation of the upgraded / new sewer lines.
- ✓ The footprint of disturbance must be demarcated with temporary fencing to indicate the limit of disturbance.
- ✓ Prior to commencing with excavations, a search and rescue for plants suitable for rehabilitating the slope post-works must be undertaken from within the demarcated area (above).
- ✓ Remove topsoil first and store separately from subsoils for replacement at conclusion of the works.
- ✓ Paving removed from the road to build the attenuation dam must be disposed of at a suitable facillity or reused on the site. No construction rubble or soil may be disposed of down the slope.
- ✓ Identify suitable soil stockpiling and sand laydown areas on a level area near the excavation site.
- ✓ Stockpiled materials need to be bunded with sandbags to prevent downslope erosion.
- ✓ Construction of new outflow structure must be kept as close to the wetland 'edge' as possible to limit disturbance by heavy machinery.
- ✓ At conclusion of construction, all exposed areas of wetland soil must be rehabilitated by revegetation with suitable wetland plants.
- ✓ Soil on the sloped area must be replaced with a final layer of topsoil into which a light cover of grass seed (e.g. Teff) and mulch must be added. Soil saver matting must be pegged over the soil and seed mix, followed by establishment of 3 to 4 horizontal silt fences along the slope. Rescued vegetation as well as bought plants suitable for the site must be actively re planted in small holes in the soil saver matting.

Disruption of the wetland flat hydrology

- ✓ Foundations must be no deeper than 1 mbgl.
- ✓ No artificial groundwater table lowering is allowed.
- ✓ No sub-surface drainage structures may be constructed in association with the development.

Conclusion of construction

- ✓ The site must be cleared of all waste materials, rubble, and debris associated with the construction phase.
- ✓ Alien vegetation must all be cleared from residential, wetland and buffer areas within the site footprint prior to site closure.
- ✓ All drainage structures must be checked to ensure they are free flowing with no blockages.
- ✓ All landforms outside of wetland and buffer areas must be reshaped to ensure they are free draining and do not create concentrated flow paths.
- ✓ There should be no exposed areas of soil. All areas should be revegetated according to the rehabilitation plan.

7.6.3 Operational Phase

Frog noise

- ✓ Plant as many trees and shrubs as possible in areas of Public Open Space, along roads, and at parking areas in proximity to the buffer of the Wetland Flat. Use species indicated in Table 8.
- ✓ Inform and educate new residents of the likelihood of significant frog noise during the breeding season, and ensure they are aware that any disruption of the wetland or its inhabitants is unlawful.
- ✓ Include a section entitled 'frog noise' on the sign to be erected at the entrance to the Wetland Flat. Ensure the information is informative and encourages tolerance from residents.

Frog deaths due to cars

- ✓ Install a solid barrier along the bottom of the fence approximately 0.6 m high. This could be in the form of green plastic irrigation sheeting secured with cable ties. The barrier should 'funnel' frogs towards a gap in the barrier at the green corridor.
- ✓ Ensure the 'frog tunnel' indicated on the Preferred Layout plan has been installed on the road. Culverts should be sunk approximately 20 cm below the soil ensuring seamless vegetation cover through the tunnels as frogs travel through.
- ✓ Install a sign at the entrance warning drivers to reduce speeds and look out for frogs / toads.
- ✓ Install speed humps either side of the frog crossing, including signage, to slow traffic.

Litter

- ✓ Divert as much stormwater to the attenuation dam as possible as litter is easier to clean up at this point.

- ✓ There are no stormwater inflows permitted to the Wetland Flat, therefore litter would either be blown or thrown into this area. Ensure sufficient public bins are installed and serviced in the Public Open Space areas where they can be easily cleared out on a regular basis by the Municipality.
- ✓ The municipality must undertake routine maintenance of stormwater outflows in the Camphersdrift Wetland which should include clearing litter from the outflow points and ensuring the free flow of water.

Alien vegetation and maintenance of green spaces

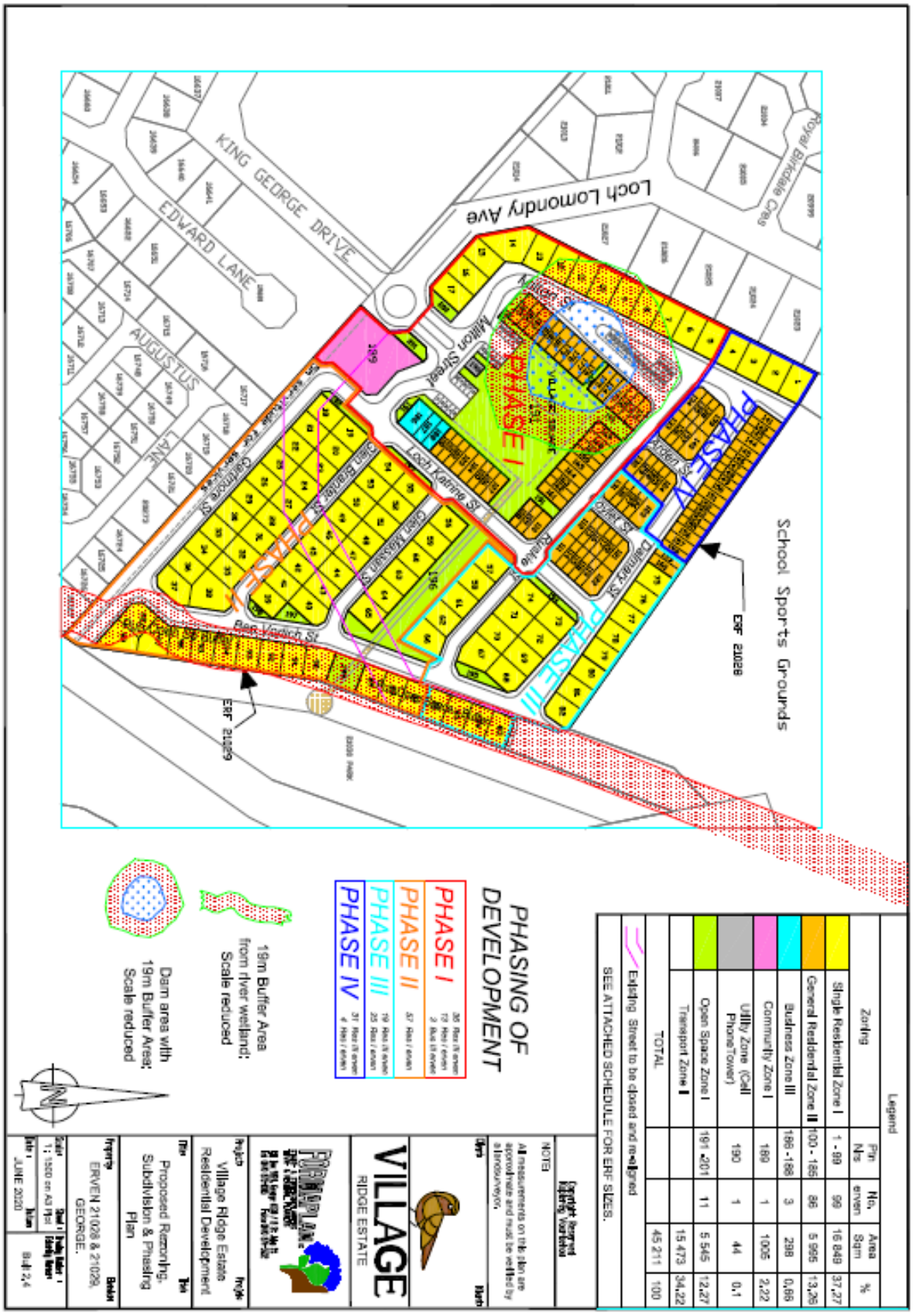
- ✓ Alien vegetation clearing must be undertaken in recently planted areas such as the green corridor, Camphersdrift wetland and attenuation dam. Recent disturbance of soil will render these areas highly susceptible to alien encroachment. Follow up clearing should be conducted every 6 months for at least 1 year.
- ✓ Mowing must be restriced to areas designated as public open space within the development only. No mowing must take place within the green corridor or along the buffer adjacent to the Camphersdrift Wetland. Mowing suppresses the growth of new plants and reduces the interception of surface runoff by plants.
- ✓ Unmowed grass and vegetation should be continuous between the Wetland Flat, green corridor, and Camphersdrift buffer so that migrating frogs are not exposed to predation or extreme temperatures.

8. CONCLUSIONS

Adoption of the Approved Layout that formed the basis of the original development which commenced in May 2021 would have resulted in serious and permanent loss of ecologically important and sensitive wetland habitat. With specialist inputs, the layout was revised to accommodate sensitive aquatic habitats and reduce operational phase impacts on wetlands such as the discharge of stormwater. The Preferred Layout is supported from an aquatic specialist perspective, provided all the mitigation measures stipulated in this report are fully implemented.

9. APPENDICES

9.1 Approved layout of Village Ridge



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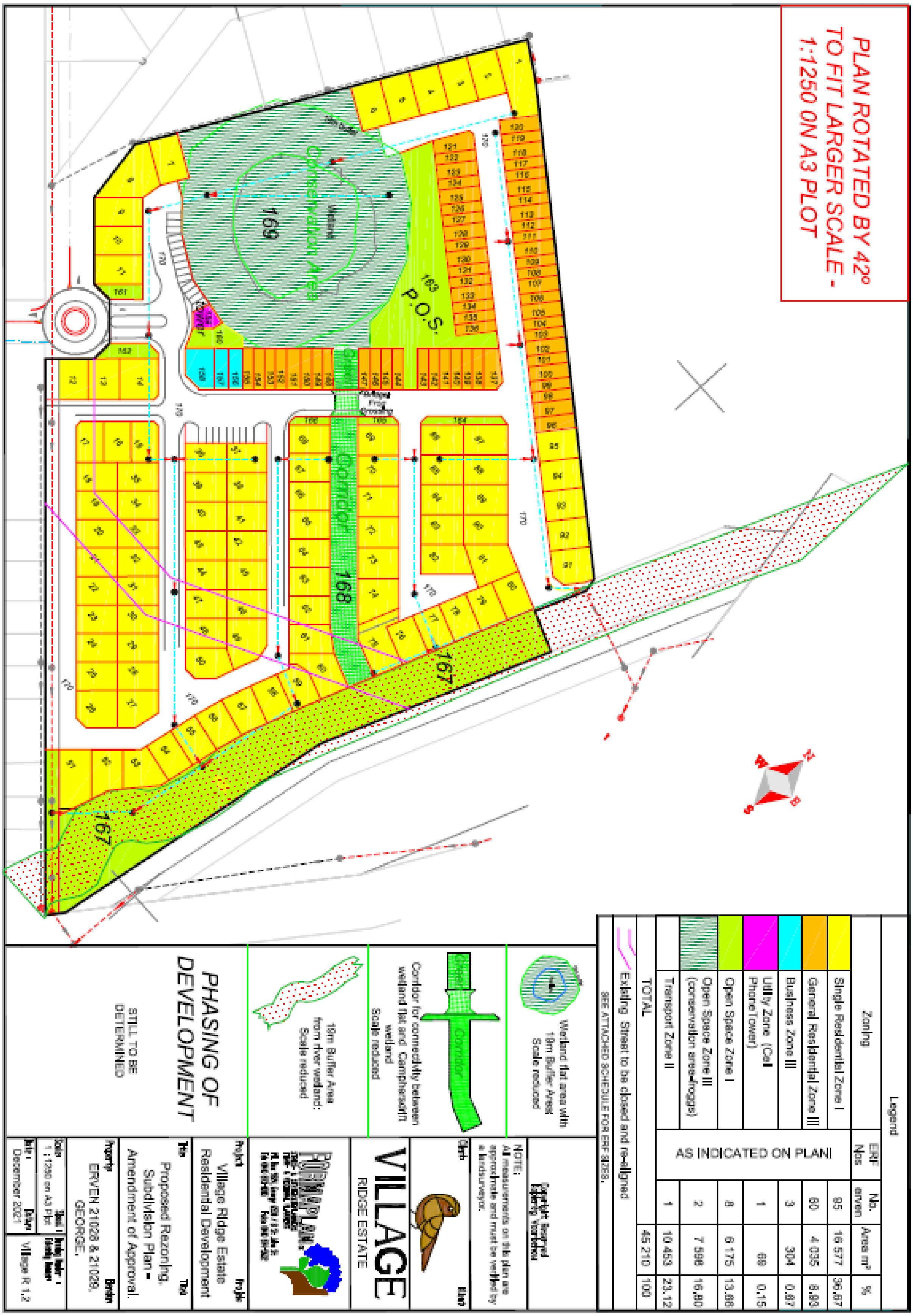
9.2 Preferred layout of Village Ridge



9.3 Wetland PES Assessment Methods

9.3.1 Channelled Valley-Bottom Wetland (Camphersdrift)

The Present Ecological State (PES) of the wetland was assessed using the Level 1 WET-Health assessment tool developed by Macfarlane *et al*. (2008). The tool aims to assess the integrity of a wetland which is defined as a measure of the deviation of wetland structure and function from the wetland's natural reference condition. The method combines an assessment of hydrological, geomorphological and vegetation health in three modules.

Data collection involved a desktop review of the extent and intensity of catchment land use impacts and was undertaken using historical and recent aerial imagery of the site (Chief Directorate: National Geo-spatial Information and satellites). Fieldwork onsite involved the identification and recording of observable impacts to the wetland at the site of relevant activities as well as at reference points upstream and downstream of the activities. The magnitude of observed impacts to the hydrological, geomorphological and vegetation components of the wetland were calculated and combined as per the tool to provide a measure of the overall wetland condition of the wetland. The condition ranges in scale from 1-10 and resultant scores were then used to assign the wetland into one of six PES categories as shown in Table 24.

Table 24.Wetland Present Ecological State (PES) categories and impact descriptions.

Ecological Category	Description	Impact Score
A	Unmodified, natural.	0 – 0.9
B	Largely natural with few modifications / in good health. A small change in natural habitats and biota may have taken place but the ecosystem functions are still predominantly unchanged.	1 – 1.9
C	Moderately modified / fair condition. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	2 – 3.9
D	Largely modified / poor condition. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	4 – 5.9
E	Seriously modified / very poor condition. The loss of natural habitat, biota and basic ecosystem functions is extensive.	6 – 7.9
F	Critically modified / totally transformed. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota.	8 - 10

9.3.2 Wetland Flat

The Wetland-IHI and Wet-Health assessment methods are not applicable to wetland flats because they currently do not include a geomorphology module that is relevant to wetland flats (or depression wetlands). These methods were developed for floodplain, peat and valley-bottom wetlands Therefore, the wetland flat was assessed using the RDM-99 method to determine the PES (DWAF, 1999).

The RDM-99 method evaluates a range of impacts potentially affecting the hydrology, water quality, geomorphology and biota of depressions and wetland flats. These impacts are scored from 0 – 5, with 0 being critically modified, and 5 being natural. Each score is allocated a level

of confidence ranging from 1 being low confidence up to 4 being very high confidence. The end result is a PES score with the same categories as those presented Table 24.

9.4 Wetland EIS Assessment Methods

The same method was applied to both wetlands associated with the site. The revised method for the determination of the EIS considers the three following ecological aspects (Rountree *et al*., 2013):

- **Ecological importance and sensitivity**
  - Biodiversity support including rare species and feeding/breeding/migration;
  - Protection status, size and rarity in the landscape context;
  - Sensitivity of the wetland to floods, droughts and water quality fluctuations.
- **Hydro-functional importance**
  - Flood attenuation;
  - Streamflow regulation;
  - Water quality enhance through sediment trapping and nutrient assimilation;
  - Carbon storage
- **Direct human benefits**
  - Water for human use and harvestable resources;
  - Cultivated foods;
  - Cultural heritage;
  - Tourism, recreation, education and research.

Each criterion is scored between 0 and 4, and the average of each subset of scores is used to derive a score for each of the three components listed above. The highest score is used to determine the overall Importance and Sensitivity category of the wetland system (Table 25).

Table 25. Ecological importance and sensitivity categories for wetlands. Interpretation of average scores for biotic and habitat determinants.

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

9.5 Impact Assessment Methods

Criteria are ascribed for each predicted impact. These include the intensity (size or degree scale), which also includes the type of impact, being either a positive or negative impact; the duration (temporal scale); and the extent (spatial scale), as well as the probability (likelihood). The methodology is quantitative, whereby professional judgement is used to identify a rating for each criterion based on a seven-point scale (Table 26) and the significance is auto-generated using a spreadsheet through application of the calculations.

For each predicted impact, certain criteria are applied to establish the likely **significance** of the impact, firstly in the case of no mitigation being applied and then with the most effective mitigation measure(s) in place.

These criteria include the **intensity** *(*size or degree scale), which also includes the **nature** of impact, being either a positive or negative impact; the **duration** (temporal scale); and the **extent** (spatial scale). These numerical ratings are used in an equation whereby the **consequence** of the impact can be calculated. Consequence is calculated as follows:

Consequence = type x (intensity + duration + extent)

To calculate the significance of an impact, the **probability** (or likelihood) of that impact occurring is applied to the consequence.

Significance = consequence x probability

Depending on the numerical result, the impact would fall into a significance category as **negligible, minor, moderate or major**, and the type would be either positive or negative.

Table 26. Assessment criteria for the evaluation of impacts

Criteria	Numeric Rating	Category	Description
Duration	1	Immediate	Impact will self-remedy immediately
	2	Brief	Impact will not last longer than 1 year
	3	Short term	Impact will last between 1 and 5 years
	4	Medium term	Impact will last between 5 and 10 years
	5	Long term	Impact will last between 10 and 15 years
	6	On-going	Impact will last between 15 and 20 years
	7	Permanent	Impact may be permanent, or in excess of 20 years
Extent	1	Very limited	Limited to specific isolated parts of the site
	2	Limited	Limited to the site and its immediate surroundings
	3	Local	Extending across the site and to nearby settlements
	4	Municipal area	Impacts felt at a municipal level
	5	Regional	Impacts felt at a regional level
	6	National	Impacts felt at a national level
	7	International	Impacts felt at an international level
Intensity	1	Negligible	Natural and/ or social functions and/ or processes are negligibly altered
	2	Very low	Natural and/ or social functions and/ or processes are slightly altered
	3	Low	Natural and/ or social functions and/ or processes are somewhat altered
	4	Moderate	Natural and/ or social functions and/ or processes are moderately altered

Criteria	Numeric Rating	Category	Description
	5	**High**	Natural and/ or social functions and/ or processes are notably altered
	6	**Very high**	Natural and/ or social functions and/ or processes are majorly altered
	7	**Extremely high**	Natural and/ or social functions and/ or processes are severely altered
Probability	**1**	**Highly unlikely / None**	Expected never to happen
	2	**Rare / improbable**	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere
	3	**Unlikely**	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
	4	**Probable**	Has occurred here or elsewhere and could therefore occur
	5	**Likely**	The impact may occur
	6	**Almost certain / Highly probable**	It is most likely that the impact will occur
	7	**Certain / Definite**	There are sound scientific reasons to expect that the impact will definitely occur

When assessing impacts, broader considerations are also considered. These include the level of confidence in the assessment rating; the reversibility of the impact; and the irreplaceability of the resource as set out in (Table 27, Table 28, and Table 29), respectively.

Table 27. Definition of confidence ratings.

Category	Description
Low	Judgement is based on intuition
Medium	Determination is based on common sense and general knowledge
High	Substantive supportive data exists to verify the assessment

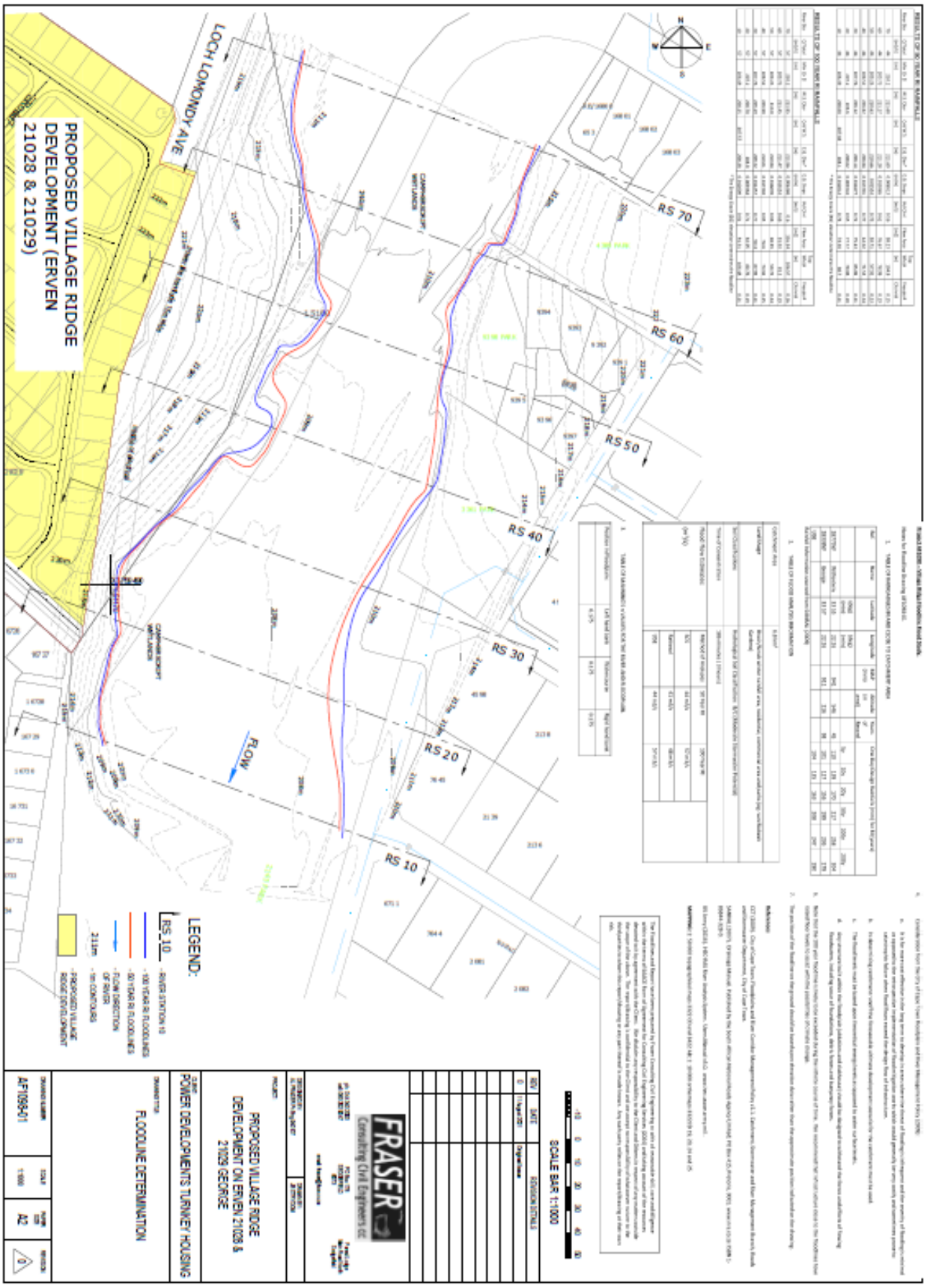
Table 28. Definition of reversibility ratings.

Category	Description
Low	The affected environment will not be able to recover from the impact - permanently modified
Medium	The affected environment will only recover from the impact with significant intervention
High	The affected environmental will be able to recover from the impact

Table 29. Definition of irreplaceability ratings.

Category	Description
Low	The resource is not damaged irreparably or is not scarce
Medium	The resource is damaged irreparably but is represented elsewhere

9.6 Floodlines determined by A. Fraser (based on approved layout)



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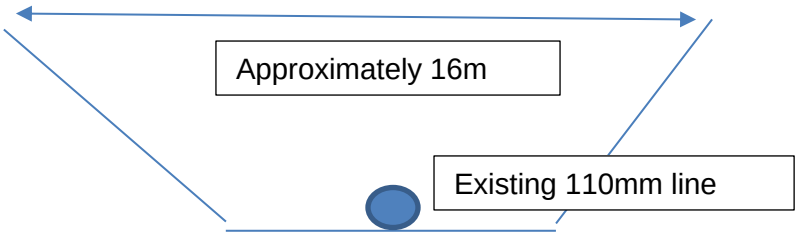
9.7 Method statement for sewer line upgrade

Contract: 503048 Zutari – The Village Ridge
Operation: Sewer Reticulation (Connection of The Ridge Village to Municipal bulk sewer)
Scope: Exposing of existing sewer line and upgrading of 110mm to a 160mm diameter line.

1. Resources:
Plant
• Excavator • Plate compactor • Small bush hand clearing equipment • TLB
People
• 3 Labourers • Environmental Control Officer (ECO) • Chipper SA • Foreman/Supervisor • Trimming team • Sewer team
Timing
• Trial and error method will be followed to establish the position of the existing manhole. This could take up to 1 week depending on the conditions encountered in the thick vegetated area. • Excavated material will be stockpiled on the existing paved area and will take up to 3-5 days. • Installation/Backfilling will take 1 week to complete. • Rehabilitation process will take up to 1 week to complete.
Materials
• 160 Class 34 uPVC sewer pipe (new pipe to be installed). • Type of 110mm existing pipe is unknown at this stage. Pipe will be disposed at municipal off-site if it is indeed a uPVC pipe. The type of pipe will only be determined once works commence. • Sandbags for silt traps (Sandbag method)
2. Method Statement:
• Instruction to be given by the Engineer to proceed with clearing the environmentally sensitive area under supervision of ECO. • Vegetation will be cleared using small bush hand clearing equipment to establish where the existing manhole is by Chipper SA. No earthworks will be done at this stage, still in process of locating the existing manhole. • ECO will be consulted during clearing process to do a search and rescue operation for indigenous vegetation that can be used during rehabilitation process. • A trial-and-error method will be followed to establish the exact position of the existing manhole by considering the manholes downstream and the existing 110mm pipe upstream. • Once the position of the existing manhole has been established, a survey will be done, and this information will be given to the Engineer to determine design. • The work area will be clearly demarcated by the Contractor to prevent machinery/workers from moving outside of the dedicated work area. • The relevant wayleaves to work underneath the power line will be obtained and care will be taken when working underneath the overhead power line to avoid any damage/injury. • Once the position of the existing manhole has been established, the exposing/excavation of the existing 110mm diameter line will be done with an excavator. • Existing paved area will be used as a laydown area for the old and new sewer pipes, as well as the bulk of the excavated material will be carted by a TLB to the existing paved area. • Area where machines may not go will be clearly demarcated upon the establishment of the position of the manhole. No machines may move beyond the existing manhole position. Machines may also not move outside the 16m wide working zone as per below. This 16m working zone will be determined once we see conditions on site.

- Working area as per the below 16m. Machine will establish access track within these boundaries. The working area might vary depending on the conditions encountered on site. This will be determined once we see conditions on site.
- Both sides of trench will be utilized. The one side will be used to stockpile minimal backfill material and the other side will be used as an access track for machine.
- Excavation will happen from the bottom to the top.
- The deep trench (approximately 3m deep) will be sloped 1:2 as a preventative measure for trench collapses, thus a total width of 8m either side of the sewer line will be excavated. The bulk of the excavated material will be stockpiled on the existing paved area. Minimal material for backfilling will be stockpiled next to the trench.



- The 110mm existing sewer pipe will be removed and the new 160mm will be laid. Existing pipeline to be removed by machine within the working area specified above and stockpiled on the existing paved area.
- A silt trap is to be constructed around the perimeter of the work area as a preventative measure for any possible silt runoff (sand bag method).
- The new 160mm line will be backfilled using plate compactor.
- The area will be trimmed up neatly after operation has been completed.
- The total work area will be revegetated using a combination of search & rescue plants from the site and/or seeding.
- The work area will be covered and stacked in a similar fashion as the steep sloped areas to the west.

3. Quality Control:

- Quality control will be done as per the required contract specifications.

4. Health and Safety:

- Risk assessment & Daily Tasks to be discussed during the toolbox talks, prior to the start of the specific activities.
- Minimum PPE must be worn at all times.

5. Environment:

- Site and environment to be kept clean at all times.
- NO EMP on contract. Contractor to comply to their own Generic EMP.
- Environmental sensitive area. Works will only be done as per the above method and great care will be taken to not step out of this boundary area.

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