Planned Expansion of Cultivated Fields on Erf 385, Hoekwil, Western Cape.

Specialist Aquatic Biodiversity Assessment

Prepared For: Eco Route
Author: Dr. J.M. Dabrowski (PhD)
Confluent Environmental Pty (Ltd)
7 St. Johns Street,
Dormehlsdrift,
George, 6529
SACNASP: Pr. Sci. Nat. (Water Resources) – 114084

Date: May 2025
Version: Draft Final

Declaration of Specialist Independence

- 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.

Dr. James Dabrowski (Ph.D., Pr.Sci.Nat. Water Resources; SACNASP Reg. No: 114084)

May 2025

EXECUTIVE SUMMARY

Wilderness Fruit (Pty) Ltd (the applicant) is applying for the clearance of indigenous vegetation to establish an additional 15 hectares of cultivated land on Erf 385. The property has existing water rights and several dams on site. The establishment of the cultivated fields is planned to occur within close proximity to freshwater resources, prompting the need to conduct an aquatic specialist assessment that meets the requirements of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA) and the National Water Act (Act 36 of 1998) (NWA).

The property occurs within the catchment area of the Touws River which has been classified as a Freshwater Ecosystem Priority Area (FEPA) and a Strategic Water Source Area (SWSA). Any further development in the catchment area must therefore be done in a sensitive manner so as to maintain watercourses and the larger Touws River catchment in a good ecological condition. Extensive agricultural activities are one of the main threats to aquatic biodiversity that have been identified in the broader catchment area. Impacts associated with agriculture are primarily related to loss of aquatic habitat due to encroachment of cultivated areas into riparian zones and wetlands and nonpoint source pollution of watercourses by nutrients, sediment and pesticides.

Two unchannelled valley-bottom wetlands and associated streams were identified either side of the proposed cultivated area on Erf 385 (to the east and west). The western wetland is fed by a perennial stream that originates from the higher lying foothills to the north. From its source, the stream follows a relatively narrow, confined channel that flows through intact forest in its upper most reaches and then through forest partially invaded by *Acacia mearnsii* and *Acacia melanoxlyn*. As the stream reaches the valley, the gradient reduces substantially and grades into an unchannelled valley-bottom wetland. The upper section of the wetland is characterised by a mixture of seasonal and temporary vegetation (dominated by the bracken fern *Pteridium aquilinum*) and permanent wetland habitat lower down, dominated by *Cliffortia odorata.* The lower extent of the wetland in particular is completely saturated, with expansive areas of standing water, densely vegetated by a variety of obligate wetland plant species that include *Juncus effusus*, *Cliffortia odorata* and *Isolepis prolifera*. This area of inundation extends right across a road that crosses the wetland and which has been proposed to be used to access the cultivated area to the east. The watercourse to the east of the proposed cultivated area is more temporary in nature. The watercourse originates from the lower foothills to the north as a non-perennial stream that grades into a small unchannelled valley bottom wetland. The channel is narrow and poorly defined and vegetated with *Aristea eklonii*. While there was no water visibly flowing into the wetland, there was a clear stream exiting the wetland. This demonstrates the value of the wetland in regulating streamflow further downstream. In contrast to the western wetland, the eastern wetland was dominated by *Carpha glomerata* and *Cliffortia odorata* withing the seasonal zone, and surrounded by species favouring less saturated conditions, such as *Helichrysum cymosum* and *Schoenus cuspidatus.* The Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of both wetlands is C (moderately modified) and High, respectively.

Given the existing road crossing (Alternative A) has developed prominent wetland features and is heavily saturated and inundated along its entire width, an alternative crossing has been assessed. The alternative crossing (Alternative B) is located across a narrower portion of the wetland which had been previously disturbed, is far less saturated and thus exhibits less prominent wetland features. The road can cross at 90 degrees to the wetland alignment (which is preferable) and surface flow through the wetland is limited to a narrow, confined surface flowing spring and establishment of a road across this portion of the wetland will therefore not affect surface flows as much as Alternative A. Both alternatives would require infilling of wetland habitat and can also alter the natural hydrological and geomorphological characteristics of the wetland by restricting flow across the road. Mitigation measures must therefore be implemented with a view to ensuring the natural hydrological and geomorphological characteristics of the wetland are maintained. In this respect the road design must continue to allow diffuse flow through the road which can be achieved by installing multiple appropriately sized culverts through the road. Alternative B results in a lower impact and risk to the wetland – and is therefore the recommended alternative.

Impacts of nonpoint source pollution originating from the cultivated fields (i.e. sediment, nutrient and pesticide pollution in surface runoff) can be effectively mitigated through the implementation of adequately sized buffers that protect watercourses from habitat loss but also play and important role in attenuating and filtering nonpoint source pollutants. In this respect, and considering the sensitivity of the catchment area, a mandatory 30 m buffer between watercourses and planned cultivated fields must be implemented. Provided that the buffer and other mitigation measures are implemented, impacts associated with the proposed establishment of cultivated areas are acceptable (negligible to minor) from an aquatic biodiversity perspective.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

1.1 Project Background

Wilderness Fruit (Pty) Ltd (the applicant) proposes to establish an additional 15 hectares of cultivated land on Erf 385 and is therefore applying for the clearance of indigenous vegetation for the development of this additional cultivated land. The property has existing water rights and several dams on site. The establishment of the cultivated fields is planned to occur within close proximity to freshwater resources, prompting the need to conduct an aquatic specialist assessment that meets the requirements of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA) and the National Water Act (Act 36 of 1998) (NWA).

1.2 Key Legislative Requirements

1.2.1 National Environmental Management Act (NEMA, 1998)

According to the protocols specified in GN 320 (Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in Terms of Sections 24(5)(A) and (H) and 44 of the National Environmental Management Act, 1998, when Applying for Environmental Authorisation), 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.

According to the protocol, prior to commencing with a specialist assessment a site sensitivity verification must be undertaken to confirm the sensitivity of the site as indicated by the screening tool:

- Where the information gathered from the site sensitivity verification differs from the screening tool designation of **Very High** aquatic biodiversity sensitivity, and it is found to be of a **Low** sensitivity, an Aquatic Biodiversity Compliance Statement must be submitted.
- Similarly, where the information gathered from the site sensitivity verification differs from the screening tool designation of **Low** aquatic biodiversity sensitivity, and it is found to be of a **Very High** sensitivity, an Aquatic Biodiversity Specialist Assessment must be submitted.

The screening tool identified the site as being of **Very High** aquatic biodiversity based on the fact that the development occurs in a Freshwater Ecosystem Priority Area (FEPA) and a Strategic Water Source Area (SWSA) and will also take place in close proximity to mapped watercourses.

1.2.2 National Water Act (NWA, 1998)

The Department of Water & Sanitation (DWS) is the custodian of South Africa's water resources and therefore assumes public trusteeship of water resources, which includes watercourses, surface water, estuaries, or aquifers. The National Water Act (NWA) (Act No. 36 of 1998) aims to protect water resources, through:

- The maintenance of the quality of the water resource to the extent that the water resources may be used in an ecologically sustainable way;
- The prevention of the degradation of the water resource; and
- The rehabilitation of the water resource.

A watercourse means:

- A river or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

No activity may take place within a watercourse unless it is authorised by the Department of Water and Sanitation (DWS). According to Section 21 (c) and (i) of the National Water Act, an authorization (Water Use License or General Authorisation) is required for any activities that impede or divert the flow of water in a watercourse or alter the bed, banks, course or characteristics of a watercourse. The regulated area of a watercourse for section 21(c) or (i) of the Act water uses means:

a) The outer edge of the 1 in 100-year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam;
b) In the absence of a determined 1 in 100-year flood line or riparian area the area within 100m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench (subject to compliance to section 144 of the Act); or
c) A 500 m radius from the delineated boundary (extent) of any wetland or pan.

According to Section 21 (c) and (i) of the NWA, any water use activities that do occur within the regulated area of a watercourse must be assessed using the DWS Risk Assessment Matrix (GN 4167 of 2023) to determine the impact of construction and operational activities on the flow, water quality, habitat and biotic characteristics of the watercourse. Low Risk activities require a General Authorisation (GA), while Medium or High Risk activities require a Water Use License (WUL).

1.3 Scope of Work

Based on the key legislative requirements listed above the scope of work for this report includes the following:

- Undertake a desktop study of relevant freshwater information for the site;

- Undertake a site visit to the study area;
- Classify and delineate the freshwater ecosystems potentially affected by the agricultural expansion;
- Determine the present ecological state, functional importance and conservation value of the freshwater ecosystems that will be potentially affected by the agricultural expansion;
- Describe and assess the significance of the potential impacts of the agricultural expansion on freshwater ecosystems; and
- Provide a summary of the findings in the form of a Freshwater Ecology Impact Assessment Report.

2. METHODS

2.1 Desktop Assessment

A desktop assessment was conducted to contextualize the affected watercourses in terms their local and regional setting, and conservation planning. An understanding of the biophysical attributes and conservation and water resource management plans of the area assists in the assessment of the importance and sensitivity of the watercourses, the setting of management objectives and the assessment of the significance of anticipated impacts. The following data sources and GIS spatial information were consulted to inform the desktop assessment:

- National Freshwater Ecosystem Priority Area (NFEPA) atlas (Nel at al., 2011);
- National Wetland Map 5 and Confidence Map (CSIR, 2018)
- Western Cape Biodiversity Spatial Plan (CapeNature, 2017); and
- DWS hydrological spatial layers.

2.2 Watercourse Assessment

A site visit was undertaken on the 23rd of April 2024, with the objective of identifying and classifying watercourses affected by the cultivate area; determining their Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS), and assessing the impacts of the establishment of orchards on watercourses.

2.2.1 Watercourse Classification

Classification of watercourses is important as this determines the PES and EIS assessment methodologies that can be applied. Furthermore, classification of the watercourse provides a fundamental understanding of the hydrological and geomorphic drivers that characterise the watercourse and therefore assists in the interpretation of impacts to the watercourse. Watercourses were categorised into discrete hydrogeomorphic units (HGMs) based on their geomorphic characteristics, source of water and pattern of water flow through the watercourse. These HGMs were then classified according to Ollis et al. (2013).

2.2.2 Wetland Delineation

Wetlands are described by the National Water Act (Act 36 of 1998) as:

“Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.”

According to DWAF (2005) wetlands must have one or more of the following attributes:

- Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation;
- The presence, at least occasionally, of plants that grow in water saturated conditions (hyrdophytes or obligate wetland plants);
- A high water table that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil.

The boundary of the wetland was delineated in accordance with DWAF (2005) guidelines which considers the following four specific indicators:

- The Terrain Unit Indicator: Identifies those parts of the landscape where wetlands are more likely to occur;
- The Soil Form Indicator: Identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation;
- The Soil Wetness Indicator: Identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation (i.e. mottling and gleying within 50 cm of the soil surface); and
- The Vegetation Indicator: Identifies hydrophilic vegetation associated with frequently saturated soils.

The boundary of wetlands was determined by identifying the presence or absence of the combination of indicators mentioned above at selected points in the field. The location of soil augering points used to assess soil wetness were marked on a hand-held GPS and saturation zones were classified according to the soil wetness indicators as follows:

- Temporary Zone: Short periods of saturation (less than three months per annum) characterised by few high chroma mottles and minimal grey matrix (< 10 %).
- Seasonal Zone: Significant periods of wetness (at least three months per annum) characterised by many low chroma mottles and a grey matrix.
- Permanent Zone: Wetness all year round characterised by a prominent grey matrix and few to no high chroma mottles.

Auger points that showed no sign of saturation were classified as ‘Out’. All augering points were imported into GIS software and, in combination with aerial imagery and other site observations of vegetation indicators, were used to plot and map the boundary of the wetland.

2.2.3 Present Ecological State

An important factor that influences the diversity and abundance of aquatic communities is the condition of the surrounding physico-chemical habitat. Habitat loss, alteration, or degradation generally results in a decline in species diversity. The PES of affected watercourses was assessed using the WET-Health v2.0 methodology (see Appendix 1).

2.2.4 Ecological Importance and Sensitivity

The ecological importance of a watercourse is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. Ecological sensitivity refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Resh et al. 1988; Milner 1994). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity. The EIS of affected watercourses was assessed using the methodology described in Appendix 2.

2.3 Sensitivity Mapping

Watercourses on or adjacent to the site were mapped in the field and verified at a desktop level using satellite imagery. A protective buffer zone was applied to watercourses potentially affected by the development. Buffer zones have been defined as a strip of land with a use, function or zoning specifically designed to act as barriers between human activities and sensitive water resources with the aim of protecting these water resources them from adverse negative impacts. Buffer zones are regarded as possibly the most effective means of mitigating impacts of agriculture on aquatic ecosystems. Appropriate buffers were estimated based on buffer zone guidelines developed by Macfarlane and Bredin (2017). These guidelines estimate required buffer zone widths based on a combination of input parameters which include, *inter alia*, the nature of the activity and associated impacts, basic climatic and soil conditions, the PES and EIS of potentially affected watercourses and the implementation of appropriate mitigation measures (as indicated in the impact assessment).

For the purposes of this assessment, the watercourse AND its associated buffer was considered to be of Very High sensitivity. If any construction or operational activities fall within the delineated watercourse OR buffer zone, the sensitivity of the site is confirmed as Very High. If all construction and operational activities fall outside of the buffer, the sensitivity is considered as Low.

2.4 Impact Assessment

Development activities typically impact on the following important drivers of aquatic ecosystems:

- *Hydrology:* Impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes and base flows and modifications to general flow characteristics, including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of over-abstraction or instream or off-stream impoundment of a wetland or river etc.);
- *Geomorphology:* This refers to the alteration of hydrological and geomorphological processes and drivers, and associated impacts to aquatic habitat and ecosystem goods and services primarily driven by changes to the sediment regime of the aquatic ecosystem and its broader catchment;
- *Modification of water quality:* This refers to the alteration or deterioration in the physical, chemical and biological characteristics of water within streams, rivers and wetlands, and associated impacts to aquatic habitat and ecosystem goods and

services (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication etc.);

- *Fragmentation:* Loss of lateral and/or longitudinal ecological connectivity due to structures crossing or bordering watercourses (e.g. road or pipeline crossing a wetland);
- *Modification of aquatic habitat:* This refers to the physical disturbance of in-stream and riparian aquatic habitat and associated ecosystem goods and services including the loss or degradation of all or part of any unique or important features associated with or within the aquatic ecosystem (e.g. waterfalls, springs, oxbow lakes, meandering or braided channels, peat soils, etc.); and
- *Aquatic biodiversity:* Impacts on community composition (numbers and density of species) and integrity (condition, viability, predator prey ratios, dispersal rates, etc.) of the faunal and vegetation communities inhabiting the site.

Modifications to these drivers ultimately influence the PES and EIS of a watercourse. Accordingly, impacts to the watercourse were described and assessed based on their potential to modify each of the above-mentioned drivers of aquatic ecosystem health, using the PES and EIS of the watercourse as a baseline against which to assess impacts. The impact assessment methodology is described in the appendix to this report (Appendix 3).

3. ASSUMPTIONS & LIMITATIONS

- With ecology being dynamic and complex, there is the likelihood that some aspects (some of which may be important) may have been overlooked;
- This assessment is based on the findings of a visual assessment of the site combined with available desktop resources. This study was not informed by detailed hydraulic, hydrological, faunal or floral assessments;
- The PES and EIS assessments undertaken are largely qualitative assessment tools and thus the results are open to professional opinion and interpretation. An effort has been made to substantiate all claims where applicable and necessary.

4. STUDY SITE

The property is in located quaternary catchment K30D of the Kromme Primary Catchment (Figure 1). The catchment area falls within the Southern Eastern Coastal Belt (Ecoregion Level 2: 25.01) (Figure 2). The terrain morphology consists predominantly of moderately undulating plains and low mountains with altitude ranging from 0 – 300 m.a.m.s.l. Rainfall occurs all year round. Summers are mild to warm (mean daily maximum temperature of 22 to 28 ºC) and winters are mild to cold (mean daily maximum temperature of 10 to 18 ºC).

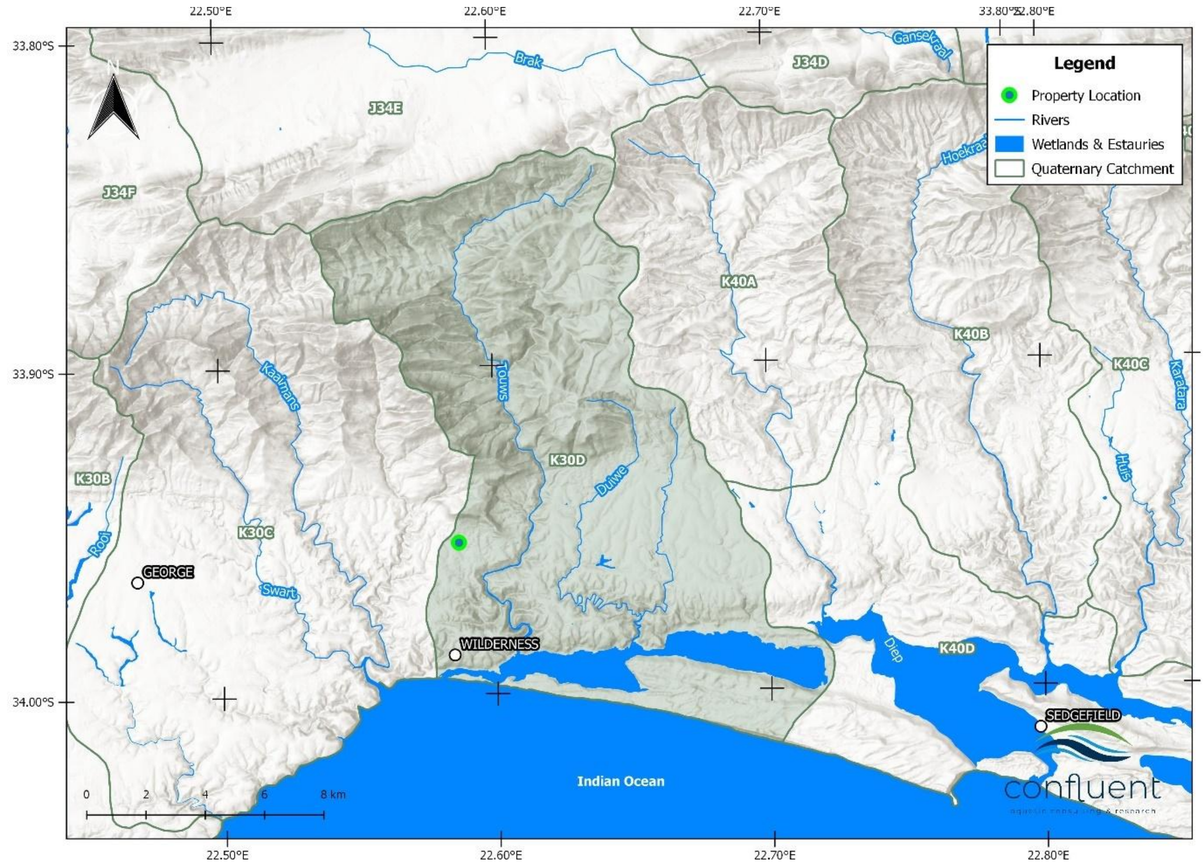

Figure 1: Location of the property in quaternary catchment K30D.

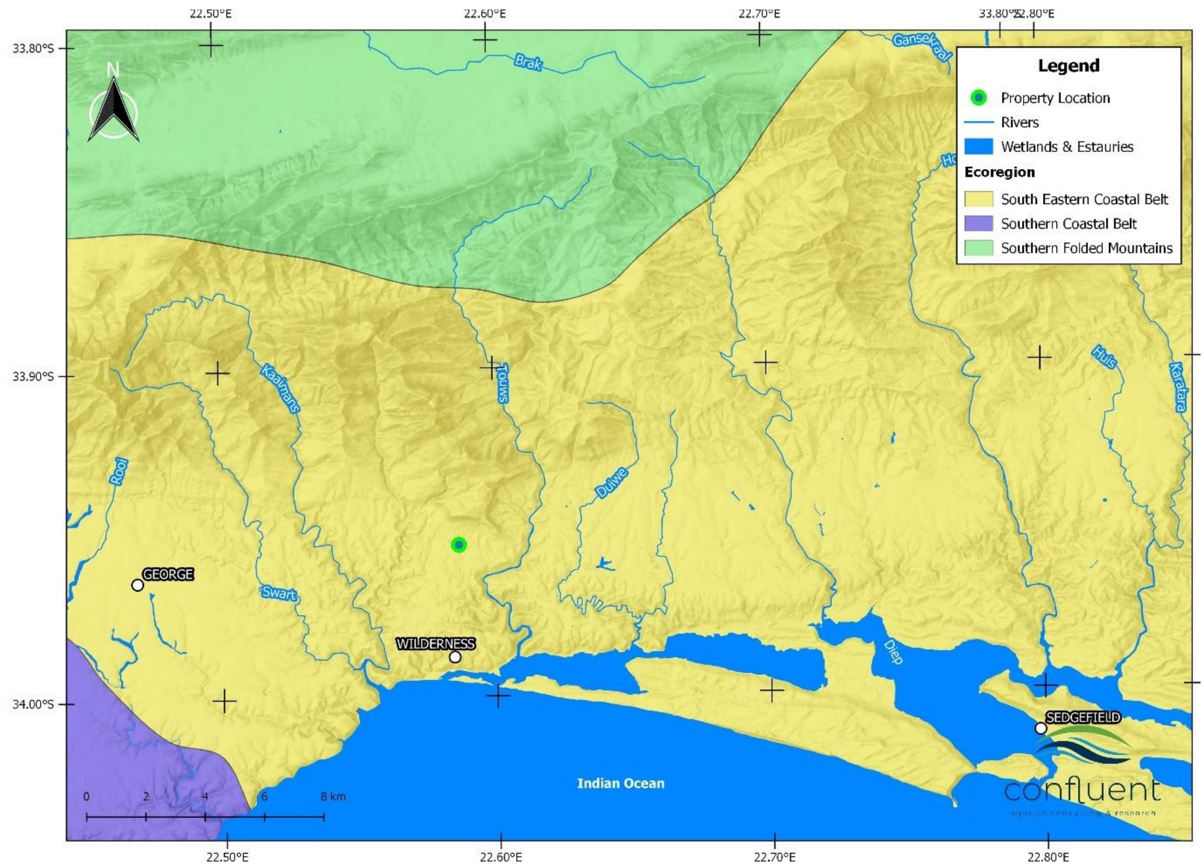

Figure 2: Map indicating the location of the property in relation to Level 1 Ecoregions.

The planned cultivated area is approximately 15 ha in extent and is located in between two watercourses that have been mapped as non-perennial streams (Figure 3). Access to the site is via an existing road that crosses the western of the two watercourses.

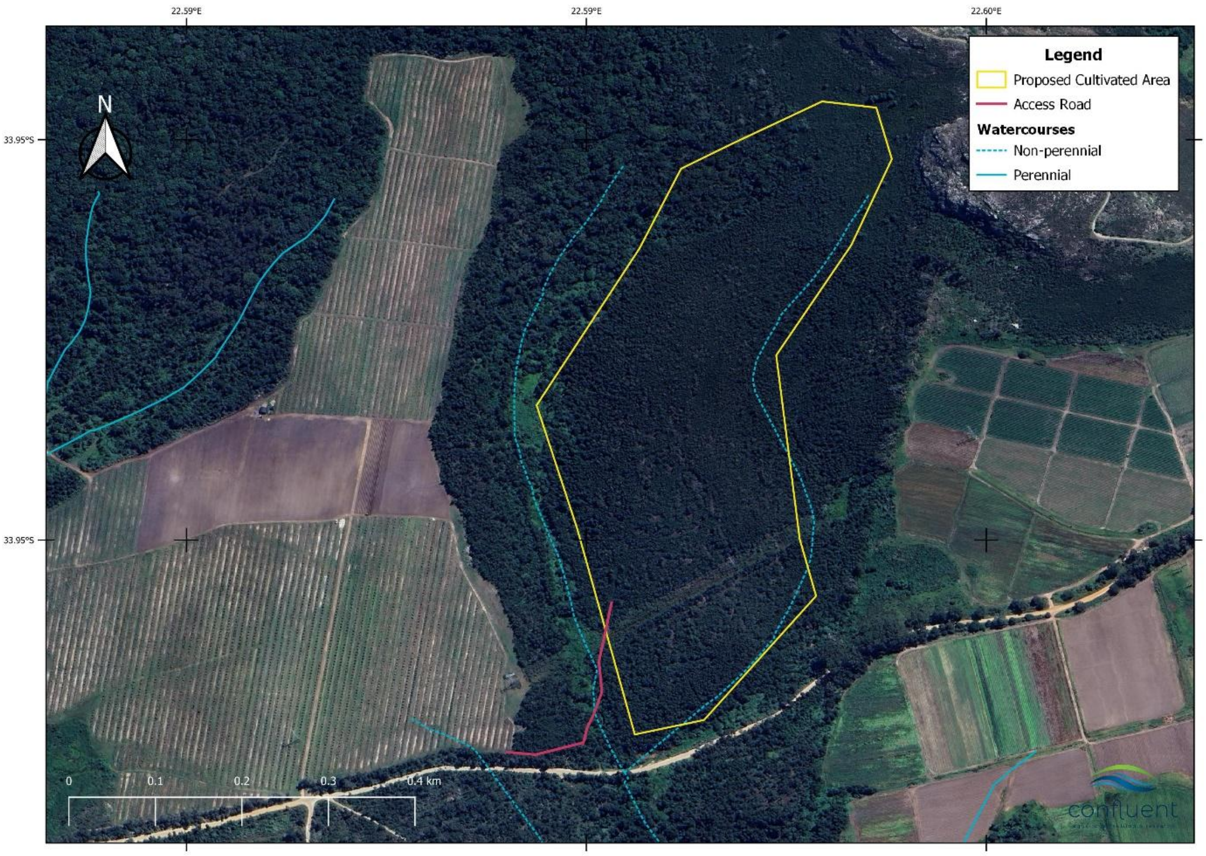

Figure 3: Map indicating the location of mapped watercourses relative to the proposed cultivated area.

4.1 National Freshwater Ecosystem Priority Areas (NFEPA)

The properties lie in sub-quaternary catchment (SQC) 9042 (Figure 4). According to the National Freshwater Ecosystem Priority Atlas, this SQC has been classified as a Freshwater Ecosystem Priority Area (FEPA; Nel *et al.,* 2011). A FEPA is an area prioritised for conserving freshwater ecosystems and associated biodiversity. The selection of FEPAs is determined through a process of systematic biodiversity planning using data on freshwater ecosystem types, species and ecological processes. FEPAs should be maintained in a good condition to manage and conserve freshwater ecosystems and to protect water resources for human users. The main river in this SQC is the Touws River, which ultimately forms the Touws River estuary before flowing into the Indian Ocean. The PES of the Touws River is a B, indicating that is largely natural and relatively unimpacted by anthropogenic activities. It is therefore important that catchment activities are managed in such a way as to prevent any further deterioration in the ecological integrity of the Touws River and its broader hydrological network.

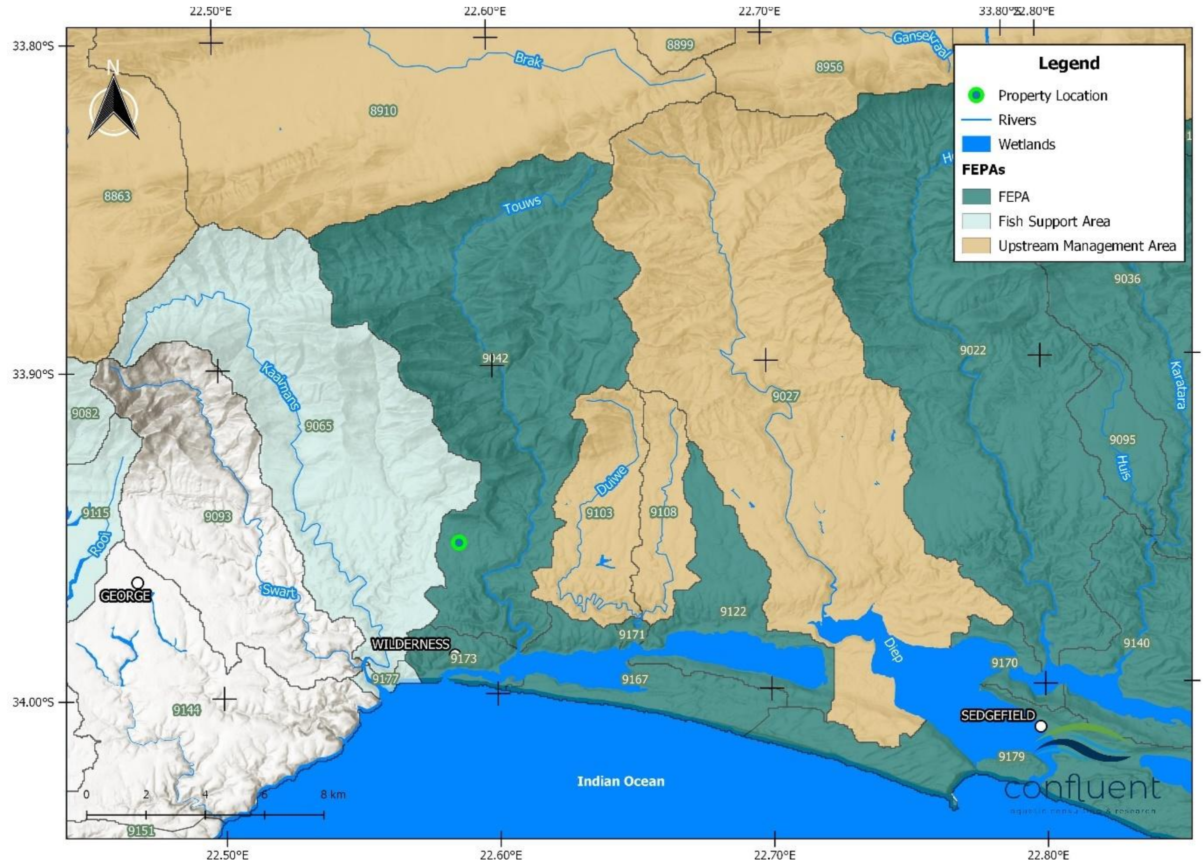

Figure 4: Map of the property in relation to FEPAs.

4.2 Strategic Water Source Area

Strategic Water Source Areas (SWSAs) are defined as areas of land that either:

a) Supply a disproportionate (i.e. relatively large) quantity of mean annual surface water runoff in relation to their size and so are considered nationally important; or

b) Have high groundwater recharge and where the groundwater forms a nationally important resource; or

c) Areas that meet both criteria (a) and (b).

The property that forms the focus of this study occurs within the Outeniqua SWSA which is considered to be of national importance (Figure 5). The SWSAs are vital for water and food security in South Africa and also provide the water used to sustain the economy. Given this context, management and implementation guidelines have been developed with the objective of facilitating and supporting well-informed and proactive land management, land-use and development planning in these nationally important and critical areas (Le Maitre, et al., 2018). The primary principle behind this objective is to protect the quantity and quality of the water they produce by maintaining or improving their condition.

With respect to agriculture, the main impacts that affect watercourses are inputs of fertilisers and agro-chemicals, soil erosion and associated sediment input and destabilisation of the bed and banks of watercourses because of the failure to maintain uncultivated buffer strips along the banks of watercourse. It is therefore important that establishment and production of macadamia and avocado orchards is done in a sensitive manner so as to prevent degradation of water resources through the impacts described above.

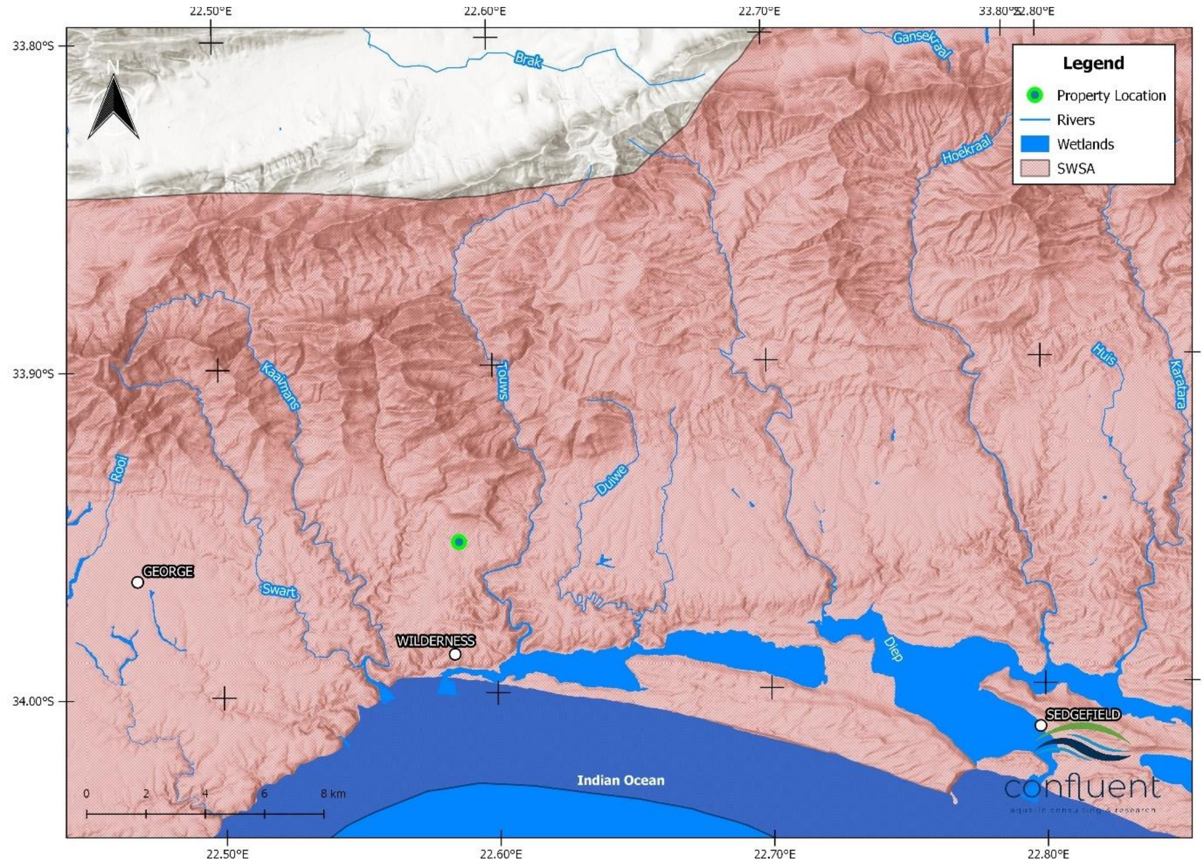

Figure 5: Map of the property location relative to mapped Strategic Water Source Areas (SWSAs)

4.3 Western Cape Biodiversity Spatial Plan (WCBSP)

According to the WCBSP for George, no aquatic CBAs are indicated to occur with Erf 385. The streams to the west and east of the proposed cultivated area have been categorized as aquatic Ecological Support Areas (ESAs - Figure 6), which are relatively unimpacted aquatic features that are not considered important for meeting biodiversity targets, but are important for providing important supporting functions (Table 1). In this particular case the streams are considered as important water source areas. The management objective of ESAs is described in Table 1, which is to maintain in a functional near natural state, ensuring that the continued provision of ecological support services is not compromised.

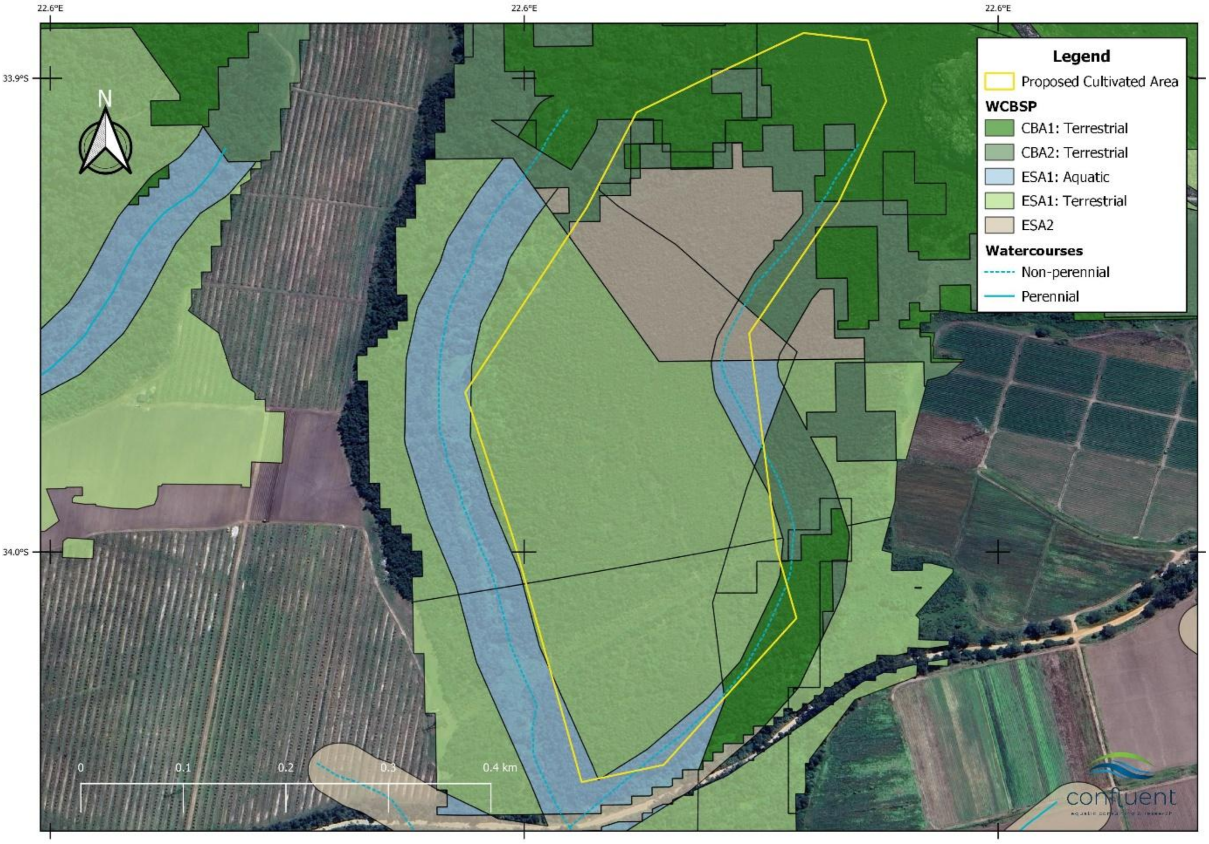

Figure 6: Map of the dams and road crossings in relation to the Western Cape Biodiversity Spatial Plan (WCBSP).

Table 1: Definitions and management objectives of the Western Cape Biodiversity Spatial Plan.

Category	Definition	Management Objective
ESA1	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.	Maintain in a functional, near-natural state. Some habitat loss is acceptable, provided the underlying biodiversity objectives and ecological functioning are not compromised.

5. SITE ASSESSMENT

5.1 Watercourse Classification

5.1.1 Western Wetland

The watercourse to the west of the proposed cultivated area occurs along a relatively wide valley-bottom, bordered on either side by relatively steep slopes. The watercourse originates as a permanent perennial stream/spring which originates from the higher lying foothills to the north. From its source, the stream follows a relatively narrow, confined channel that flows through intact forest in its upper most reaches and forest partially invaded by *Acacia mearnsii* and *Acacia melanoxlyn.* As the stream reaches the valley, the gradient reduces substantially and the stream grades into an unchannelled valley-bottom wetland (Figure 7). As the name implies, these wetlands are located on valley bottoms and are generally located along low gradients, which favours deposition of sediment and results in diffuse (as opposed to channelled) streamflow, ultimately resulting in prolonged saturation levels and high levels of organic matter. The upper section of the wetland is characterised by a mixture of seasonal and temporary vegetation (dominated by the bracken fern *Pteridium aquilinum*) and permanent wetland habitat lower down, dominated by *Cliffortia odorata.* The lower extent of the wetland in particular is completely saturated, with expansive areas of standing water, densely vegetated by a variety of obligate wetland plant species that include *Juncus effusus*, *Cliffortia odorata* and *Isolepis prolifera*. This area of inundation extends right across a road that crosses the wetland and which has been proposed to be used to access the cultivated area to the east. The road is clearly visible in 2019 (when large-scale clearing of alien invasive tree species seemed to have occurred) and has since become overgrown as the invasive species have re-established across the area (Figure 8). Within the delineated area of the wetland, the entire width of the road is inundated and saturated and is densely vegetated with a variety of wetland plant species. Wetland plant indicators along the more seasonal zones of the wetland included *Cyperus polystachyos* and *Helichrysum cymosum*. The primary source of water sustaining the wetland is the perennial stream, however later surface and sub-surface runoff will play an important contribution during wetter periods, with the relatively flat gradient of the wetland area favouring prolonged retention of water along the valley-bottom.

5.1.2 Eastern Wetland

The watercourse to the east of the proposed cultivated area is more temporary in nature. The watercourse originates from the lower foothills to the north as a non-perennial stream that grades into an unchannelled valley bottom wetland. The channel is narrow and poorly defined and vegetated with *Aristea eklonii*. While there was no water visibly flowing into the wetland, there was a clear stream exiting the wetland. This demonstrates the value of the wetland in regulating streamflow further downstream. In contrast to the western wetland, the eastern wetland was dominated by *Carpha glomerata* and *Cliffortia odorata* withing the seasonal zone, and surrounded by species favouring less saturated conditions, such as *Helichrysum cymosum* and *Schoenus cuspidatus.*

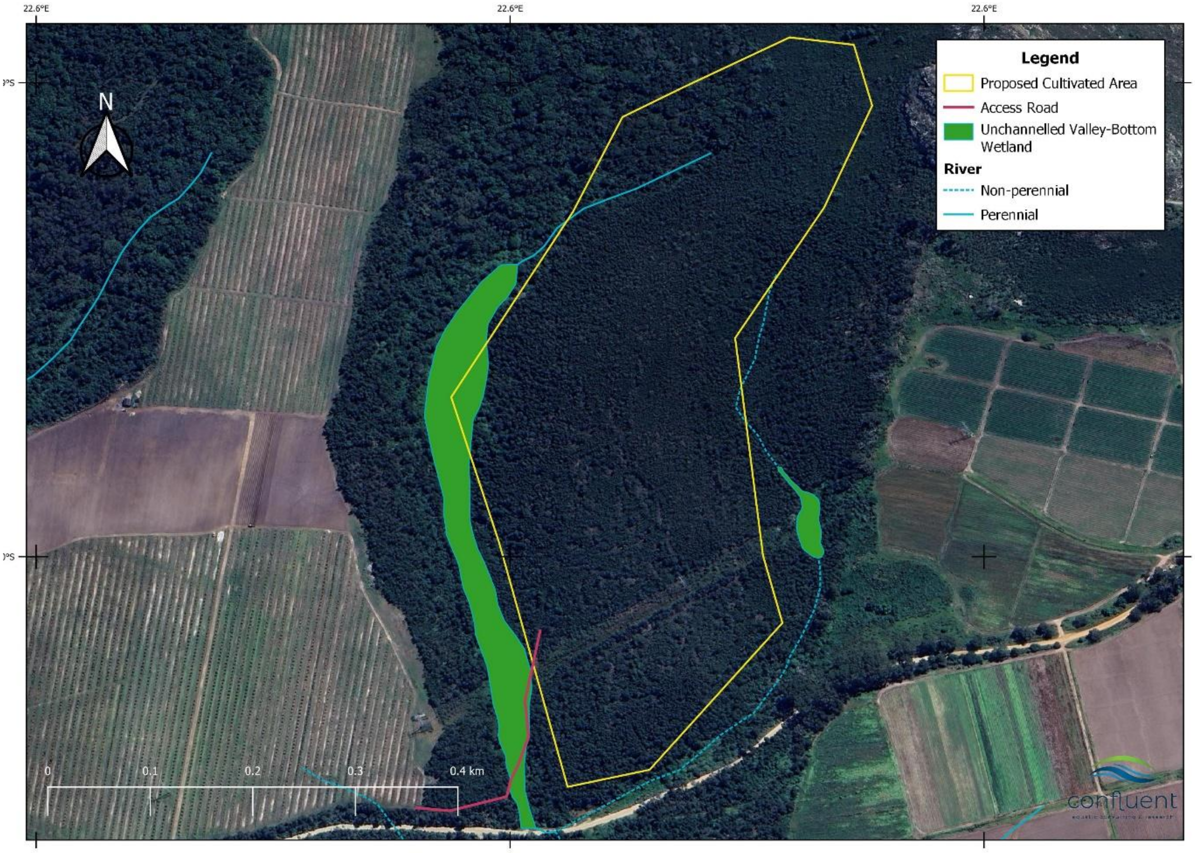

Figure 7: Map indicating watercourses located to the east and west of the proposed cultivated area.

Figure 8: Google Earth images indicating the road crossing in 2019 (left) and currently (2024) (see yellow ellipse). The broad band of cleared vegetation along the northern extent of the circled area is an ESKOM servitude for a power line traversing the property.

Figure 9: Photographs illustrating the perennial stream feeding the western wetland (A); upper reaches of unchannelled valley-bottom wetland dominated by P. aquilinum (B); lower, inundated section of the unchannelled valley-bottom wetland dominated by C. odorata, I. prolifera and J. effusus (C); inundated road crossing, densely vegetated with wetland plants (D); the eastern wetland dominated by C. odorata and C. glomerata (E); narrow stream leaving the eastern wetland (F).

5.2 Present Ecological State (PES)

5.2.1 Wetlands

The most significant impact affecting the wetlands is high level of invasion by dense stands of invasive plant species. While invasion is comparatively lower within the delineated area of each wetland, invasion along the periphery of each wetland and their respective catchment areas is severe, comprising predominantly of Black Wattle (*Acacia mearnsii*) and Bugweed

(*Solanum mauritianum*). The highly invaded slopes offer poor buffering capabilities due to the lack of any vegetative ground cover beneath the canopy. High invasion most likely leads to a decrease of water inputs into each of the wetlands, thus impacting on the natural hydrology of the wetlands. While there have been some historical crossings through each of the wetlands, these do not appear to be currently impeding flows or affecting water distribution through the wetlands or affecting sediment transport and deposition throughout the wetland. There are no major upstream impacts affecting water quality which is considered to be very good. Within the wetland, particularly around the seasonal and temporary zones, moderate invasion by alien species has occurred, most notably by *A. mearnsii* and *S. mauritianum.* The PES of the two wetlands has therefore been determined as **C (Moderately Modified)** (Table 2).

Table 2: Summary of Wet-Health scores derived for the Western and Eastern Wetland.

Final (adjusted) Scores				
PES Assessment	**Hydrology**	**Geomorphology**	**Water Quality**	**Vegetation**
Impact Score	2.2	3.0	0.9	4.0
PES Score (%)	78%	70%	91%	60%
Ecological Category	**C**	**C**	**A**	**D**
Trajectory of change	↑	↑	↑	
Confidence (revised results)	Medium	Not rated	Not rated	Not rated
Combined Impact Score	2.5			
Combined PES Score (%)	75%			
Combined Ecological Category	**C**			

5.3 Importance & Sensitivity

5.3.1 Wetlands

The overall importance and sensitivity of the both wetlands is **High**, based on the hydro-functional attributes that these type of wetlands offer (Table 4), which are particularly important in agricultural landscapes. The ecological importance and sensitivity of the wetlands is **Moderate** (Table 3) and direct human benefits are considered to be **Low** (Table 5).

Table 3. Ecological Importance and Sensitivity importance criteria for wetlands on Erf 385.

Criteria	Score	Motivation
Biodiversity support		
Presence of Red Data species	1	More than one population (or taxon) judged to be unique on a local scale.
Populations of unique species	2	More than one population (or taxon) judged to be unique on a local scale.
Migration/feeding/breeding sites	2	Locally important for migration along riparian corridors
Average	**1.67**	
Landscape scale		
Protection status of wetland	1	The wetland is present within an area important for the conservation of ecological diversity on a local scale (ESA).
Protection status of vegetation type	1	Not protected
Regional context of the ecological integrity	1	The wetland has a lower PES (C) relative to the broader catchment area (B).
Size and rarity of the wetland types present	3	Moderate size, relatively rare throughout the landscape.
Diversity of habitat types	2	Moderate diversity of habitats as a result of diverse vegetation associated with distinct zones of inundation and soil saturation within the wetlands.
Average	**1.6**	
Sensitivity of the wetland		
Sensitivity to changes in floods	2	Moderately sensitive to floods.
Sensitivity to changes in low flows	2	Moderately sized wetlands that are moderately sensitive to lower flows.
Sensitivity to changes in water quality	1	Capable of attenuating pollutants and are therefore relatively insensitive to changes in water quality.
Average	**1.67**	
ECOLOGICAL IMPORTANCE AND SENSITIVITY	**1.67 (Moderate)**	

Table 4: Hydro-functional importance criteria results for wetlands on Erf 385.

Hydro-functional importance			Score	Motivation
Regulating & supporting benefits	Flood attenuation		3	Established benefit
	Streamflow regulation		3	Established benefit
	Water quality enhancement	Sediment trapping	3	
		Phosphate assimilation	3	
		Nitrate assimilation	3	
		Toxicant assimilation	3	
		Erosion control	3	Prolongs water retention
	Carbon storage		2	No obvious peatlands
HYDRO-FUNCTIONAL IMPORTANCE			**2.6 (High)**	

Table 5: Direct human benefit importance criteria results for wetlands on Erf 385.

Direct human benefits		Score	Motivation
Subsistence benefits	Water for human use	1	Low importance for abstraction for irrigation
	Harvestable resources /cultivated foods	0	None
Cultural benefits	Cultural heritage	0	None known
	Tourism and recreation & education and research	1	Offers good bird-watching potential
DIRECT HUMAN BENEFITS		**0.5 (Low)**	

6. BUFFER DETERMINATION

Buffer zones have been defined as a strip of land with a use, function or zoning specifically designed to act as barriers between human activities and sensitive water resources with the aim of protecting these water resources them from adverse negative impacts. Buffer zones are regarded as possibly the most effective means of mitigating impacts of agriculture on aquatic ecosystems. The majority of existing impacts currently experienced in the Touws River catchment can be attributed to the lack of appropriate buffers in between watercourses and agricultural fields – particularly dairy pastures.

The majority of existing impacts currently experienced in the Touws River catchment can be attributed to the lack of appropriate buffers in between watercourses and agricultural fields – Buffers for watercourses within Erf 385 were estimated based on buffer zone guidelines developed by Macfarlane and Bredin (2017). The location of the watercourses in sensitive FEPA and SWSA catchments was also considered in the buffer determination. Buffer determination considered the implementation of mitigation measures specified in the impact assessment below and was determined based on the following catchment and buffer characteristics:

- Mean Annual Precipitation Class: > 800 mm.
- Rainfall Intensity: Zone 4.
- The inherent runoff potential of soil in the catchment area is moderate (B soils).
- Average slope of the rivers catchment is >11 %.
- Inherent erosion potential of the catchment soils is high (K factor > 0.7).
- The slope of the buffer area is gentle (0 - 2 %).
- Interception characteristics of the vegetation in the buffer is considered to be poor (dominated by low growing grasses that provide relatively dense ground coverage).

Based on these inputs the buffer for the wetland is set to 30 m (Figure 10) and as stipulated in Section 2.3 is considered to be an area of Very High sensitivity.

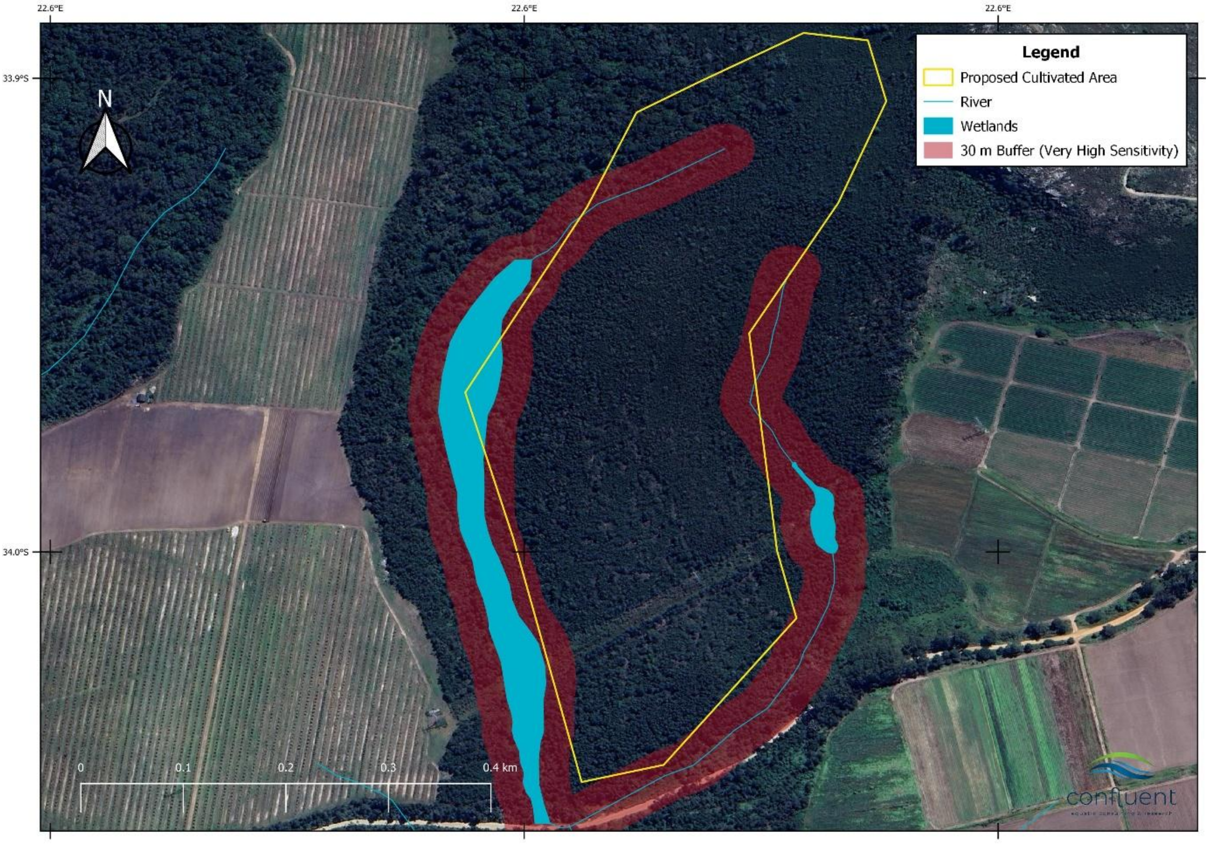

Figure 10: Map indicating watercourse and 30 m buffer in relation to proposed cultivated area.

7. IMPACT ASSESSMENT

Each of the impacts expected to occur during the construction and operational phase have been assessed in terms of their significance. The main impacts associated with the establishment and operation of cultivated fields is habitat loss related to the encroachment of cultivated areas into the riparian zone of streams/rivers or the delineated area of wetlands and nonpoint source pollution of watercourses caused by surface runoff of nutrients, pesticides and sediment and spray drift of pesticides during application. The most effective mitigation measure for all of these impacts is the establishment of an appropriately sized, well vegetated buffer zone that keeps agricultural activities well outside the delineated area of watercourses, minimises preferential, concentrated flow paths and filters nonpoint source pollutants.

Given the existing road crossing (Alternative A) has developed prominent wetland features and is heavily saturated and inundated along its entire width, an alternative crossing has been assessed. The alternative crossing (Alternative B) is located across a narrower portion of the wetland which had been previously disturbed, is far less saturated and thus exhibits less prominent permanent wetland features (Figure 11 and Figure 12). The road can cross at 90 degrees to the wetland alignment (which is preferable) and surface flow through the wetland is limited to a narrow, confined surface flowing spring (Figure 11) and establishment of a road across this portion of the wetland will therefore not affect surface flows as much as Alternative A.

Figure 11: Photographs indicating the narrow surface flowing spring (left) and the relatively disturbed vegetation consisting of invasive S. mauritianum and grasses and bracken fern (P. aquilinum) – right.

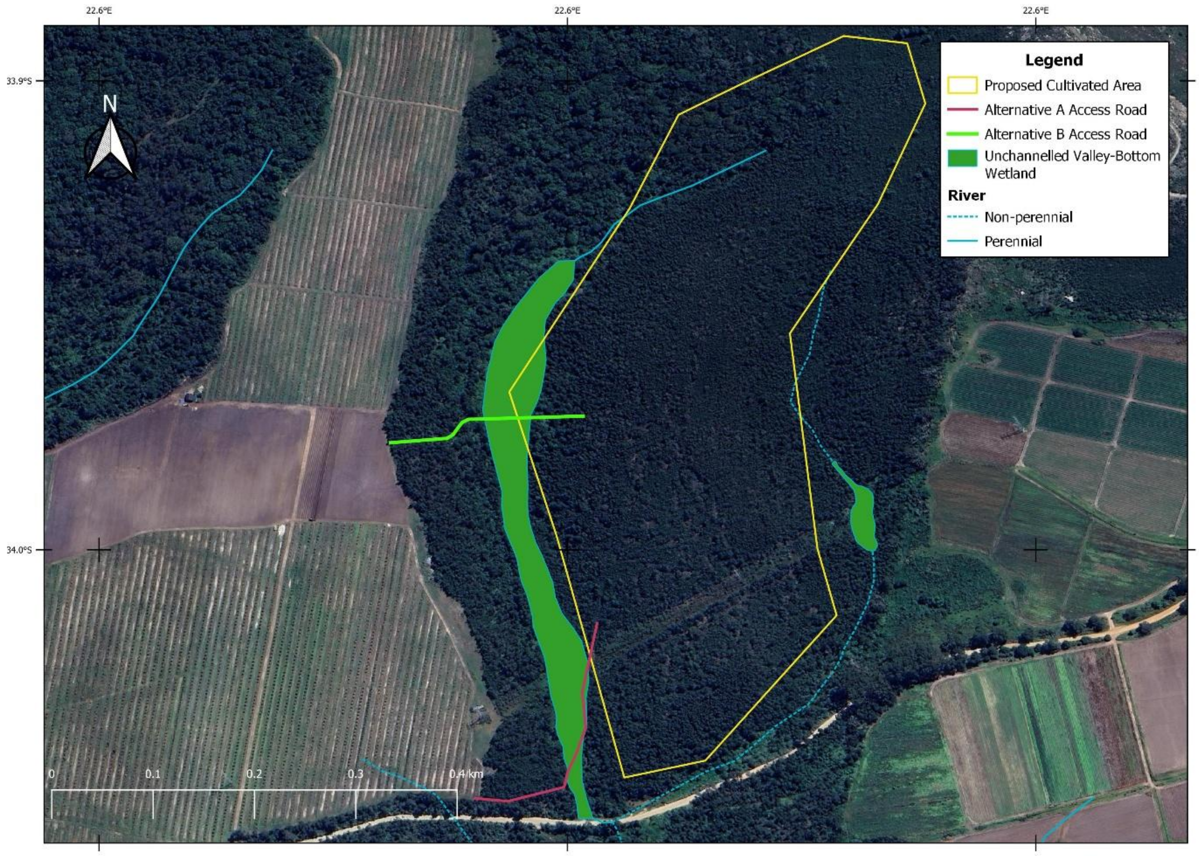

Figure 12: Map indicating proposed road crossing alternatives.

7.1 Layout & Design Phase

Impact 1: Degradation of wetland habitat caused by upgrading the access road.

Additionally, infilling across the wetland can alter the natural hydrological and geomorphological characteristics of the wetland by restricting flow across the road. This has the effect of increasing the extent of inundation and sedimentation upstream of the road and reducing (or channelising) flow and sediment inputs downstream of the road, leading to a reduced extent or erosion of the wetland. Mitigation measures must therefore be implemented with a view to maintaining the natural hydrological and geomorphological characteristic**s** of the wetland are maintained. In this respect the road must be upgraded to continue to allow diffuse flow through the road which can be achieved by installing multiple appropriately sized culverts through the road.

	Alternative A		Alternative B	
	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity	Very High	Moderate	High	Low
Duration	Permanent	Permanent	Permanent	Permanent
Extent	Very limited	Very limited	Very limited	Very limited
Probability	Almost Certain	Likely	Almost Certain	Likely
Significance	**-84: Moderate**	**-60: Minor**	**-78: Moderate**	**-55: Minor**
Reversibility	High	High	High	High
Irreplaceability	Low	Low	Low	Low
Confidence	High	High	High	High

Mitigation:

- Multiple culverts (at least 300 mm diameter) must be placed through the road (every 5 m along the delineated width of the wetland) to facilitate diffuse flow beneath the road.
- The invert of each culvert must be level with bed of the wetland upstream and downstream of the road as the bed Figure 14.
- The width of the road surface must not exceed 4 m.
- An ECO must be appointed to oversee the upgrade of the road to ensure that the above-mentioned mitigation measures are implemented.
- **For Alternative A:** As the road crosses the wetland at an angle, culverts must be orientated parallel to the direction of flow through the wetland and must NOT be orientated perpendicular to the alignment of the road (see Figure 13).

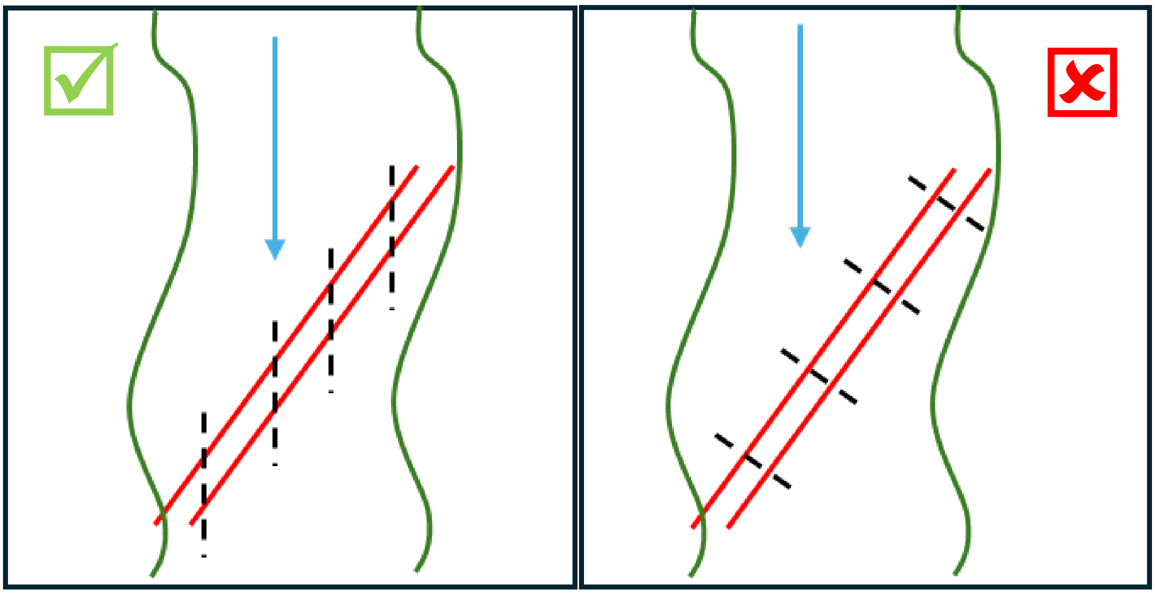

Figure 13: Sketch indicating orientation of correct orientation of culverts (black dashed lines) relative to the flow of water (blue arrow) and the alignment of the road (red lines).

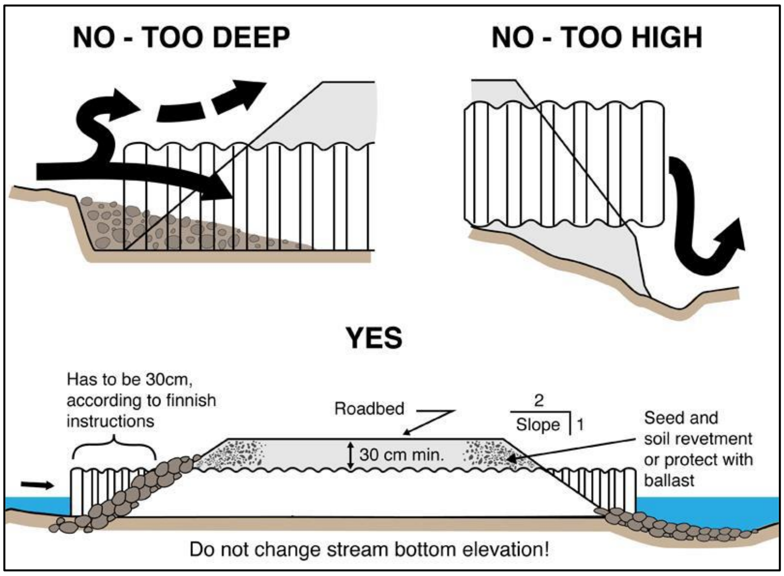

Figure 14: Diagram illustrating the ideal placement of culverts relative to the bed of the wetland.

7.2 Construction Phase Impacts

Impact 2: Loss of wetland habitat during the establishment of orchards

The current extent of the proposed cultivated area will extend into sections of wetland habitat and will provide minimal buffer area and associated protection of the wetland. In addition, preparation of orchards during the construction phase could potentially result in the degradation of wetland habitat if these take place in too close proximity to orchards. This will result in loss and degradation of wetland habitat over time, particularly considering the steep slopes and poor buffering capability of uncleared vegetation.

	Without Mitigation	With Mitigation
Intensity	Very high	Low
Duration	Permanent	Ongoing
Extent	Limited	Very limited
Probability	Certain	Unlikely
Significance	**-105: Moderate**	**-30: Negligible**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- Implementation of a 30 m buffer to protect the watercourse during the establishment of the orchards. The outer edge of the buffer must be clearly demarcated and activities within the buffer must be avoided;
- No orchards are to be established within the buffer;
- No equipment or materials to be stored or stockpiled in the buffer;
- No heavy machinery to operate within buffer;
- Apart from the road crossing the wetland, no roads to be established within the buffer; and
- An ECO must be appointed to oversee the establishment of the cultivated area relative to the delineation of the 30 m buffer.

Impact 3: Disturbance and pollution of aquatic habitat caused by construction of the road crossing.

Alternative A: The existing road crossing the western wetland has been completely inundated and revegetated by wetland plant species and will need to be upgraded in order to make it passable to vehicles. This would require infilling along the existing alignment of the road, which will result in loss of permanent wetland habitat.

Alternative B: The alternative crossing is located across a narrower portion of the wetland which has been previously disturbed, is far less saturated and thus exhibits less prominent permanent wetland features.

In addition, for both alternatives, construction of the crossing will require that vehicles and machinery will need to access the watercourse which can result in:

- Physical disturbance of aquatic habitat (beyond the footprint of the road);
- Pollution through leaks and spills of hydrocarbons (i.e. fuel and oil from construction vehicles and machinery) and other construction materials (e.g. cement) and
- Mobilisation of sediment due excavation of the bed and banks and operation of construction vehicles in the watercourse.

	Alternative A		**Alternative B**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity	High	Moderate	Low	Very Low
Duration	Permanent	Permanent	Permanent	Permanent
Extent	Very limited	Very limited	Very limited	Very limited
Probability	Certain	Certain	Certain	Certain
Significance	**-91: Moderate**	**-84: Moderate**	**-84: Moderate**	**-70: Minor**
Reversibility	High	High	High	High
Irreplaceability	Low	Low	Low	Low
Confidence	High	High	High	High

Mitigation:

- Construction of the road crossing must occur during the drier summer season;
- Working areas must be clearly demarcated and no vehicle access or disturbance must take place outside of demarcated areas;
- Rehabilitate and naturalise areas beyond the development footprint, which have been affected by the construction activities, using indigenous grass species;
- Use excavators instead of bulldozers to reduce sedimentation and consolidate the entry and exit points to reduce scouring;
- Vehicles must be restricted to travelling only on designated roadways to limit the ecological footprint of the proposed development activities;
- Restrict vehicle access to the watercourse to single points that are clearly demarcated;
- Excavators and all other machinery and vehicles must be checked for oil and fuel leaks daily. No machinery or vehicles with leaks are permitted to work in the watercourse;
- No fuel storage, refuelling, vehicle maintenance or vehicle depots to be allowed within 30 m of the edge of the delineated watercourse;

- Ensure that all stockpiles are well managed and have measures such as berms and hessian sheets implemented to prevent erosion and sedimentation. Stockpiles must be located more than 30 m from the edge of the wetland;
- Contractors used for the project should have spill kits available to ensure that any fuel or oil spills are cleaned and disposed correctly;
- Adequate sanitary facilities and ablutions must be provided for all personnel throughout the project area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation) and must be routinely serviced; and
- No dumping of construction or waste material is permitted. All construction and waste materials must be removed from the wetland and correctly disposed.

7.3 Operational Phase

Impact 4: Pollution of watercourse caused by surface runoff of sediments, pesticides and nutrients from orchards.

Cultivated fields will be established on relatively steep slopes which could mobilise nonpoint source pollution of sediments, nutrients and pesticides via surface runoff into watercourses.

	Without Mitigation	With Mitigation
Intensity	High	Moderate
Duration	Long term	Long term
Extent	Local	Limited
Probability	Certain	Probably
Significance	**-91 (Moderate)**	**-44: (Minor)**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- Planting rows must be planted along the contours as opposed to perpendicular to the contours;
- A permanent cover crop must be cultivated on the orchard row (underneath the trees) and in work rows (rows between the trees) which will improve water retention and soil structure and control unwanted weeds and also minimise transport of soil, nutrients and pesticides in surface runoff;
- Implementation and maintenance of 30 m buffer between cultivated fields and watercourses; and
- Control of alien invasive plant species must be carried out within buffer areas to encourage recolonisation by indigenous vegetation and improve the structural integrity of the buffer.

Impact 5: Pollution of watercourse caused by spray drift during pesticide application.

Drift of pesticides into sensitive non-target areas during spraying can result in high concentrations of toxic pesticides being deposited in watercourses. While contamination is likely to be short-term, the high concentrations typically associated with spray drift events can lead to chronic and/or acute toxiciological effects to aquatic and other biota inhabiting watercourses. The most effective measure to reduce drift deposition in watercourses is a) to increase the distance between the closest point of application and the watercourse through the establishment of a buffer and b) encourage growth of

vegetation within the buffer which effectively intercepts spray droplets and minimises deposition in the watercourse.		
	Without Mitigation	**With Mitigation**
Intensity	High	Low
Duration	Ongoing	Ongoing
Extent	Local	Limited
Probability	Certain	Probably
Significance	**-98 (Moderate)**	**-44 (Minor)**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- Implementation and maintenance of a vegetated 30 m buffer between cultivated fields and watercourses.

Impact 6: Impairment of wetland habitat caused by increased stormwater inputs. Hardened road surfaces act as conduits for the conveyance of high energy stormwater flows directly into watercourses which can lead to erosion of the bed and banks and discharge of sediments and pollutants into watercourses.		
	Without Mitigation	**With Mitigation**
Intensity	High	Low
Duration	Ongoing	Ongoing
Extent	Limited	Limited
Probability	Likely	Unlikely
Significance	**-65: Minor**	**-33: Negligible**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- Water on the road approaching the wetland must be diverted off of the road as quickly as possible, to minimise the amount of water running directly down the road and into the wetland. The drainage must lead the water to vegetated filter strips or swales alongside the road, which remove sediment and other pollutants from the water.
- Having more frequent drains on the approach to the wetland ensures that the least amount of water is discharged directly into the wetland and reduced sediment loading.

8. DWS RISK ASSESSMENT

Risks of activities associated with the formalisation of the agricultural area to the adjacent wetlands were determined according to the risk assessment matrix developed as part of GN 4167 of 2023 (Section 21 (c) and (i) water use Risk Assessment Protocol) - Table 6. The first stage of the risk assessment is the identification of environmental activities, aspects and impacts and essentially mirror those that were identified in the impact assessment (see Section 7). The intensity of impact to receptors and resources (i.e. hydrology, water quality, geomorphology, biota and vegetation) is rated (from 0 to 5, representing negligible and very high impact, respectively), which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. Risks were then quantified based on the anticipated spatial scale, duration and likelihood of occurrence and assumed the full implementation of recommended mitigation measures described in Section 7.

The establishment of a 30 m buffer will provide the most effective means of avoiding nonpoint source pollution impacts on wetlands from the cultivated fields. Of the two alternative road crossings, Alternative B will result in a lower impact and, given the Low Risk, fulfils the requirements to for a General Authorisation. Alternative A is located in a more sensitive portion of the wetland and will result in greater hydro-geomorphological impacts and will also result in the loss of permanently saturated and inundated wetland habitat.

Table 6: DWS Risk Assessment for the layout, construction and operational phase.

Phase	Activity	Impact	Potentially affected watercourses: Name/s	Potentially affected watercourses: PES	Potentially affected watercourses: Ecological Importance	Intensity of Impact on Resource Quality – Abiotic Habitat (Drivers): Hydrology	Abiotic Habitat (Drivers): Water Quality	Abiotic Habitat (Drivers): Geomorph	Biota (Responses): Vegetation	Biota (Responses): Fauna	Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating (without mitigation)	Confidence level
LAYOUT	Design of Road Crossing - Alternative A	Alteration hydrogeomorphological characteristics caused by impedance of flow.	Western Wetland	C	High	2	0	2	2	2	**4**	2	5	**11**	**4**	**44**	60%	**26.4**	L	High
LAYOUT	Design of Road Crossing - Alternative B	Alteration hydrogeomorphological characteristics caused by impedance of flow.	Western Wetland	C	High	1	0	1	1	1	**2**	2	5	**9**	**4**	**36**	20%	**7.2**	L	High
CONSTRUCTION	Establishment of cultivated areas	Loss and degradation of wetland habitat caused by expansion of cultivated areas	Eastern & Western Wetlands	C	High	1	1	1	1	1	**2**	1	5	**8**	**4**	**32**	40%	**12.8**	L	High
CONSTRUCTION	Upgrading of access road - Alternative A	Loss and disturbance of wetland habitat	Western Wetland	C	High	1	2	2	2	2	**4**	1	5	**10**	**4**	**40**	80%	**32**	**M**	High
CONSTRUCTION	Upgrading of access road - Alternative B	Loss and disturbance of wetland habitat	Western Wetland	C	High	1	1	1	1	1	**2**	1	5	**8**	**4**	**32**	80%	**25.6**	L	High
	Vehicles operating within delienated area of wetland	Pollution of watercourse caused by hydrocarbons (fuel and oil)	Western Wetland	C	High	1	2	1	2	2	**4**	1	1	**6**	**4**	**24**	40%	**9.6**	L	High
OPERATIONAL	Cultivated areas	Nonpoint source pollution (sediments, fertilisers and pesticides)	Eastern & Western Wetlands	C	High	1	1	1	1	1	**2**	4	5	**11**	**4**	**44**	40%	**17.6**	L	High
OPERATIONAL	Cultivated areas	Pollution of wetland caused by spray drift of pesticides during application	Eastern & Western Wetlands	C	High	1	1	1	1	1	**2**	4	5	**11**	**4**	**44**	40%	**17.6**	L	High

9. CONCLUSION

Two wetlands and associated streams were identified either side of the proposed cultivated area on Erf 385. These wetlands occur within a catchment area that has been classified as a FEPA and a SWSA. Any further development in the catchment area must therefore be done in a sensitive manner so as to maintain watercourses and the larger Touws River catchment in a good ecological condition. Extensive agricultural activities are one of the main threats to aquatic biodiversity that have been identified in the broader catchment area. Impacts associated with agriculture are primarily related to loss of aquatic habitat due to encroachment of cultivated areas into riparian zones and wetlands and nonpoint source pollution of watercourses by nutrients, sediment and pesticides. All of these impacts can be effectively mitigated through the implementation of adequately sized buffers that protect watercourses from habitat loss but also play and important role in attenuating and filtering nonpoint source pollutants. In this respect, and considering the sensitivity of the catchment area, a mandatory 30 m buffer between watercourses and planned cultivated fields must be implemented. Provided that the buffer and other mitigation measures are implemented, impacts associated with the proposed establishment of cultivated areas are acceptable from an aquatic biodiversity perspective.

Both road crossing alternatives would require infilling of wetland habitat and can also alter the natural hydrological and geomorphological characteristics of the wetland by restricting flow across the road. Mitigation measures must therefore be implemented with a view to ensuring the natural hydrological and geomorphological characteristics of the wetland are maintained. In this respect the road design must continue to allow diffuse flow through the road which can be achieved by installing multiple appropriately sized culverts through the road. Alternative B results in a lower impact and risk to the wetland – and is therefore the recommended alternative.

10. REFERENCES

CapeNature (2017). *2017 WCBSP George [Vector] 2017*. Available from the Biodiversity GIS website, downloaded on 26 March 2019.

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.

Le Maitre, D.C., Walsdorff, A., Cape, L., Seyler, H., Audouin, M, Smith-Adao, L., Nel, J.A., Holland, M. and Witthüser. K. (2018). Strategic Water Source Areas: Management Framework and Implementation Guidelines for Planners and Managers. WRC Report No. TT 754/2/18, Water Research Commission, Pretoria.

Milner, A.M. (1994). System recovery. In: Calow P and Petts GE (eds.): The rivers handbook. Vol. 2. Blackwell Scientific Publications. London.

Nel, J.L., Murray, K.M., Maherry, A.M., Petersen, C.P., Roux, D.J., Driver, A., Hill, L., van Deventer, H., Funke, N., Swartz, E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L. and Nienaber, S. (2011). *Technical Report for the National Freshwater Ecosystem Priority Areas project.* WRC Report No. 1801/2/11. Water Research Commission, Pretoria, South Africa.

Ollis, D.J., Snaddon, C.D., Job, N.M. and Mbona, N. (2013). *Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems.* SANBI Biodiversity Series 22. South African National Biodiversity Institute, Pretoria

Resh, V.H., Brown, A.P., Covich, M.E., Gurtz, H.W., Li, G.W., Minshall, S.R., Reice, A.L., Sheldon, J.B., Wallace and Wissmar, R.C. (1988). The role of disturbance theory in stream ecology. Journal of the North American Benthological Society. 7: 433-455.

APPENDIX 1 – WET-HEALTH

WET-Health 2.0 is designed to assess the PES of a wetland by scoring the perceived deviation from a theoretical reference condition, where the reference condition is defined as the un-impacted condition in which ecosystems show little or no influence of human actions. In thinking about wetland health or PES, it is thus appropriate to consider 'deviation' from the natural or reference condition, with the ecological state of a wetland taken as a measure of the extent to which human impacts have caused the wetland to differ from the natural reference condition. Whilst wetland features vary considerably from one wetland to the next, wetlands are all broadly influenced/ by their climatic and geological setting and by three core inter-related drivers, namely hydrology, geomorphology and water quality. The biology of the wetland (in which vegetation generally plays a central role) responds to changes in these drivers, and to activities within and around the wetland. The interrelatedness of these four components is illustrated schematically in Figure 1 below and forms the basis of the modular-based approach adopted in WET-Health Version 2.

Desktop and field data were captured in GIS software and used to populate the Level 1 WET-Health tool (Macfarlane et al., 2020) which was used to derive the PES of the wetland HGM units. The magnitude of observed impacts on the hydrological, geomorphological, water quality and vegetation components of the wetland were calculated and combined as per the tool to provide a measure of the overall condition of the wetland on a scale from 1-10. Resultant scores were then used to assign the wetland into one of six PES categories as shown in Table 7 below.

Table 7: Wetland Present Ecological State (PES) categories and impact descriptions.

ECOLOGICAL CATEGORY	DESCRIPTION	IMPACT SCORE*	PES SCORE (%)*
A	Unmodified, natural.	0-0.9	90-00
B	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	80-89
C	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2-3.9	60-79
D	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	40-59
E	Seriously modified. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	20-39
F	Critically modified. Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	0-19

<u>Reference:</u>

Macfarlane, D.M., Ollis, D.J. and Kotze, D.C. (2020). WET-Health (Version 2.0). *A Refined Suite of Tools for Assessing the Present Ecological State of Wetland Ecosystems*. WRC Report No. TT 820/20. Water Research Commission, Pretoria, South Africa.

APPENDIX 2 – ECOLOGICAL IMPORTANCE AND SENSITIVITY (WETLANDS)

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 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 8: Ecological importance and sensitivity categories. 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

Reference:

Rountree, M.W., Malan, H.L., Weston, B.C. (2013). Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Version 2). Water Research Commission report No. 1788/1/12.

APPENDIX 3: IMPACT ASSESSMENT METHODOLOGY

Individual impacts for the construction and operational phase were identified and rated according to criteria which include their intensity, duration and extent. The ratings were then used to calculate the consequence of the impact which can be either negative or positive as follows:

Consequence *= type x (intensity + duration + extent)*

Where type is either negative (i.e. -1) or positive (i.e. 1). The significance of the impact was then calculated by applying the probability of occurrence to the consequence as follows:

Significance *= consequence x probability*

The criteria and their associated ratings are shown in Table 9.

Table 9: Categorical descriptions for impacts and their associated ratings

Rating	Intensity	Duration	Extent	Probability
1	Negligible	Immediate	Very limited	Highly unlikely
2	Very low	Brief	Limited	Rare
3	Low	Short term	Local	Unlikely
4	Moderate	Medium term	Municipal area	Probably
5	High	Long term	Regional	Likely
6	Very high	Ongoing	National	Almost certain
7	Extremely high	Permanent	International	Certain

Categories assigned to the calculated significance ratings are presented in Table 10.

Table 10: Value ranges for significance ratings, where (-) indicates a negative impact and (+) indicates a positive impact

Significance Rating	Range	
Major (-)	-147	-109
Moderate (-)	-108	-73
Minor (-)	-72	-36
Negligible (-)	-35	-1
Neutral	0	0
Negligible (+)	1	35
Minor (+)	36	72
Moderate (+)	73	108
Major (+)	109	147

Each impact was considered from the perspective of whether losses or gains would be irreversible or result in the irreplaceable loss of biodiversity of ecosystem services. The level of confidence was also determined and rated as low, medium or high (Table 11).

Table 11: Definition of reversibility, irreplaceability and confidence ratings.

Rating	Reversibility	Irreplaceability	Confidence
Low	Permanent modification, no recovery possible.	No irreparable damage and the resource isn't scarce.	Judgement based on intuition.
Medium	Recovery possible with significant intervention.	Irreparable damage but is represented elsewhere.	Based on common sense and general knowledge
High	Recovery likely.	Irreparable damage and is not represented elsewhere.	Substantial data supports the assessment