Aquatic Biodiversity Impact Assessment

Proposed construction of a new 14.5 ML reservoir for bulk water supply on RE/325, Pacaltsdorp (West), George.

Prepared for Cape EAPrac (Pty) Ltd

by

Dr. Jackie Dabrowski

Confluent Environmental (Pty) Ltd

confluent
aquatic consulting & research

Tel: 083 256 3159
Email: jackie@confluent.co.za

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;

• This document and all information contained herein is and will remain the intellectual property of Confluent Environmental. This document, in its entirety or any portion thereof, may not be altered in any manner or form, for any purpose without the specific and written consent of the specialist investigators.

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

Jackie Dabrowski (Ph.D., Pr.Sci.Nat. *Aquatic Science*)
SACNASP Registration Number 115166
Co-director: Confluent Environmental (Pty) Ltd

Qualifications: BSc, BSc Honours (Entomology), MSc & PhD (Veterinary Science)

Expertise: > 13 years' experience working on aquatic ecosystems across South Africa, with a focus on the Southern Cape in the last 6 years. Includes research and consulting expertise, having published > 10 water-related research articles and compiled > 150 aquatic specialist reports. Research and consulting have been in a range of sectors including agriculture, urban developments, linear structures, renewable energy, conservation, and mining.

TABLE OF CONTENTS

confluent
aquatic consulting & research

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Confluent Environmental Pty (Ltd) were appointed by Cape EAPrac to provide aquatic specialist inputs to the proposed 14.5ML reservoir for bulk water supply to Pacalstdorp in George, Western Cape (Figure 1). Recent low-cost housing developments on serviced erven and increasing densification in the Pacaltsdorp area have increased the demand for water in the area. The proposed reservoir has two alternative site locations on RE/325 which is a large Erf owned by the George Municipality (Figure 1).

Option C is located adjacent to Olympic Street and west of the Pacaltsdorp Sportsfields, while Option B which is the preferred alternative, is located southwest of the sportsfields (Figure 1).

Figure 1. Proposed alternative sites for the location of a 14.5 ML reservoir, pumpstation and pipelines on RE/325, Pacaltsdorp.

1.1 The Proposed Development

Details for the proposed reservoir were obtained from the engineering report provided by Royal Haskoning DHV (2023). The proposed layout indicates the infrastructure required in 2 phases. The first phase is for a 14.5ML reservoir, pump station and pipelines, followed by a second phase which includes two water towers, a second 14.5ML reservoir and pump station. The second phase would take place at some point in the future as dictated by demand. Interconnecting pipelines between the existing reservoir and water tower, and the new infrastructure will be required, and are proposed to run mostly outside the perimeter of the sports ground. A more detailed overview of the proposed layout of infrastructure at the preferred location (Option B) is provided in Figure 2. The reservoir site is accessed by two existing dirt roads that run along the western and southern boundary of the sports ground. Pipelines will be laid adjacent to both roads, and while the western road is in good condition, the southern road will require improvement to ensure safe and easy access for the pipeline maintenance. The site layout has already been informed by the wetland delineation and buffers determined in this assessment. Inputs were also provided regarding stormwater attenuation and protection from reservoir scouring on site which have been accommodated in the layout through provision of level spreaders.

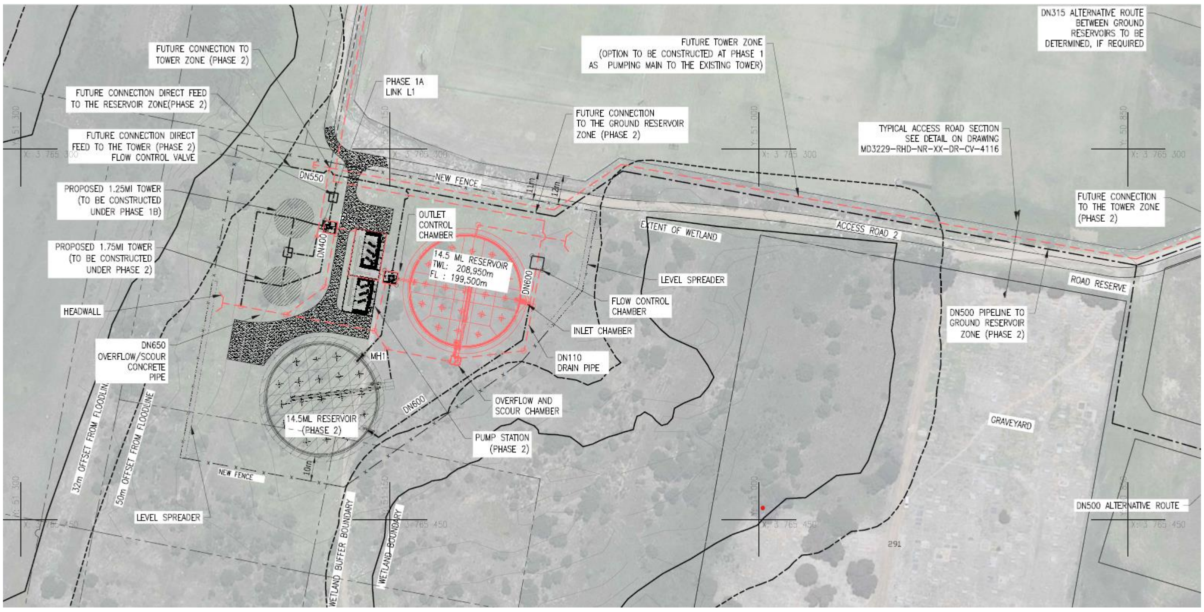

Figure 2. Proposed bulk water supply infrastructure at the preferred location in Pacalstorp. Red lines indicate infrastructure proposed for first phase and black lines indicate phase 2 infrastructure.

Earthworks, concrete works and shuttering (reservoir and roof) are required to construct the new 14.5ML reservoir in which to store potable water. Preliminary design and construction details for the reservoir have been provided with the following approach:

- Excavate to 1m depth over the entire structure footprint (and stockpile for use as fill around the reservoir and site landscaping).
- Remove all unsuitable material as determined on site by the geotechnical engineer.
- Prepare all surfaces 150 mm *in situ* preparation, rip and recompacted to 93% MDD.
- Replace any unsuitable material with fill up to the excavation level – using G5 material placed in 175 mm layers and compacted to 95% MDD.
- Construct engineered fill, 500mm thick using crushed stone G4/G5, stabilised to C4 with 5% cement, compacted in layers 175 mm thick, on a basal reinforcement geogrid.

The 1m deep foundation excavation, *in situ* preparation, engineered fill and reservoir wall section are indicated in Figure 3.

Stormwater and scouring

The proposal to manage stormwater and reservoir scouring events is to attenuate most of the water on the reservoir site. Scour water would be split in two directions (west / east) and the outflow is indicated as headwalls in Figure 2. The fenceline of the reservoir is specified to be set in concrete, which will be slightly raised around the perimeter to retain and spread scour and stormwater on the site. The site is mostly level, but water will be directed to protected (rock-lined) channels from where it can seep into the ground. (Figure 17).

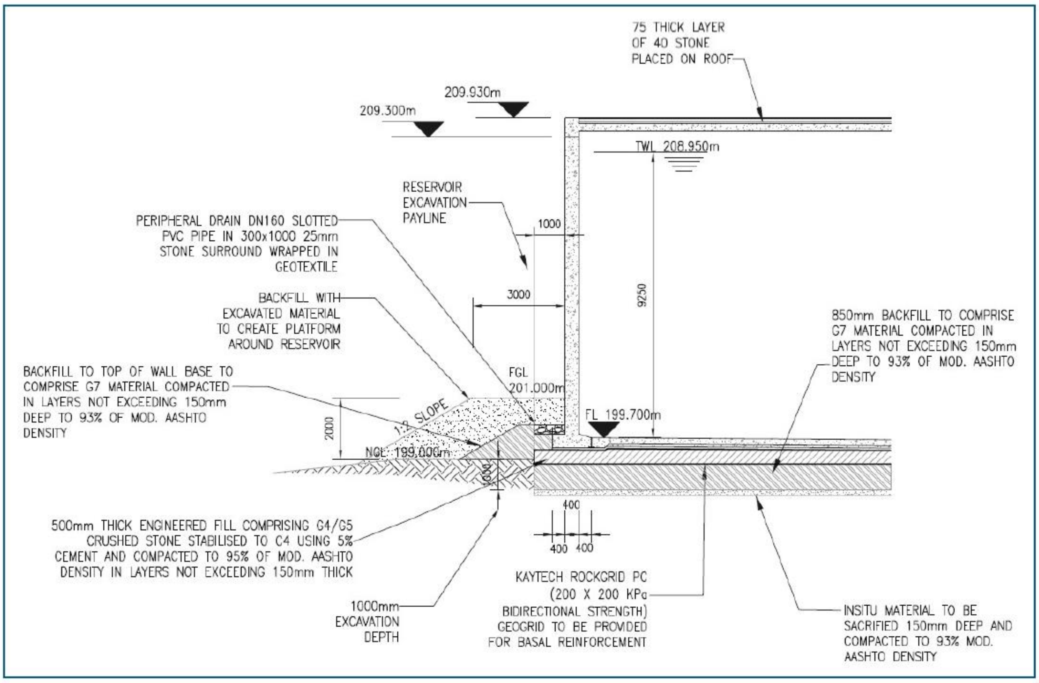

Figure 3. Circular reservoir wall section and foundation (from Royal Haskoning DHV Engineering Report).

The southern access road that must be upgraded to accommodate maintenance of pipelines for the first and 2nd phase will be maintained at the same width as the present track, but a new surface of gravel will be laid and compacted to improve accessibility. The pipelines will be laid between the road and the existing vibracrete wall along the boundary of the sportsground (Figure 4).

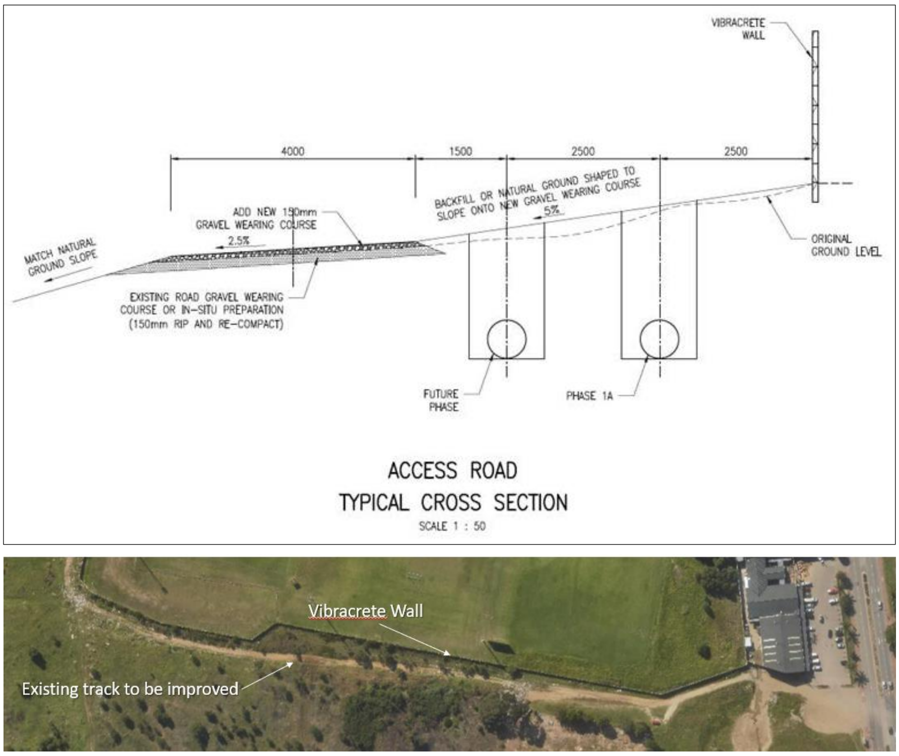

Figure 4. Cross section showing proposed improvements to the southern access track.

1.2 DFFE Screening Tool Results

According to the Department of Environment, Forestry and Fisheries (DFFE) screening tool, aquatic biodiversity at the site has a **Very High** sensitivity (Figure 5). The sensitivity features identified are a) the location of the site within the Outeniqua Strategic Water Source Area (SWSA), and b) a Critical Biodiversity Area: Aquatic.

The scope of work for this report is guided by the legislative requirements of the National Environmental Management Act (NEMA) and the National Water Act (NWA; Act No 36 of 1998).

Figure 5. Results of the DFFE Screening Tool which indicate Very High Sensitivity of the Aquatic Biodiversity theme.

1.3 Scope of work

According to the protocols specified in GN 320 (Protocol for the specialist assessment and minimum report content requirements for environmental impacts on aquatic biodiversity) of the National Environmental Management Act (NEMA; Act No. 107 of 1998), assessment and reporting requirements for aquatic biodiversity are associated with a level of environmental sensitivity identified by the national web-based environmental screening tool (screening tool). An applicant intending to undertake an activity identified in the scope of this protocol on a site identified by the screening tool as being of:

- **Very High** sensitivity for aquatic biodiversity, must submit an Aquatic Biodiversity Specialist Assessment; or
- **Low** sensitivity for aquatic biodiversity, must submit an Aquatic Biodiversity Compliance Statement.

The objectives of this assessment included the following:

- To undertake a desktop analysis and site inspection to verify the sensitivity of aquatic biodiversity as **Very High** or **Low**; and

- Compile an Aquatic Biodiversity Compliance Statement or Aquatic Biodiversity Specialist Assessment based on the site verification of the sensitivity of the site. This includes assessment of the following:

  Interrogation of available desktop resources including:

  - DWS spatial layers (1:50 000 rivers)
  - National Freshwater Ecosystem Priority Areas (NFEPA) spatial layers (Nel *et al.,* 2011)
  - National Wetland Map 5 and Confidence Map (CSIR, 2018)
  - Western Cape Biodiversity Spatial Plan (WCBSP, 2017).

  Conduct a site visit to determine the site sensitivity:

  - Identification and classification of watercourses within and adjacent to the site according to methods detailed by Ollis *et al*. (2013);
  - Determine the watercourse Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) using an appropriate method (if watercourses are present).
  - Delineate wetland / riparian areas following methods prescribed by DWAF (2015).
  - Determine an appropriate buffer for wetland areas using the site-specific buffer tool developed by Macfarlane and Bredin (2016).

This report will also need to comply with GN509 of the National Water Act (NWA; Act 36 of 1998) if the proposed development will take place in the area defined as the Regulated Area. In the case of wetlands, this is development that takes place within 500m of a wetland. In this case, a Risk Matrix must be compiled by a SACNASP-registered aquatic scientist to determine the level of risk posed by the development to the wetland assuming full implementation of all mitigation measures. If the risk is 'Low' then the development can be Generally Authorised, but if the risk is 'Medium' or 'High' then a Water Use License Application will be required.

1.4 Assumptions and Exclusions

Two site visits were conducted in May and June 2023 which is considered Winter. It is possible that sensitive features such as rare or unique biota (e.g. amphibians), plants or habitat were not observed during the site visit, but are influenced by season, time of day, flow level or vegetation cover. However, recent good rainfall would have meant that any wetland features would have been quite evident and easy to identify. In fact, this May was considered the 6th wettest May on record since the late 1800s (*pers. comm*. J. Crowther, local dairy farmer).

The development area on Option B has been historically disturbed with earth moving and dumping for at least a decade. Disturbance involving earth moving can result in the loss of wetland areas due to infilling, or the creation of wetland areas due to excavation or dumping of wetland soils. This type of disturbance complicates wetland delineation significantly. All available desktop and field methods were applied to accurately delineate wetlands on site.

The assessment of PES&EIS is limited to the watercourse areas assessed for this report and does not extend across the entire system.

Watercourse delineations and buffer determinations are site and land use specific and cannot be extrapolated beyond the area assessed in this report.

2. CATCHMENT CONTEXT

2.1 Catchment features

The development site is located on the watershed between quaternary catchments K30B and K30C in the catchment of the Gwaing River. However, the position of the two development options drains in a westerly direction to K30B. Watercourses on the site form headwater tributaries of the Gwaing River. Rainfall is relatively high by South African standards with a Mean Annual Precipitation of 787 mm which can fall with a Very High intensity. Coupled with the Very High erodibility of soils in the area, erosion of soils and stormwater management are factors which must always be carefully considered when planning a development in this area (Table 1 & Figure 6).

Table 1. Summary of relevant catchment features for the proposed development area.

Feature	Description
Quaternary catchment	K30B & K30C
Mean Annual Runoff	300 mm
Mean Annual Precipitation	787 mm
Inherent erosion potential of soils (K-factor)	0.74, Very High
Rainfall intensity	Very High
Ecoregion Level II	20.02, Southeastern coastal belt
Geomorphological Zone	Not applicable
NFEPA area	Sub-quaternary reach 9151, no classification.
Mapped Vegetation Type	FFg5: Garden Route Granite Fynbos (Critically Endangered)
Conservation	Ecological Support Area, Critical Biodiversity Area (Terrestrial & Aquatic) WCBSP (2017)

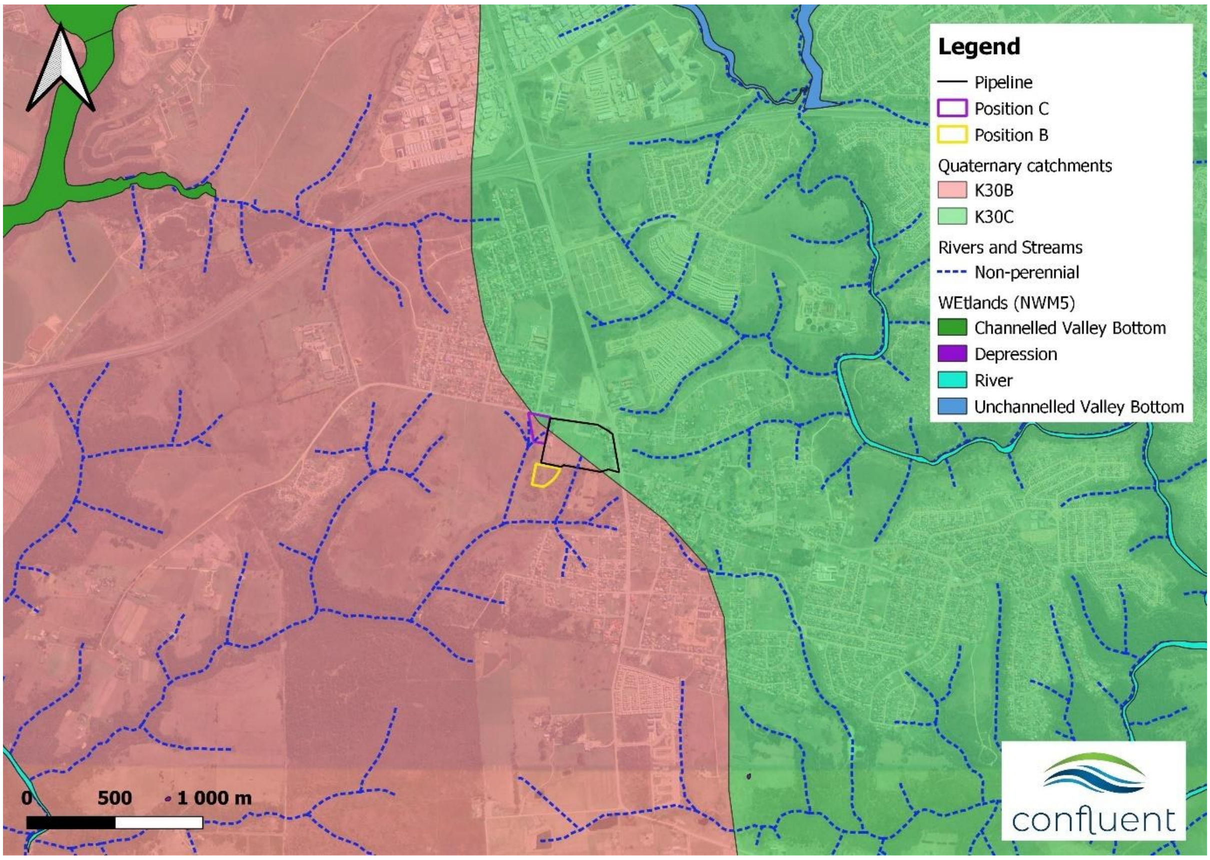

Figure 6. Location of the two alternative development sites on the boundary between quaternary catchments K30B and K30C.

Rainfall occurs year-round with seasonal peaks in spring and autumn (Figure 7).

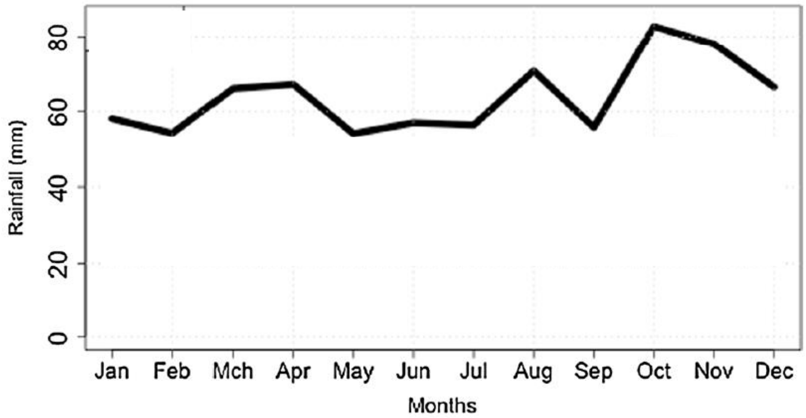

Figure 7. Area-averaged monthly rainfall for the coastal Southern Cape indicating peaks in Mar-Apr, Aug, and Oct. Data averaged between 1979 and 2011 (Engelbrecht *et al*., 2015).

The project area is located within the southeastern coastal belt (Ecoregion Level 2:20.02). The terrain is described as closed hills of moderate and high relief and moderately undulating plains. Altitude ranges between 0 – 1 300 m.a.m.s.l.

2.2 Vegetation

The mapped vegetation type at the site is mapped as Garden Route Granite Fynbos (FFg5; Critically Endangered; NVM, 2018). A detailed botanical specialist assessment is available for both alternative site options (Confluent Environmental, Botanical Specialist Assessment 2023).

2.3 Conservation and catchment management

2.3.1 WCBSP

The Western Cape Biodiversity Spatial Plan (WCBSP; 2017) indicates the headwater area of wetlands as an Ecological Support Area 2 (ESA2) along with a terrestrial Critical Biodiversity Area 2 (CBA2). While Position B is located in a terrestrial CBA2 except for an existing dirt track which is unmapped (Figure 8). Both sites drain to watercourses which are mapped CBA1 Aquatic features downstream and therefore require careful management to ensure these areas are not degraded by upstream impacts. The track to be upgraded passes through the upper section of the ESA2 on the eastern wetland. However, this mapped unit also extends into the sportsground. The definition and management objectives of each of these management classes are described in

Table 2.

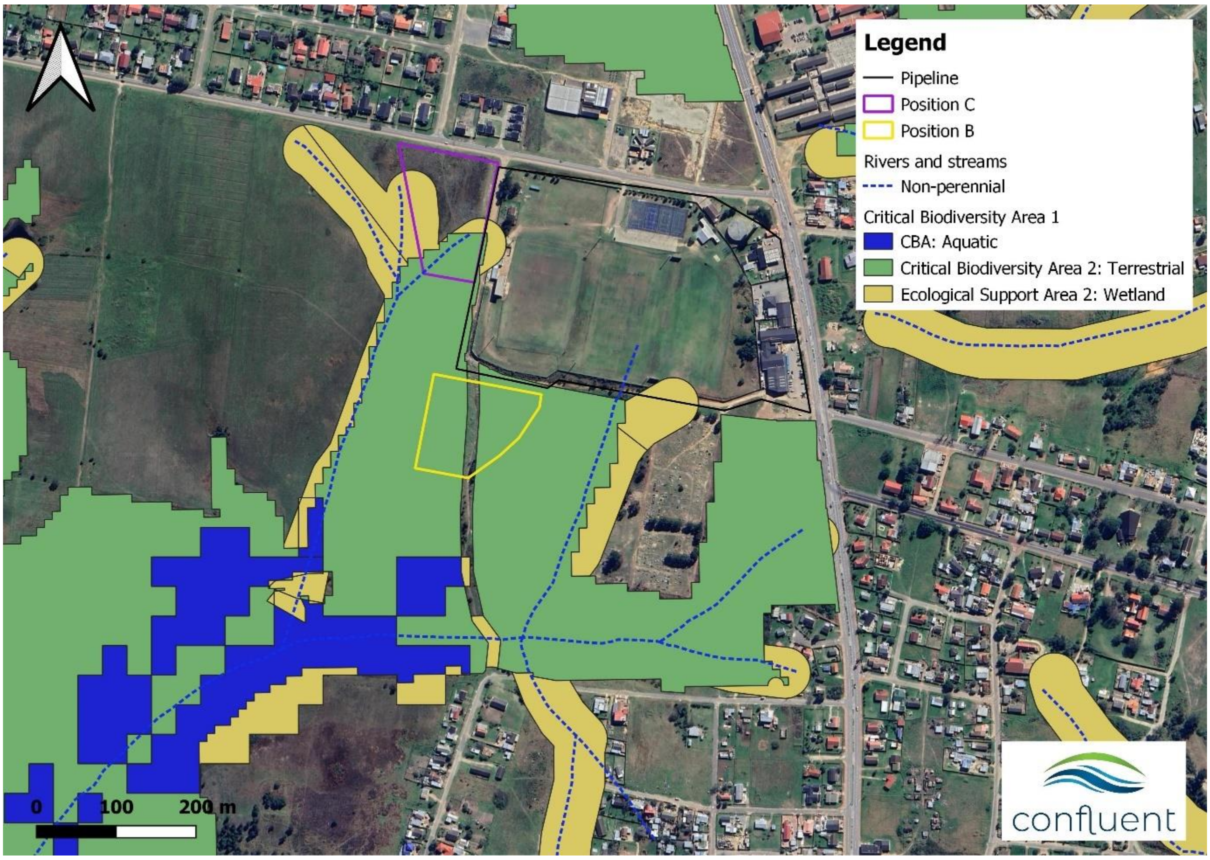

Figure 8. Alternative reservoir site locations and pipeline in relation to mapped conservation features of the Western Cape Biodiversity Spatial Plan (2017).

Necessary actions in relation to the WCBSP are to ensure that development on the site does not result in negative impacts to ecological structure and function of watercourses adjacent to the site.

Table 2. Definitions and objectives for conservation categories identified in the Western Cape Biodiversity Spatial Plan (WCBSP, 2017).

WCBSP Category	Definition	Management Objective
Critical Biodiversity Area 1 (CBA1)	Areas in a natural condition that are required to meet biodiversity targets, for species, ecosystems or ecological processes and infrastructure.	Maintain in a natural or near-natural state, with no further loss of natural habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land uses are appropriate.
Critical Biodiversity Area 2 (CBA2)	Areas in a degraded or secondary condition that are required to meet biodiversity targets, for species, ecosystems or ecological processes and infrastructure.	Maintain in a natural or near-natural state, with no further loss of habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land-uses are appropriate.
Ecological Support Area 2 (ESA2)	Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of PAs or CBAs, and are often vital for delivering ecosystem services.	Restore and/or manage to minimize impact on ecological processes and ecological infrastructure functioning, especially soil and water-related services, and to allow for faunal movement.

2.3.2 NFEPA

According to the National Freshwater Ecosystem Priority Atlas (NFEPA; Nel *et al*., 2011) the sub-quaternary reach (SQR 9151) is not classified at any level. The NFEPA wetlands layer does not indicate any wetland features on either of the site options or immediately downstream (Figure 6). This, however, contradicts the WCBSP which does identify wetland features indicated as ESAs and CBAs.

2.3.3 Strategic Water Source Area

Aquatic biodiversity within the site has been identified as Very High. One of the reasons is that the site falls within the Outeniqua Strategic Water Source Area for surface water (SWSA-sw). SWSAs are defined as areas of land that supply a disproportionate (ie. Relatively large) quantity of mean annual runoff in relation to their size and are therefore considered nationally relevant (Le Maitre *et al*., 2018). A key objective in the management of SWSAs is to ensure the quantity and quality of water within and flowing from SWSAs is protected from developments that cause unacceptable and irreparable impacts.

2.4 Mapped Watercourses

Mapped watercourses include non-perennial drainage lines and wetlands according to the National Wetland Map (5) and the NFEPA atlas. The 1:50 000 rivers and streams layer shows two watercourses that start on the site at Position C, while there are no mapped flow paths within the footprint of Position B. Position B would drain to non-perennial watercourses / wetlands to the east and the west of the site.

2.5 Previous Aquatic Assessment

A preliminary wetland scan for the proposed low-cost housing development on Erf 325 west was compiled by the Freshwater Consulting Group (FCG; L. Day & J. Ewart-Smith) in 2014. The purpose of this study was to identify and broadly map wetlands on site from aerial footage and based on a short site visit. The wetland areas mapped at the desktop level were presented as 10 different areas, of which areas 8 and 9 are of relevance for this assessment (Figure 9).

Unfortunately, no detailed wetland delineations were undertaken for either of the wetlands indicated in the two alternative site options in Figure 9. The report describes wetland area 8 as: *"Hillslope seeps feeding valley bottom wetland, impacted by dumping and excavation but supporting wetland fauna (frogs) and isolated stands of relatively unimpacted plant communities."* The Present Ecological State (PES) for this wetland was rated as D, Largely Modified, and the Ecological Importance and Sensitivity (EIS) was rated as Moderate.

Relevant recommendations for management of wetland areas in the context of the proposed high density low-cost housing development are listed below:

- Wetlands of Moderate and High EIS should be protected from development impacts with adequate buffers, the management of which must be clearly stipulated.
- Development layout should maximise opportunities for wetland corridor surveillance, minimising the opportunities for dumping and controlling the movement of livestock.
- Opportunities for the stormwater attenuation (quantity) and amelioration (quality) should be maximised.

The current assessment further refines the delineation of wetlands identified in the FCG report.

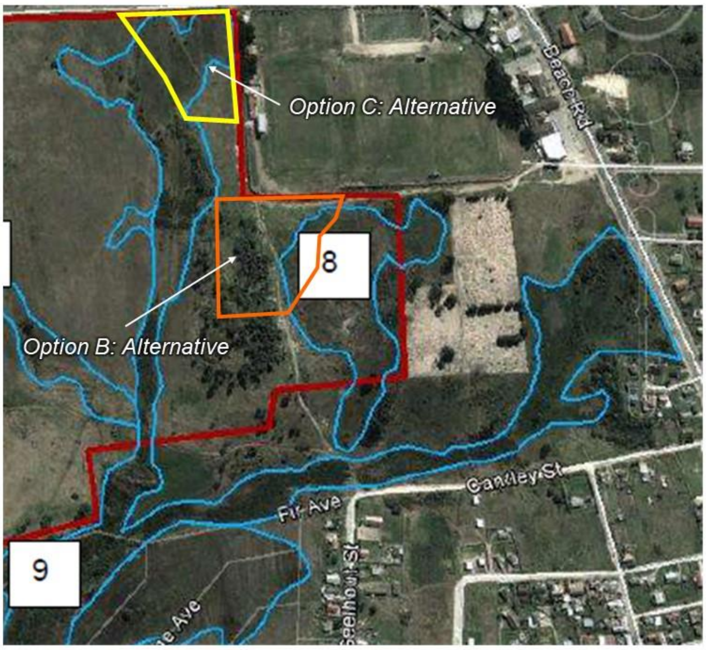

Figure 9. Extract of mapped wetland areas at a desktop level according to the FCG wetland scan report (Day & Ewart-Smith, 2017). The approximate area of the two development options have been superimposed.

2.6 Historical assessment

In 1939, darkened areas of vegetation indicative of wetlands were distinct at development option C, but non were observed at option B. These features correspond with mapped drainage lines indicated in Figure 6. A rectangular feature consisting of tree rows was established south of the present-day sports fieds in 1939. This area is now a cemetary, and the rectangular area may have been the initial establishment of this land use. The cemetary was established partially over the mapped wetland and darker vegetation area south of the sportsfield, and it is noteworthy that the north-west corner is not used and has revegetated, as a wetland is not suitable for this purpose. The 1974 image shows that vegetation in both site options was cleared for agricultural use. Probably grazing livestock.

Figure 10. Historical photos showing the two optional development sites through notable changes between 1939 and 1974 (CD:NGI & Google Earth imagery).

3. SITE ASSESSMENT

3.1 Site visit

The site was visited on 17 May and 13 June 2023. Weather was clear and no rain had fallen within the preceding 48 hrs. However, a prolonged period of rainfall was experienced in the preceding four-six weeks prior to the site visit which had left many areas wetter than usual in the George district.

3.2 Site assessment

The entire site footprint of both development options was walked to establish whether any wetlands or other watercourses are present on either development site. The wetland areas immediately adjacent to both development areas were assessed to determine dominant wetland plant species and conduct soil auguring (Figure 11).

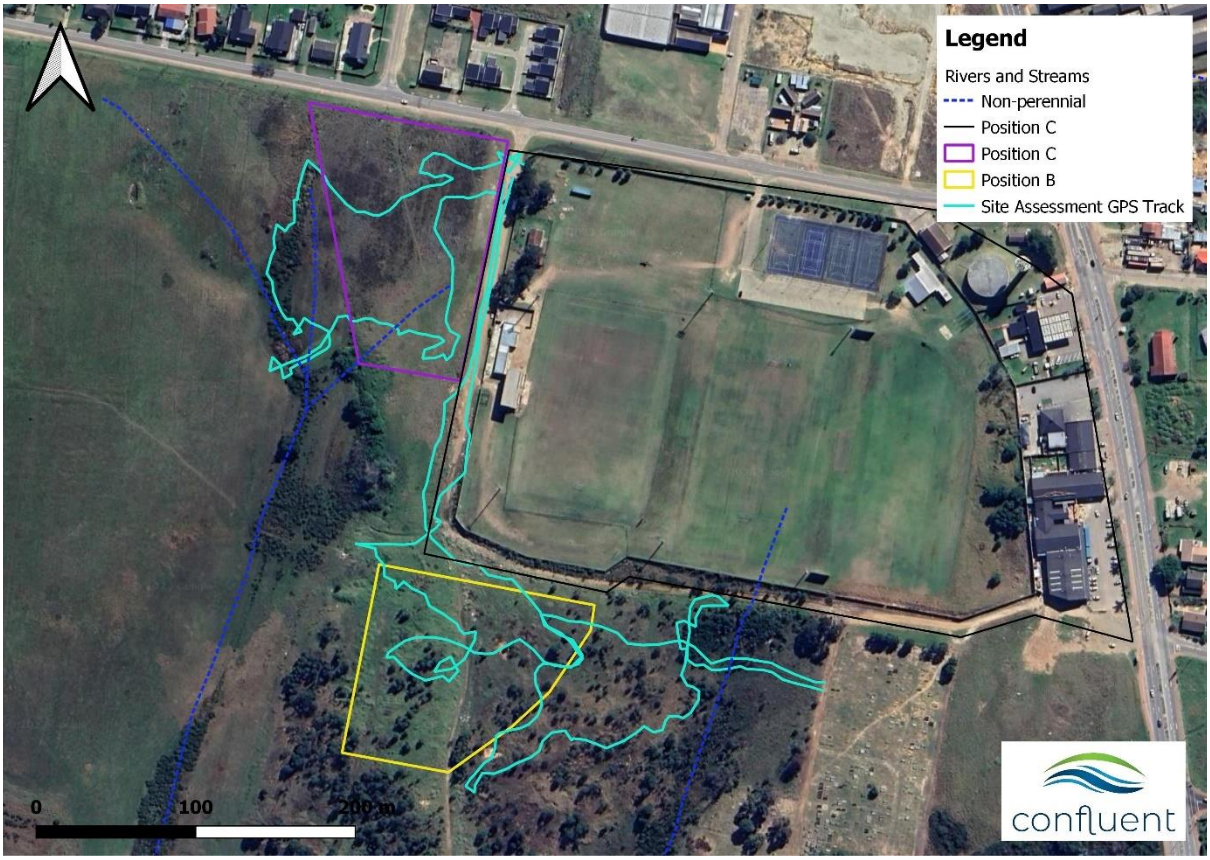

Figure 11. Satellite image of the development site(s) indicating the site assessment GPS track.

3.3 Watercourse Classification

The watercourses on site are named West Wetland and East Wetland for ease of reference. Both wetlands on site were classified as Unchannelled Valley-Bottom Wetlands (UVB; Ollis *et al*., 2013; Figure 12). No channel is present in either wetland and both are located within distinct valley bottoms (Figure 13). The upper headwaters are partially supported by seep wetland areas. It is important to note that this wetland type is highly sensitive to concentrated, high velocity runoff typical of piped stormwater outlets. Runoff of this nature results in channel incision, downcutting and erosion of the wetland.

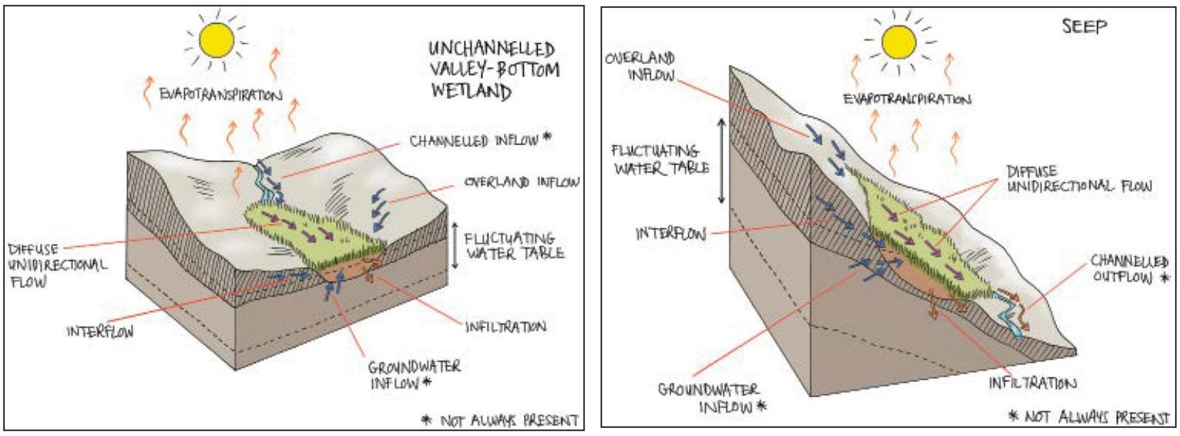

Figure 12. Conceptual illustration of the wetland types located East and West of the two development options (from Ollis *et al*., 2013).

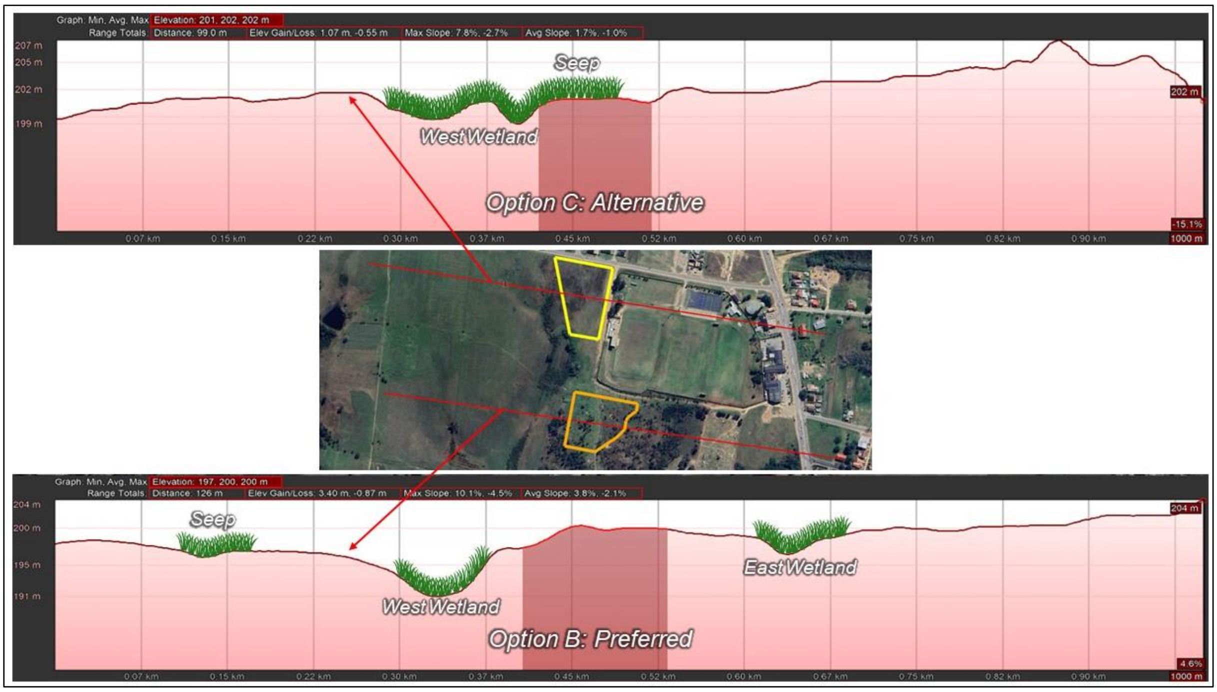

Figure 13. 1 000 m cross section through central region of each development option showing the elevation profile, development footprint (shaded) and relative location of delineated wetlands.

3.4 Wetland Delineation

Wetlands were delineated using a combination of hydrophilic plant species, soils with redoximorphic features (e.g. mottling and/or gleying), and topographical location. A distinctive feature of the East Wetland and a seep area in the West Wetland was extensive stands of *Watsonia* cf. *pillansii* as well as *Juncus effusus, Juncus exertus, Eliocharus limosa, Typha capensis*, *Helichrysum foetidum*, *Cliffortia strobilifera* and *Zantedeschia aethiopica*. Within the development area of Option B is extensive earth moving and dumped rubble and soil which is obscured by vegetation, especially kikuyu grass. There are a few areas within the site where earth moving (excavation or soil dumping) have resulted in small 'puddles' of standing water. The delineated wetland extent is indicated in Figure 16.

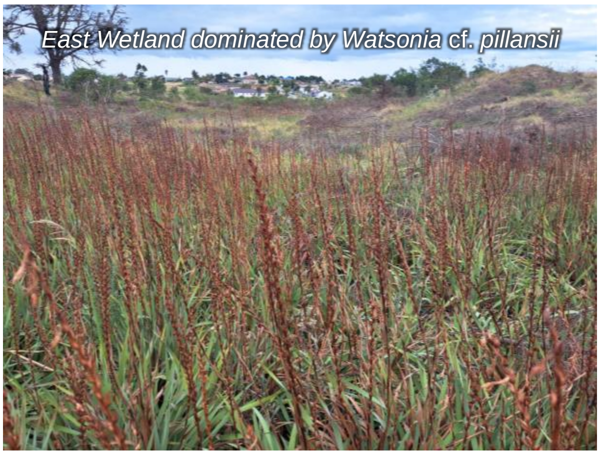

Figure 14. Photos of East and West Wetland and typical conditions on Site Options B and C.

Hydric soils display indicators which are predominantly formed by the accumulation or loss of iron, manganese, sulfur or carbon under permanent or periodic saturated and anaerobic conditions. Soil augur samples from the permanent zone of East Wetland had a dark organic-rich mineral layer with no mottling, indicative of reduced microbial activity under saturated conditions (Figure 15). West Wetland soils and outer areas of the East Wetland were typical of temporary and seasonal wetland soils where saturation periods are less than or greater than 3 months of the year respectively (as a general guideline).

Figure 15. Soil auger examples from wetland and terrestrial areas in the site area.

3.5 Wetland Buffer

The refined wetland delineation and buffers differ marginally in some areas in comparison to the wetland scan compiled by the FCG (Figure 9) but are fundamentally similar.

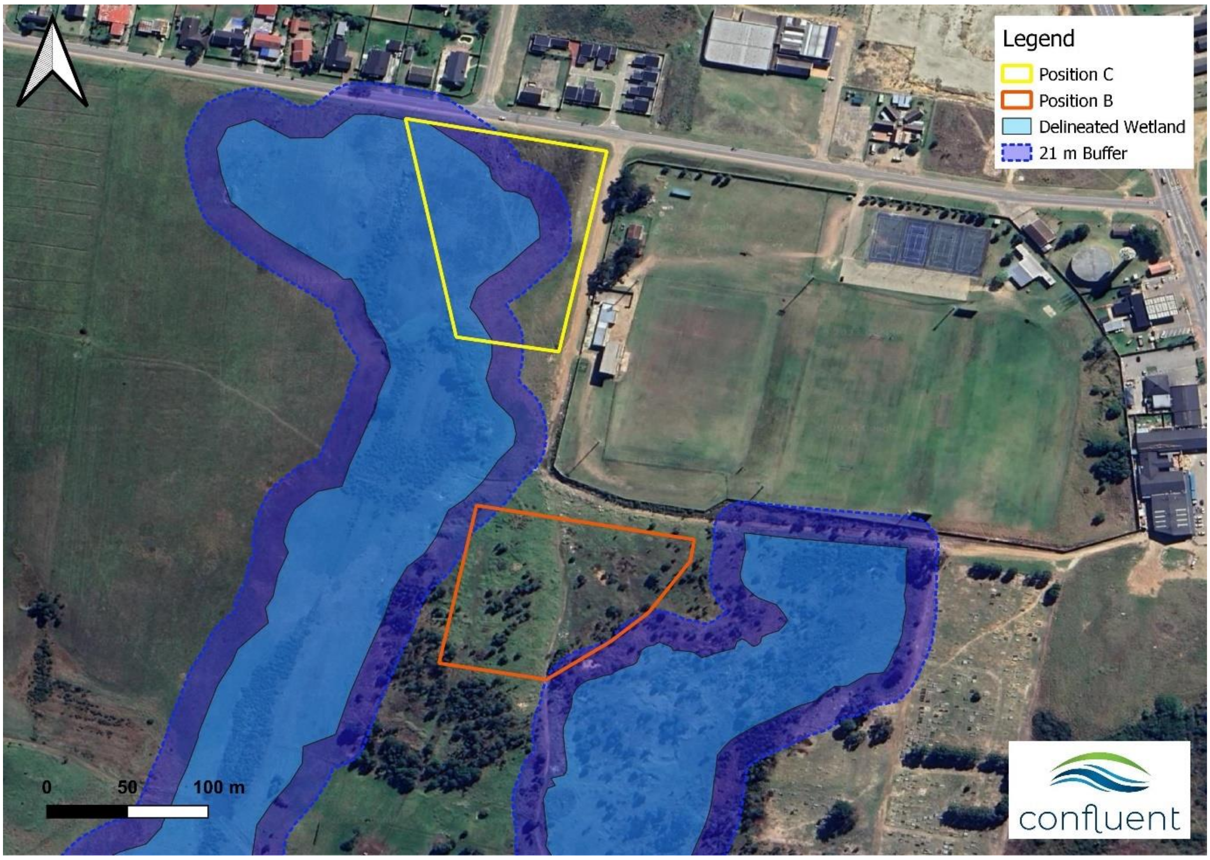

Figure 16. Delineated wetlands and 21 m wetland buffers in relation to both development options.

4. ECO-CLASSIFICATION

4.1 Present Ecological State

Methods used to determine the Present Ecological State (PES) of wetlands are provided in Appendix 1. The results of the PES assessment determined both the East and West unchanneled valley-bottom wetlands to be in a **Category B, Largely Natural** condition. The description for wetlands in this condition is: *"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."*

Fairly minor modifications have occurred with little change to the hydrology and geomorphology of both systems. The greatest change has been to the vegetation which scored a C, due to the presence of isolated patches of dense alien vegetation. While recent clearing of black wattle was observed, it had unfortunately been left lying in wetland habitat which can cause smothering of vegetation. Fortunately, local residents are collecting the dead trees for firewood.

Table 3. Summarised Present Ecological State determined using WET-Health for the East and West Wetlands.

PES Component	Comments	PES
Hydrology	- Moderate increase in flood peaks on West Wetland due to stormwater inflows. - Small impeding feature (dam) on West Wetland. - No erosion, gullies, excavations or infilling,	B/C
Geomorphology	- Small dam reduces downstream flow of water, sediment and organic matter to a minor degree.	A
Vegetation	- Small area of natural vegetation modified by dam (shallow flooding). - Wetland / riparian vegetation transformed historically by agriculture (dryland grazing; old lands) - Original catchment of East Wetland transformed to sportsfield. - Isolated dense patches of alien vegetation (Pampas grass & black wattle mainly)	C
OVERALL ECOLOGICAL CATEGORY	**LARGELY NATURAL**	**B**

4.2 Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity (EIS) was determined using methods provided in Appendix 2. The outcome of the assessment was that both wetlands have an EIS rated as '**High'** (Table 4).

Table 4. Summarised Ecological Importance and Sensitivity of East and West Wetland.

Ecological importance and sensitivity	Score 0-4	Confidence 1-5	Motivation
Biodiversity support	**0.6**		
Presence of Red Data species	0	3	None observed, and only suitable habitat for *A. knysnae* is the small dam which is artificial. With limited dispersal options, it seems unlikely it would be present.
Populations of unique species	1	3	Large colonies of *Watsonia* cf. *pillansii* and wetland grasses.
Migration/feeding/breeding sites	3	4	Habitat for amphibians, reptiles, small mammals, birds etc. Herons observed, and evidence of feeding mongoose / otter.
Landscape scale	**1.6**		
Protection status of wetland	0	4	No protection from WCBSP, only biosphere
Protection status of vegetation type	3	4	Listed as Critically Endangered, but poorly protected
Regional context of the ecological integrity	3	4	In relatively good conditions for peri-urban wetlands but will be increasingly pressured if proposed developments go ahead.

Size and rarity of the wetland types present	2	4	Moderate size but fairly typical seeps and valley bottom wetlands in the area.
Diversity of habitat types	1	4	Seeps and unchanneled valley bottom wetlands are similar habitats. Small dam adds some diversity.
Sensitivity of the wetland	**2.3**		
Sensitivity to changes in floods	3	3	Unchannelled VB wetlands very sensitive
Sensitivity to changes in low flows	3	3	Unchannelled VB wetlands most sensitive
Sensitivity to changes in water quality	1	4	High nutrients can transform vegetation, but act as a biological filter.
Hydrofunctional Importance	**2**	**3**	
Direct human benefits	**1**	**3**	
ECOLOGICAL IMPORTANCE AND SENSITIVITY	**2.2**	**HIGH**	

5. SITE SENSITIVITY VERIFICATION

The Site Sensitivity in terms of Aquatic Biodiversity for Option C is **confirmed as Very High** as indicated by the DFFE Screening Tool because actual wetland habitat is present on the site. The Site Sensitivity for Option B, provided encroachments by the fenceline into the buffer are only minor, is confirmed as **Low**. In this case an impact assessment will be compiled to provide a meaningful comparison of impacts between the two sites, and to provide mitigation measures to ensure both wetlands are protected.

6. IMPACT ASSESSMENT

Methods used for the impact assessment are provided in Appendix 3. The impact assessment follows the mitigation hierarchy of avoidance, minimisation of impacts, restoration of damaged ecosystems and offsets for residual damage, prioritised in that order.

6.1 Site consideration for Option C

The impact assessment commences with consideration of the impacts of wetland habitat loss and downstream consequences in the West Wetland. A significant portion of the development site for Option C consists of wetland habitat and the 21 m buffer (Figure 16). Considering that development on this site would result in the permanent loss of approximately 0.55 ha of wetland habitat, it would be best to avoid this impact altogether, as no wetland habitat is present within the footprint of Option B. Only minor mitigation measures are possible, and these will not reduce the loss of wetland, but rather aim to rescue vegetation from the site prior to construction, and identify a wetland offset area. The impacts in both cases are considered a Moderate Negative. Therefore, Option C is not supported as the proposed site for the reservoirs, especially considering that Option B has no wetland habitat within the development footprint.

Table 5. Construction Phase Impact: Option C excavation and removal of wetland soils and vegetation.

Project phase	Construction			
Impact	Option C Site: Excavation and removal of wetland soils and vegetation			
Description of impact	Permanent loss of approximately 0.66 ha of wetland			
Mitigatability	Low	Mitigation does not exist; or mitigation will slightly reduce the significance of impacts		
Potential mitigation	• Identify suitable alternative wetland areas as an offset which must receive adequate protection in terms of zoning, management and maintenance. This process requires application for a Water Use License. • Undertake a search and rescue for wetland plant species in the disturbance footprint which can be planted in alien invaded areas of the West Wetland (or offset area) once aliens have been removed. • Ensure construction phase earth-moving does not result in sedimentation in the remaining wetland habitat by installing silt fencing along the perimeter of the site prior to construction.			
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	Very high	Natural and/ or social functions and/ or processes are majorly altered	Very high	Natural and/ or social functions and/ or processes are majorly altered
Probability	Certain / definite	There are sound scientific reasons to expect that the impact will definitely	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	Low	The affected environment will not be able to recover from the impact - permanently modified	Low	The affected environment will not be able to recover from the impact - permanently modified
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	The significance is a "moderate negative" with and without mitigation because the impact of completely clearing wetland vegetation and soils cannot be reduced to a large extent.			
Cumulative impacts	The area is undergoing rapid expansion for urban development, placing wetlands more at risk of loss.			

6.2 Design and Layout Phase Impacts

6.2.1 Stormwater management

The impact assessment will consider more detailed aspects of the development at Site B which is the preferred option in terms of aquatic sensitivity.

The detailed Site Development Plan that was initially provided had an underground stormwater pipe transferring all stormwater runoff and water discharged from the reservoir due to periodic maintenance which cleans sediment from the reservoir bottom. The pipe ended in a headwall It was since discussed that given the sensitivity of the wetland type to channel incision, and impending high density residential development across the remainder of the site, it would be beneficial to attenuate as much stormwater within the site as possible. Subsequently the engineers utilised the fence design specifications from the George Municipality as a SuDS intervention. The base of the fence must be installed into concrete beams which are usually buried below ground. However, they will be slightly raised along lengths of the fenceline to retain stormwater on site. This is termed a level spreader and acts as a small attenuation dam (Figure 17). Reno mattress protection will be installed below the fenceline to ensure any overflows do not cause erosion.

Furthermore, stormwater from the site was subsequently split between both sides and will ultimately drain via the level spreaders to both the West and East Wetland, further reducing the impact of high velocity, concentrated flows. The comparison of stormwater impacts with and without mitigation is assessed in the operational phase impact assessment.

Figure 17. Example of a level spreader with the outflow section protected by rip rap.

6.2.2 Fenceline

The eastern site boundary on the original SDP had a wavy line which corresponded with the original wetland delineation compiled by FCG (2014). The engineering team requested that the line be straightened if possible for the sake of simplicity. The revised East Wetland area is completely outside of the fenceline, and the 21m buffer only slightly encroaches into the buffer. This encroachment is not considered a major drawback as the function of the buffer will not be compromised in a significant manner. This impact is considered further in the Operational Phase Impact Assessment.

6.2.3 Pipeline and alternatives

Pipelines running into and out of the reservoir serve to connect the existing and proposed new reservoir(s) with residential areas to the west and east of the site (although all termed Pacaltsdorp West). The proposed reservoir has inflowing and outflowing pipelines, which are planned along the fenceline and road reserve surrounding the Pacalstdorp sports ground. An alternative route adjacent to Beach Road to the east is indicated in Figure 1. As these routes all follow existing infrastructure (walls, roads, pavements etc.) there is not much difference in which options are selected, and no additional serious impact anticipated from an aquatic systems perspective. The design and layout phase is therefore considered as it is for the assessment of construction and operational phase impacts.

6.3 Construction Phase Impact Assessment

6.3.1 Site establishment pre-construction

No-go zones for environmentally sensitive areas must be established before commencement of construction and all personnel involved in the project must be briefed that these are no-go areas (Figure 18).

Figure 18. No-go area indicated in red for the duration of the construction phase.

Provided the mitigation measures are followed as indicated in Table 7 and Figure 18, risks to the wetland and buffer areas can be minimised to a negligible negative impact.

6.3.2 Road Upgrade

Provided the road upgrade along the southern boundary of the sportsground is not increased beyond its current footprint, and resurfacing does not result in material washing into the wetland, the anticipated impact is a Negligible Negative (Table 6).

Table 6. Construction Phase Impact: habitat degradation of Eastern wetland during road upgrade.

Project phase	**Construction**			
Impact	**Habitat degradation of Eastern wetland during road upgrade**			
Description of impact	**Soil destabilisation and sedimentation smothering vegetation**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Existing or new surface material must not be pushed to the wetland edge of the road. This side of the road must be kept clear of loose, unstable material to avoid it falling / spreading into wetland habitat. • Trenching for the new pipeline should place soil 'upstream' of the trench so that it washes back into the trench in the event of signifcant rainfall, as opposed to across the road and into the wetland. • If feasible, the pipeline should not have any joins or connections aligned to the wetland area as joins are more prone to leaks. Try and keep joins out of the wetland area. • Once the road upgrade and pipe installation have concluded, seed the exposed topsoil along the pipeline with a combination of Cynodon dactylon (Kweek) and / or Stenotaphrum secundatum (Buffalo grass). • Works to upgrade the road must not increase the road's footprint; it must be kept at the same width.**			
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	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	Likely	The impact may 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				
Cumulative impacts	Not applicable			

Table 7. Construction Phase Impact: Disturbance to wetland and buffer areas.

Project phase	**Construction**			
Impact	**Disturbance to wetland and buffer areas**			
Description of impact	**Vehicles, workers and materials active in wetland and buffer areas**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Pre-construction, temporary fencing must be erected along No-Go areas as indicated in Fig. 17. • Signage indicating No-go areas must be placed on fencing. • All contractors must be briefed that vehicles, workers and materials may not encroach into No-Go areas around wetlands. • Access road for the site should preferably be from Olympic Street. Access road from Beach Road only to be used for pipeline installation and upgrade of the road. The aim is to concentrate heavy construction vehicle traffic along one access route where it can be controlled, and the wetland is not in such close proximity to the road.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Medium term	Impact will last between 5 and 10 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	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Negligible	Natural and/ or social functions and/ or processes are negligibly 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	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	The impact of increasing the footprint of disturbance by entering no-go areas can be mitigated to a large extent by full implementation of these mitigation measures.			
Cumulative impacts	Not applicable			

6.3.3 Puddle Plants Rescue

A few small (5 – 10 m^2) puddles formed by earthworks are present within the development footprint. While these are artificial waterbodies, they do contain a few (2-3) wetland plant species. It is recommended that a wetland plant rescue be undertaken prior to construction. These plants can either be replanted in stormwater attenuation areas post-construction or can be utilised in a suitable wetland revegetation / rehabilitation project elsewhere in George. The mitigated impact is a Negligible Negative (Table 8).

Table 8. Construction Phase Impact: Loss of artificial wetland habitats.

Project phase	Construction			
Impact	Loss of artificial wetland habitats			
Description of impact	Puddles in the development footprint with wetland plants will be destroyed and permanently transformed			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	• Prior to commencement of construction, undertake a wetland plant rescue from artificial puddles with inputs from an aquatic ecologist. • Plants can either be used to vegetate stormwater attenuation areas on the site post construction (if conditions are suitable), or for other rehabilitation projects in George with similar habitat.			
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	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	Negligible	Natural and/ or social functions and/ or processes are negligibly altered
Probability	Certain / definite	There are sound scientific reasons to expect that the impact will definitely occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a
Confidence	High	Substantive supportive data exists to verify the assessment	Medium	Determination is based on common sense and general knowledge
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	Puddles are artificial, isolated, and number < 10 across the site.			
Cumulative impacts	No applicable			

6.3.4 Stormwater Management

Given the site slopes to the west, south and east, it is foreseeable that any rainfall resulting in runoff during the construction phase will carry sediment laden water into surrounding wetland areas if the site is not managed to prevent this. Proactive mitigation measures have been recommended, but reactive measures may be required as construction progresses due to localised changes in topography due to earthworks. The mitigated risk is a Negligible Negative impact, but this could vary to a Minor Negative if unforeseen erosion and sedimentation takes place.

Table 9. Construction Phase Impact: Stormwater runoff from the site

Project phase	**Construction**			
Impact	**Stormwater runoff from the site**			
Description of impact	**Sedimentation in wetlands and creation of preferential flow paths**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• The site office should have a store of materials suitable for rapid response to erosion control such as shade-cloth (silt-fencing), haybales (check-dams), wooden droppers, hessian fabric, and fencing wire. • All material stores should be kept on flat areas and bunded to prevent material loss during rainfall. • When construction commences in the reservoir area, create a compacted, low soil berm along the permiter of the site approximatly 400 mm high to retain stormwater on site and reduce runoff. • Soil from the trench for installation of the pipeline along the road west of the sportsground should be placed upslope of the trench so that in the event of rainfall it washes back into the trench and not into the natural area. • Monitor the site during / following periods of rainfall, and install haybale check dams at points where runoff collects and could overtop / breach the soil berm. • Check ahead for rainfall. Do not continue work during rainfall, and ensure the site is prepared to minimise erosion and sediment-laden runoff in advance of rainfall. • Following rainfall, water pumped out of pools in excavated areas must not be directed to wetlands. The soil berm system or a temporary haybale check dam can be constructed to contain water until it seeps into the ground or slowly disperses through the haybales which act as a filter.**			
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	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	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	Risk reduction is dependent on proactive and reactive mitigation measures as contruction progresses across the site.			
Cumulative impacts	Not applicable			

6.4 Operational Phase Impact Assessment

6.4.1 Stormwater Management

Unchannelled valley bottom wetlands are very sensitive to high velocity, concentrated inflows of water. Even a single severe event can result in channel incision followed by drawing down of the water table and a reduction in wetland habitat area. This is one of the most serious impacts affecting wetlands in the George area and should be avoided at all costs. Mitigation measures have been recommended in Table 10 which should reduce the risk to a negligible negative level. However, it is emphasised that monitoring is required to ensure that despite the level spreader aimed at attenuating stormwater and other flows emanating from the site erosion cuts or gullies do not form at the site.

Table 10. Operational Phase Impact: Stormwater

Project phase	Operation			
Impact	Channel incision in wetlands or erosion cuts due to high velocity outflows			
Description of impact	Reservoir overflow events, scouring for maintenance, or stormwater runoff could degrade wetland habitat			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	• Stormwater runoff and any overflows / scouring for maintenance to be attenuatied within the site development area using the level spreader at the base of the fenceline as an attenuation pond. • Entire stormwater attenuation feature must be revegetated post-construction with a mixture of Cynodon dactylon (Kweek) and Stenotaphrum secundatum (Buffalo). • A ground level, vegetated reno mattress should be installed along the outer length of the level spreader to reduce the risk of scour should the level spreader be overtopped in a significant high flow event. • An emergency overflow pipe connecting the water tower to the reservoir (greater storage capacity) should be installed when this is constructed to reduce the risk of high velocity overflows from the water tower. • Monitoring of the performance of the level spreader should be undertaken following high rainfall events to identify problematic flow paths. Any erosion observed must be proactively repaired and a solution found which does not transfer negative impacts to wetlands to the west and east of the site.			
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	Local	Extending across the site and to nearby settlements	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	Medium	Determination is based on common sense and general knowledge
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	Unchannelled valley bottom wetlands are extremely susceptible to channel incision (with a cascade of resulting impacts) due to high velocity, point source inflows. This must be avoided at all costs.			
Cumulative impacts	No applicable			

6.4.2 Alien Vegetation

Every effort must be made to ensure the area disturbed during construction is kept free of alien vegetation. This includes not only the reservoir site, but the pipeline areas too. Follow up alien vegetation control must take place on a routine basis bi-annually in perpetuity. Provided the recommended mitigation measures are followed the impacts are predicted to be a Negligible Positive (Table 11).

Table 11. Operational Phase Impact: Alien vegetation encroachment

Project phase	**Operation**			
Impact	**Alien vegetation encroachment**			
Description of impact	**Loss of indigenous wetland vegetation due to gradual invasion by alien plants**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• All areas disturbed during the construction phase (the reservoir site as well as pipeline areas) must be inspected for and cleared of alien vegetation 6 months and 12 months following construction. • No pesticides to be used in any wetland or buffer areas. Alien plants must be removed by hand / hand tools only. • Where indigenous vegetation struggles to cover disturbed areas naturally, sow seeds of indigenous grasses such as Cynodont dactylon and Stenotaphrum secondaturm.**			
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	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	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 - positive**	
Comment on significance				
Cumulative impacts	Not applicable			

6.4.3 Rubbish Dumping

Upgrading of the road along the southern boundary of the sportsground could increase the incidence of illegal dumping in the wetland. This is a difficult practice to prevent, but the recommendation to add a lockable bollard, boom or access gate on both access roads may reduce the risk (Table 12).

Table 12. Operational phase impact: increased illegal rubbish dumping due to upgraded access road.

Project phase	**Operation**			
Impact	**Rubbish dumping in the eastern wetland due to upgraded road access**			
Description of impact	**Wetland habitat degradation and loss**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	• **Create a barrier across the road restricting access to municipal personnel working on the reservoir and pipeline only. This could be a boom or a gate located between the cemetary and the wetland.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Medium term	Impact will last between 5 and 10 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	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	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	Not applicable			

7. RISK ASSESSMENT MATRIX

Methods used to determine scores in the Risk Matrix are explained in Appendix 4. The assessment considers the risks in their mitigated state, and it is therefore imperative that control measures to mitigate impacts are fully implemented for the level of risk to apply. The risk matrix considers the severity of risks to the flow regime, water quality, habitat (including geomorphology), and biota.

The same impacts considered in the impact assessment were included in the Risk Assessment Matrix. In their mitigated state, all impacts were considered to pose a **Low Risk** to the two wetlands on either side of the proposed reservoir site (Table 13).

Table 13. Risk Assessment Matrix for the proposed reservoir for Pacaltsdorp West.

Phases	Activity	Aspect	Impact	Flow Regime (Severity)	Water Quality (Severity)	Habitat (Severity)	Biota (Severity)	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures	PES AND EIS OF WATERCOURSE
	Vehicles, people and materials disturbing wetland and buffer aresa.	Degradation of habitat and soil disturbance	Loss of wetland plants, habitat and biota.	0	1	2	1	1	2	2	5	1	2	5	1	9	45	Low	70	• Pre-construction, temporary fencing must be erected along No-Go areas as indicated in Fig. 17. • Signage indicating No-go areas must be placed on fencing. • All contractors must be briefed that vehicles, workers and materials may not encroach into No-Go areas around wetlands. • Access road for the site should preferably be from Olympic Street. Access road from Beach Road only to be used for pipeline installation.	
	Earthworks for construction	Loss of artificial wetland habitat	Loss of minor areas of artificial wetland plants and habitat	0	0	1	1	0,5	1	1	2,5	1	2	5	1	9	22,5		80	• Prior to commencement of construction, undertake a wetland plant rescue from artificial puddles with inputs from an aquatic ecologist. • Plants can either be used to revegetate stormwater attenuation areas on the site post construction (if conditions are suitable) or for other rehabilitation projects in George with similar habitat.	
CONSTRUCTION PHASE																				• The site office should have a store of materials suitable for rapid response to erosion control such as shade-cloth (silt-fencing), haybales (check-dams), wooden droppers, hessian fabric, and fencing wire. • All material stores should be kept on flat areas and bunded to prevent material loss during rainfall.	

	Earthworks for construction	Sediment laden stormwater runoff	Erosion of wetland slopes and sedimentation of wetland habitat	1	1	2	2	1,5	1	2	4,5	1	2	5	2	10	45	Low	80	• When construction commences in the reservoir area, create a compacted, low soil berm along the permiter of the site approximatly 400 mm high to retain stormwater on site and reduce runoff. • Soil from the trench for installation of the pipeline along the road west of the sportsground should be placed upslope of the trench so that in the event of rainfall it washes back into the trench and not into the natural area. • Monitor the site during / following periods of rainfall, and install haybale check dams at points where runoff collects and could overtop / breach the soil berm. • Check ahead for rainfall. Do not continue work during rainfall, and ensure the site is prepared to minimise erosion and sediment-laden runoff in advance of rainfall. • Following rainfall, water pumped out of pools in excavated areas must not be directed to wetlands. The soil berm system or a temporary haybale check dam can be constructed to contain water until it seeps into the ground or slowly disperses through the haybales which act as a filter.	PES: B EIS: High
	Upgrade of the existing track and pipeline installation along the southern boundary of the sportsground	Earthmoving resulting in soil or gravel spreading or being pushed into the wetland	Degradation of wetland habitat by smothering plants	0	1	2	1	1	1	2	4	1	2	5	2	10	40	Low	80	• Existing or new surface material must not be pushed to the wetland edge of the road. This side of the road must be kept clear of loose, unstable material to avoid it falling / spreading into wetland habitat. • Trenching for the new pipeline should place soil 'upstream' of the trench so that it washes back into the trench in the event of signifcant rainfall, as opposed to across the road and into the wetland. • If feasible, the pipeline should not have any joins or connections aligned to the wetland area as joins are more prone to leaks. Try and keep joins out of the wetland area. • Once the road upgrade and pipe installation have concluded, seed the exposed topsoil along the pipeline with a combination of Cynodon dactylon (Kweek) and / or Stenotaphrum secundatum (Buffalo grass). • Works to upgrade the road must not increase the road's footprint; it must be kept at the same width.	

OPERATIONAL PHASE	Discharge of stormwater, reservoir overflows or scouring operations	Release of water	Channel incision in wetlands or erosion cuts due to high velocity outflows	2	1	2	2	1,75	2	1	4,75	1	2	5	1	9	42,8	Low	70	• Stormwater runoff and any overflows / scouring for maintenance to be attenuatied within the site development area using the level spreader at the base of the fenceline as an attenuation pond. • Entire stormwater attenuation feature must be revegetated post-construction with a mixture of Cynodon dactylon (Kweek) and Stenotaphrum secundatum (Buffalo). • A ground level, vegetated reno mattress should be installed along the outer length of the level spreader to reduce the risk of scour should the level spreader be overtopped in a significant high flow event. • An emergency overflow pipe connecting the water tower to the reservoir (greater storage capacity) should be installed when this is constructed to reduce the risk of high velocity overflows from the water tower. • Monitoring of the performance of the level spreader should be undertaken following high rainfall events to identify problematic flow paths. Any erosion observed must be proactively repaired and a solution found which does not transfer negative impacts to wetlands to the west and east of the site.	
	Improvement of access road along southern sportsground library	Improved access for illegal dumping	Habitat degradation and pollution of the wetland	0	1	2	1	1	1	1	3	2	2	5	2	11	33	Low	80	• Install an obstacle to traffic between the cemetary and the wetland such as a gate, boom, or lockable bollard.	
	Maintenance of areas disturbed during construction phase	Alien vegetation encroachment	Loss of indigenous wetland vegetation due to gradual invasion by alien plants	1	0	2	1	1	2	2	5	1	2	5	1	9	45	Low	70	• All areas disturbed during the construction phase (the reservoir site as well as pipeline areas) must be inspected for and cleared of alien vegetation 6 months and 12 months following construction. • No pesticides to be used in any wetland or buffer areas. Alien plants must be removed by hand / hand tools only. • Where indigenous vegetation struggles to cover disturbed areas naturally, sow seeds of indigenous grasses such as Cynodont dactylon and Stenotaphrum secondaturm. .	

8. CONCLUSIONS

The proposed reservoir, water tower and pump station development for Pacaltsdorp West is required to provide a secure supply of potable water to this area, where extensive development is taking place. Two alternative locations were assessed, namely Site C and Site B; the latter was the preferred option. As a large area of wetland habitat was delineated within the proposed site footprint on Site C, support for Site B is upheld. However, unchanneled valley bottom wetlands to the west and east of the site require careful management to ensure they are not negatively affected by the development. The PES of both wetlands was B, Largely Natural, and their Ecological Importance and Sensitivity was determined as High.

Both wetlands were delineated, and a buffer of 21 m was determined using the site-specific wetland buffer tool. The proposed fenceline around the reservoirs encroaches slightly into the buffer at two locations, but this is not considered a major impact. The proposed upgrade of the access road along the southern boundary of the sportsground is to improve access which will be required for maintenance of pipelines. The road and adjacent area for pipelines along the vibracrete wall is already existing and the improvement will not increase the footprint, therefore minimal impacts are anticipated from this work. Wetland delineations and buffers, as well as discussions with the engineers regarding onsite attenuation of stormwater all informed the revised layout which was assessed in this report.

Provided all mitigation measures for the design and layout, construction and operational phases are fully implemented, the development should have a negligible negative impact on aquatic ecosystems. Compilation of the Risk Assessment Matrix also determined that the risk to aquatic ecosystems was Low provided all control measures are implemented.

Therefore, the proposed reservoir development will require a General Authorisation for Section 21 c) and i) water uses as defined in the National Water Act, and as described in GN509 of 2016.

Construction of the reservoirs is supported provided all mitigation measures are fully implemented.

9. APPENDICES

9.1 Present Ecological State Methods

The wetland area 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 14.

Table 14. Wetland Present Ecological State 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

9.2 Ecological Importance and Sensitivity Methods

The revised method for the determination of the EIS of a wetland 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 enhancement 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 15).

Table 15.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

9.3 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 16) 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 16. 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
	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
Probab ility	1	**Highly unlikely / None**	Expected never to happen
	2	**Rare / improbable**	Conceivable, but only in extreme circumstances, and/or might occur for this

Criteria	Numeric Rating	Category	Description
			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 17, Table 18, & Table 19), respectively.

Table 17. 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 18. 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 19. 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

9.4 Risk Matrix Methods

The risk assessment matrix (Based on DWS 2016 publication: Section 21 c) and i) water use Risk Assessment Protocol) was implemented to assess risks for each activity associated with the construction and operational phase.

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

- An activity is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation.
- An aspect is an 'element of an organizations activities, products and services which can interact with the environment'. The interaction of an aspect with the environment may result in an impact.
- Environmental impacts are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity.
- Resources are components of the biophysical environment and include the flow regime, water quality, habitat and biota of the affected watercourse.
- Severity refers to the degree of change to the status of each of the receptor. An overall severity score is calculated as the average of all scores receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.
- Spatial extent refers to the geographical scale of the impact (Table 21).
- Duration refers to the length of time over which the stressor will cause a change in the resource or receptor (Table 22)
- Frequency of activity refers to how often the proposed activity will take place (Table 23)
- Frequency of impact refers to the frequency with which a stressor (aspect) will impact on the resource (Table 24).

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria (refer to the table below). The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity, impact, legal issues and the detection of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 20. The values for likelihood and consequence of the impact are then read off a significance rating matrix and are used to determine whether mitigation is necessary.

In accordance with the method stipulated in the risk assessment key, all impacts for flow regime, water quality, habitat and biota were scored as a 5 (i.e. average Severity score of 5) as all activities occurred within the delineated boundary of the wetland.

Table 20. Scores used to rate the impact of the aspect on resource quality (flow regime, water quality, geomorphology, biota and habitat)

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5
Where "or wetland(s) are involved" it means that the activity is located within the delineated boundary of any wetland.	

Table 21. Scores used to rate the spatial scale that the aspect is impacting on.

Area specific (at impact site)	1
Whole site (entire surface right)	2
Regional / neighbouring areas (downstream within quaternary catchment)	3
National (impacting beyond secondary catchment or provinces)	4
Global (impacting beyond SA boundary)	5

Table 22. Scores used to rate the duration of the aspects impact on resource quality

One day to one month, PES, EIS and/or REC not impacted	1
One month to one year, PES, EIS and/or REC impacted but no change in status	2
One year to 10 years, PES, EIS and/or REC impacted to a lower status but can be improved over this period through mitigation	3
Life of the activity, PES, EIS and/or REC permanently lowered	4
More than life of the organisation/facility, PES and EIS scores, a E or F	5

Table 23. Scores used to rate the frequency of the activity

Annually or less	1
Bi-annually	2
Monthly	3
Weekly	4
Daily	5

Table 24. Scores used to rate the frequency of the activity’s impact on resource quality

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

Table 25. Scores used to rate the extent to which the activity is governed by legislation

No legislation	1
Fully covered by legislation (wetlands are legally governed)	5

Table 26. Scores used to rate the ability to identify and react to impacts of the activity on resource quality, people and property.

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Table 27. Rating classes

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.
56 – 169	(M) Moderate Risk	Risk and impact on watercourses are notable and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.
170 – 300	(H) High Risk	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.

Table 28. Calculations used to determine the risk of the activity to water resource quality

Consequence = Severity + Spatial Scale + Duration
Likelihood = Frequency of Activity + Frequency of Incident + Legal Issues + Detection
Significance\Risk = Consequence x Likelihood

10. REFERENCES

Council for Scientific and Industrial Research (CSIR; 2018). National Wetland Map 5 and Confidence Map [Vector] 2018. Available from the Biodiversity GIS website, downloaded on 30 September 2020.

Department of Water Affairs and Forestry (DWAF; 2005). A practical field procedure for identification and delineation of wetlands and riparian areas. Pretoria, South Africa.

Le Maitre, D., Seyler, H., Holland, M., Smith-Adao, L., Nel, J., Maherry, A. and Witthuser, K. (2018). Identification, delineation and importance of the strategic water source areas of South Africa, Lesotho and Swaziland for surface water and groundwater. Water Research Commission report TT754/1/18.

Macfarlane, D.M. and Bredin, I. (2016). Desktop tool for the determination of preliminary aquatic impact buffer zone requirements. Version 1.0. Water Research Commission, Pretoria.

Macfarlane, D.M., Kotze, D.C., Ellery, W.N., Walters, D., Koopman, V., Goodman, P., Goge, C. (2008). WET-Health: A technique for rapidly assessing wetland health. Water Research Commission Report No. TT 340/08.

Nel, J.L., Driver, A., Strydom, W.F., Maherry, A., Peterson, C., Hill, L., Roux, D.J., Nienaber, S., van Deventer, H., Swartz, E. and Smith-Adao, L.B. (2011) Atlas of freshwater ecosystem priority areas in South Africa: Maps to support sustainable development of water resources. Water Research Commission Report No. TT 500/11.

Ollis, D., Snaddon, K., Job, N., & Mbona, N. (2013). Classification system for wetlands and other aquatic ecosystems in South Africa. South African National Biodiversity Institute.

South African National Biodiversity Institute (2006- 2018). The Vegetation Map of South Africa, Lesotho and Swaziland, Mucina, L., Rutherford, M.C. and Powrie, L.W. (Editors), Online, http://bgis.sanbi.org/Projects/Detail/186, Version 2018.