WETLAND ASSESSMENT

PES, EIS, REC

Strubensvalley Ext 24

Proponent:
RENICO
Project Reference:
22040 – Strubensvalley Ext 24
Report Date:
June 2021
Report Reference:
22040_WPES_1_1

Document Control

Project Name	**Strubensvalley Ext 24** – Residential Development
Report Title	Wetland Assessment
Authority Reference Number	GAUT 002/21-22/E2896
Report Status	Final

Applicant Name	**Renico Construction (Pty) Ltd.**

	Name	Signature	Date
Document Compilation	**Mr. D. Botha** (M.A. Env.Man.) (PHED) Wetland Specialist | Pr.Sci.Nat.		2020/12 2021/01 – update 2021/06 - Finalise
Field Assessment	**Mr. D. Botha** (M.A. Env.Man.) (PHED) Wetland Specialist | Pr.Sci.Nat.		2020/11 2021/01
Document Review	**Mr. P. Singh** (M.Sc. Aquatic Health) Aquatic Specialist | Pr.Sci.Nat.		2021/01 2021/06
Document Signoff	**Mr. D. Botha** (M.A. Env.Man.) (PHED) Wetland Specialist | Pr.Sci.Nat.		2021/06/24

DOCUMENT PROGRESS

Distribution List

Date	Report Reference Number	Document Distribution	Number of Copies
2021/01	22040_WPES_0	EAP	Digital
2021/06	22040_WPES_1_1	EAP	Digital

Amendments on Document

Date	Report Reference Number		Description of Amendment
2021/06/24	22040_WPES_0	22040_WPES_1_1	Finalise report – Final layout updates

DECLARATION OF INDEPENDENCE

Specialist Name	Mr. D. Botha
Declaration of Independence	I declare, as a specialist appointed in terms of the National Environmental Management Act (Act No 108 of 1998) and the associated 2014 Environmental Impact Assessment (EIA) Regulations, that: • I act as the independent specialist in this application; • I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant; • I declare that there are no circumstances that may compromise my objectivity in performing such work; • I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity; • I will comply with the Act, Regulations and all other applicable legislation; • I have no, and will not engage in, conflicting interests in the undertaking of the activity; • I undertake to disclose to the applicant and the competent authority 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 the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; • All the particulars furnished by me in this form are true and correct; and • I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.
Signature	
Date	2021/06/24

INDEMNITY AND CONDITIONS RELATING TO THIS REPORT

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

Although Prism Environmental Management Services exercises due care and diligence in rendering services and preparing documents, Prism Environmental Management Services accepts no liability, and the client, by receiving this document, indemnifies Prism Environmental Management Services and its directors, managers, agents and employees against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by Prism Environmental Management Services and by the use of the information contained in this document.

This report must not be altered or added to without the prior written consent of the author. This also refers to electronic copies of this report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

Executive Summary

Prism Environmental Management Services was requested by **RENICO** to undertake a wetland assessment to delineate the wetland and to determine the Present Ecological State (PES), the Ecological Importance and Sensitivity (EIS) and the Recommended Ecological Classification (REC) for the proposed development of **Strubensvalley Ext 24.** This, specifically to inform the Environmental Impact Assessment (EIA) and Water Use License Application (WULA) for the said development.

The proposed development is located on Erf 1327 and 1328, **Strubensvallei Ext 24**, City of Johannesburg (CoJ), Gauteng Province (*here after referred to as the study site/s*). The study site measures approximately 2,1ha. The study site is located in quaternary catchment A21E in the Limpopo Water Management Area (WMA 1). The study area falls within the Grassland Biome (Biome 06), the Highveld Level-1 Ecoregion (Ecoregion 11) (Kleynhans *et al.*, 2005).

The field investigations concluded that one natural wetland system was identified in the study area.

The following Hydrogeomorphic wetland was identified during the site evaluation:

- SV24_UCVB – Unchanneled Valley Bottom Wetland - was found on the valley floor close to the head of the catchment, draining towards the West.

<table>
<tr><th>Study</th><th colspan="11">Findings and Conclusions</th></tr>
<tr><td rowspan="11">Wetland Assessment</td><td colspan="11">The development site is affected by the wetland, and the development will slightly impact on the wetland. Hence, the recommendation of a buffer area (15m).</td></tr>
<tr><td colspan="11">It must further be noted that a major part of this small wetland unit will be severely impacted on by the proposed Metro Boulevard Intersection with Christiaan DeWet Drive. It will alter the wetlands present status and thus change the future existence. Thus, a further reason for the reduced buffer (15m) recommendations.</td></tr>
<tr><td colspan="11">The buffer area could be used to assist with storm water management and flow management at the transitional point leading from the development and infrastructure installations into the wetland area.</td></tr>
<tr><td colspan="11">The infrastructure installations and connections to the external services will impact on the wetland and must be managed carefully during construction.</td></tr>
<tr><td colspan="11">Careful design and interdisciplinary consultation between the professional team would be required. Interflows and sheet flow must be managed at the contact points.</td></tr>
<tr><td>Wetland</td><td>Wetland HGM</td><td colspan="2">Wetland</td><td colspan="2">15m Buffer</td><td colspan="2">PES</td><td colspan="2">EIS</td><td>REC</td></tr>
<tr><td rowspan="2">SV24_UCVB</td><td rowspan="2">UCVB</td><td>On site</td><td>External linked to services</td><td>On site</td><td>External linked to services</td><td>Category</td><td>Trajectory of change</td><td>Category</td><td>Trajectory of change</td><td>Category</td></tr>
<tr><td>Yes</td><td>Yes</td><td>Yes</td><td>Yes</td><td>C - Moderate</td><td>↓</td><td>C - Moderate</td><td>↓</td><td>C - Moderately modified.</td></tr>
<tr><td colspan="3" rowspan="3">Recommended Monitoring Requirements</td><td colspan="3">Wetland Assessment ➡</td><td colspan="2">Wetland Specialist</td><td colspan="3">Monthly Visual Inspections</td></tr>
<tr><td colspan="3">Environmental Control Officers ➡</td><td colspan="2">ECO</td><td colspan="3">Bi-Weekly Visual Inspections</td></tr>
<tr><td colspan="3">Closure Audit ➡</td><td colspan="2">Wetland Specialist</td><td colspan="3">Closure Audit</td></tr>
</table>

Concluded from the results presented in this document, the construction activities will in all likelihood impact slightly on the wetland system but can be mitigated to satisfactory standards if all mitigatory actions are implemented with due care. It is key to preserve water quality and supply to the downstream aquatic resources.

In respect of the construction phase, it is important to ensure that the required erosion protection measures linked to the wetland intersecting sections be carefully designed and installed.

The project can be supported, should all the mitigation measures be implemented and monitored against to ensure compliance and protection of the aquatic resource.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

Prism Environmental Management Services was requested by **RENICO** to undertake a wetland assessment to delineate the wetland and to determine the Present Ecological State (PES), the Ecological Importance and Sensitivity (EIS) and the Recommended Ecological Classification (REC) for the proposed development of **Strubensvalley Ext 24.** This, specifically to inform the Environmental Impact Assessment (EIA) and Water Use License Application (WULA) for the said development.

1.1 Project Description

RENICO is intending to develop a residential township on Erf 1327 and 1328, **Strubensvallei Ext 24**. The development will be zoned for residential use. The site extends from North to South along Christiaan de Wet Road and falls under jurisdiction of City of Johannesburg (CoJ).

The proposed development involves the development of several Residential 3 units on approximately 1,97 hectares in extent, Erf 1327. In addition, the proposed development also involves the provision of all necessary services to the development including water, sanitation, stormwater and internal roads.

The site is also affected by the proposed development of the intersection with Christiaan de Wet Road and the Metro Boulevard. Same does not form part of the application for this development but, must be kept in mind as part of the development layout and aspects to be assessed.

1.1.1 Study Site Location

The proposed development is located on **Erf 1327**, **Strubensvallei Ext 24**, City of Johannesburg (CoJ), Gauteng Province (*here after referred to as the study site/s*) (Figure 1.2) (Figure 1.3). The study site measures approximately 1,97 ha. The study site is located in quaternary catchment A21E in the Limpopo Water Management Area (WMA 1), (Figure 1.4). The study area falls within the Grassland Biome (Biome 06), the Highveld Level-1 Ecoregion (Ecoregion 11) (Kleynhans *et al.*, 2005) (Figure 1.5).

1.2 Scope and Purpose

The aim of this study was to undertake a wetland assessment to delineate the wetland and to determine the Present Ecological State (PES), the Ecological Importance and Sensitivity (EIS) and the Recommended Ecological Classification (REC) for the proposed development. This, specifically to inform the Environmental Impact Assessment (EIA) and Water Use License Application (WULA) for the said development.

1.3 Overview of Specialist

Prism EMS has conducted the required wetland specialist assessment and delineation of the wetlands on site to inform the Environmental Impact Assessment (EIA) and Water Use License Application (WULA). The team under lead of Mr. D. Botha has conducted the assessment. The details of the team are tabularised in Table 1-1.

Table 1-1: Details of Specialist

Specialist	Mr. D. Botha – Wetland Specialist
Company:	Prism EMS
Qualifications:	M.A. Environmental Management B.A. Hons. Geography & Environmental Management, B.A. Humanities Post Higher Education Diploma Wetland and Wetland Delineation *(DWAF Accredited Short Course)* Soil Classification and Wetland Delineation – Short Course – *Terrasoil Science* Tools for Wetland Assessment – *Rhodes University* SASS5 Aquatic Biomonitoring Training – *Department of Water Affairs, Ground Truth* Wetland Plant Taxonomy – *Water Research Commission* Hydropedology and Wetland Functioning – *Water Business Academy / Terra Soil Science* Wetland Legislation | Law application in wetland management – *WetRest Centre for Wetland Research and Training*
Experience:	18^{+} Years
Affiliation/ Registration	South African Council for Natural Scientific Professions (SACNASP) registered Scientist | Pr.Sci.Nat. (119979) Registered Member of Environmental Assessment Practitioners Association of South Africa (EAPASA)(2019/1209) Member of the International Association for Impact Assessors (IAIAsa) (1653) Member of the Gauteng Wetland Forum Member of the South African Wetland Society
Address:	12A Beacon Road, Poortview, Johannesburg
Tel:	087 985 0951
Fax:	086 601 4800
Email:	dewet@prismems.co.za

Designation	**Name**	**Qualification**	**Professional Registration**	**Role**
		Specialist Team		
Ecologist	A.E. van Wyk	B.Sc. Environmental and Biological Sciences B.Sc. Hons. Environmental and Biological Sciences (in progress) 5 Years' Experience	Cand.Sci.Nat (pending)	Field Assistant
Aquatic Specialist	Mr. P. Singh	MSc Aquatic Health (Cum Laude) BSc.Hons (Biodiversity & Conservation) BSc (Bot & Zoo) Rand Water Water Purification of Drinking Water – *Rand Water Vereeniging* Ecotoxicity Test Methods and Validation - *Golder Associates Research Laboratory* 10 Years' Experience	Pr. Sci. Nat. (116822)	Peer Review

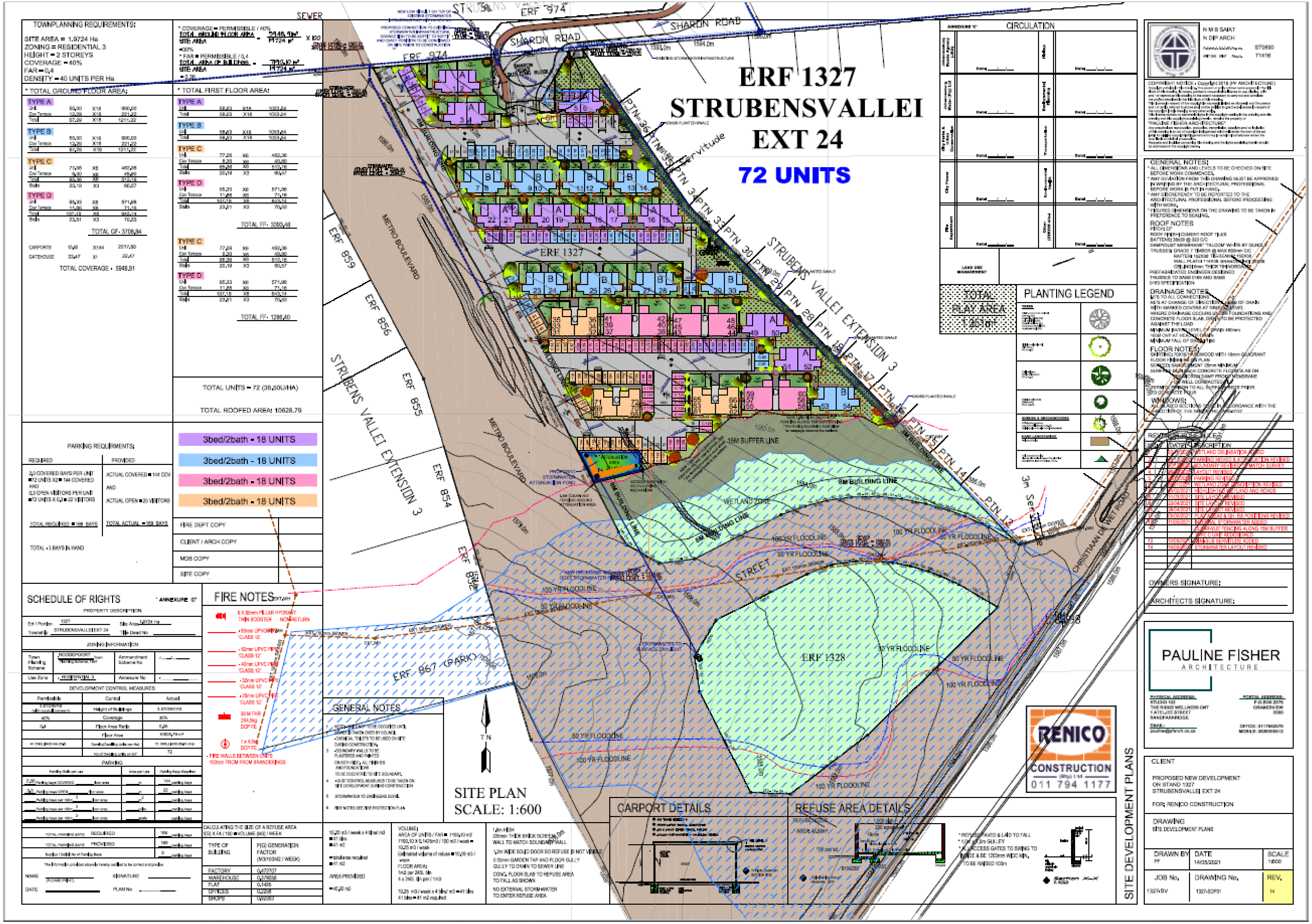


Figure 1-1: Proposed Layout.

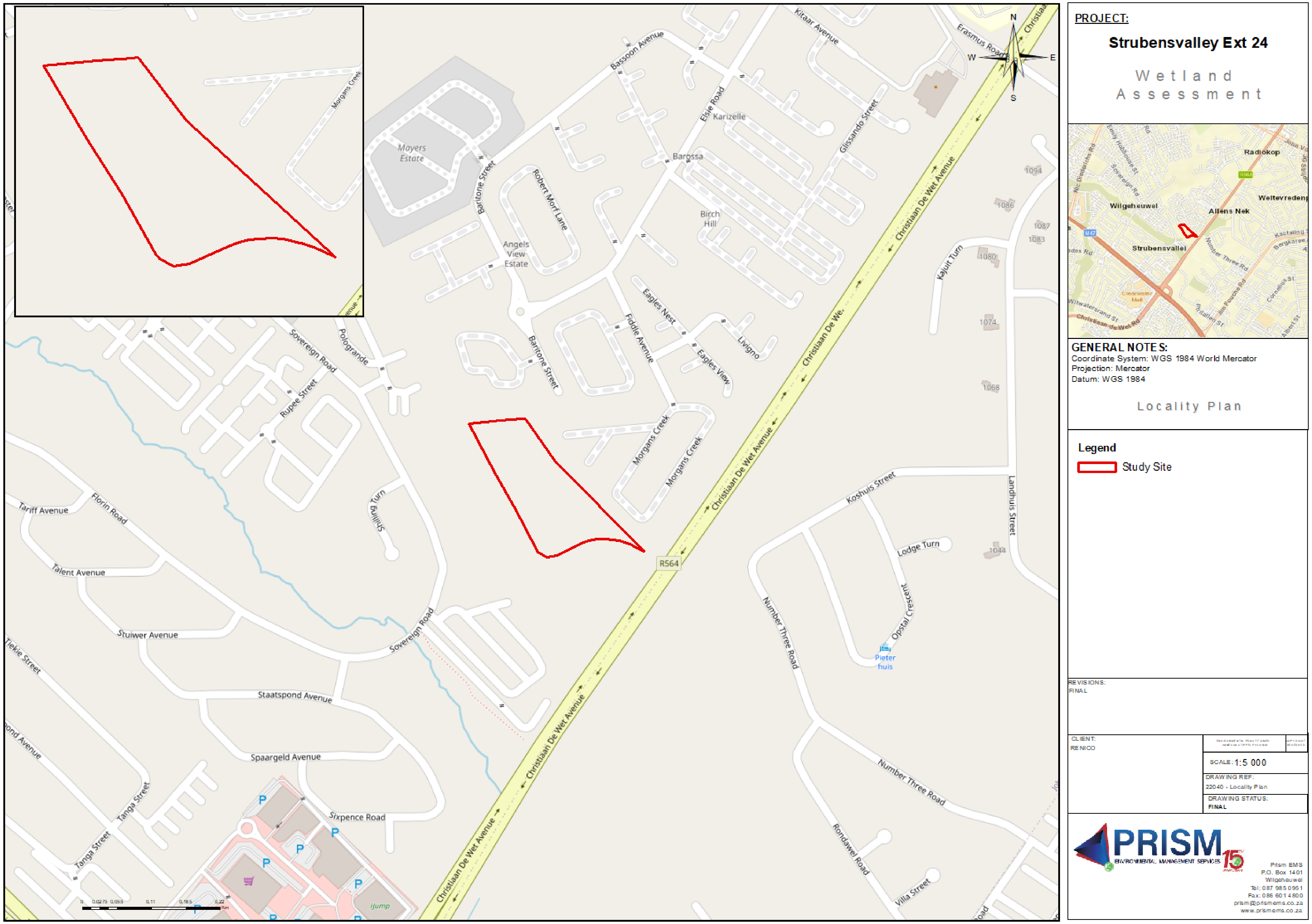


Figure 1-2: Locality Plan.

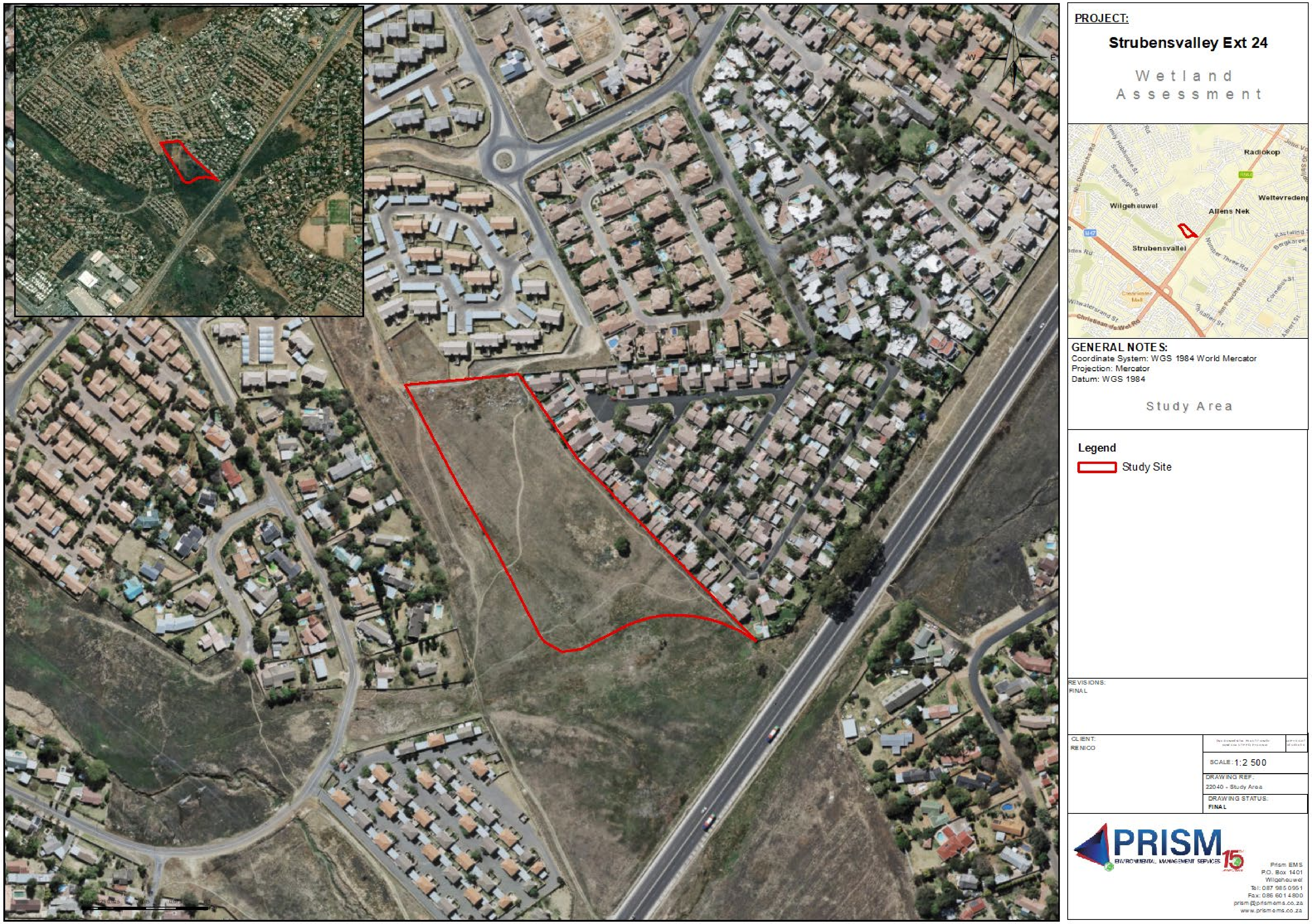


Figure 1-3: Map of the survey area.

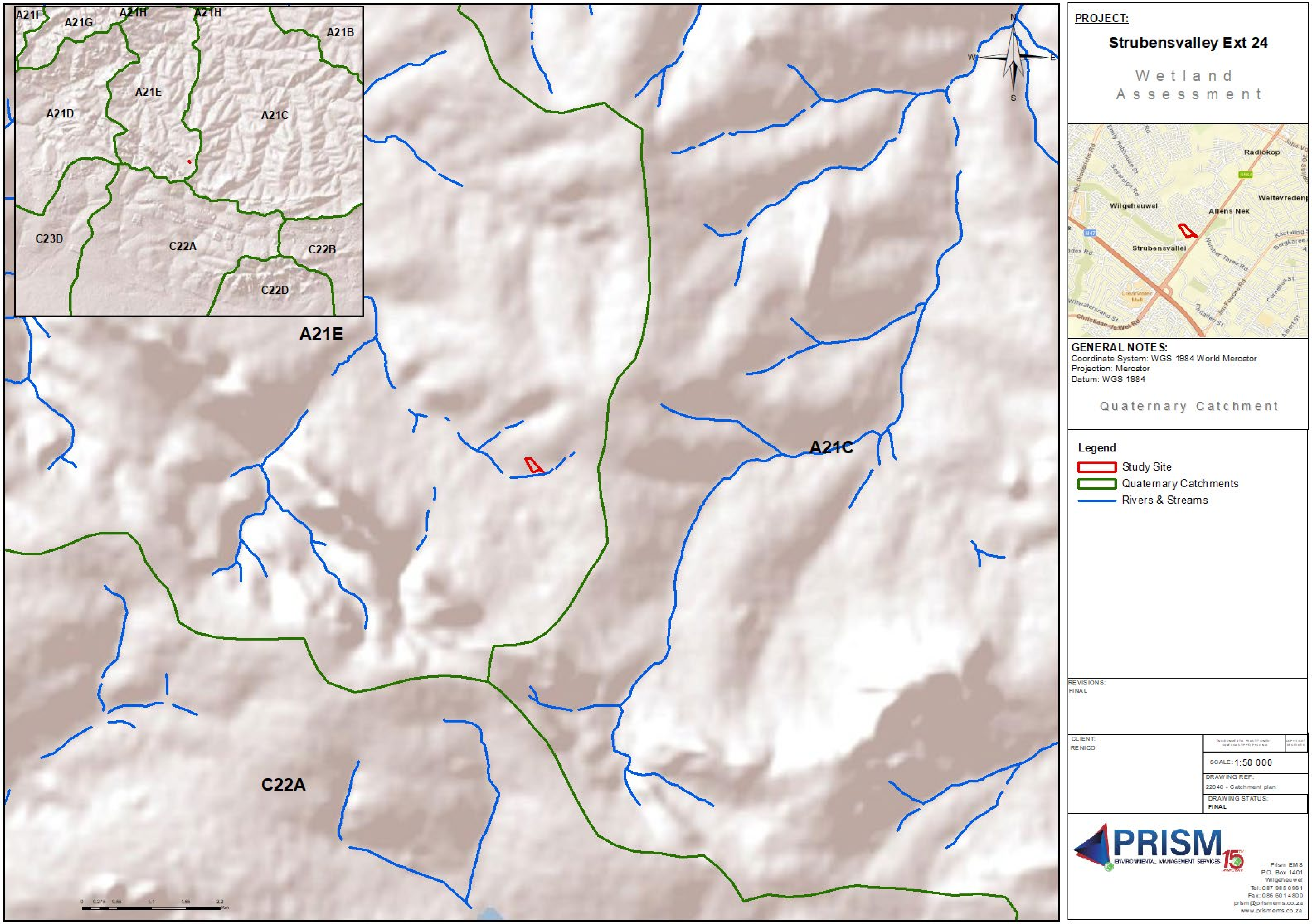


Figure 1-4: Map of the Catchment Area.

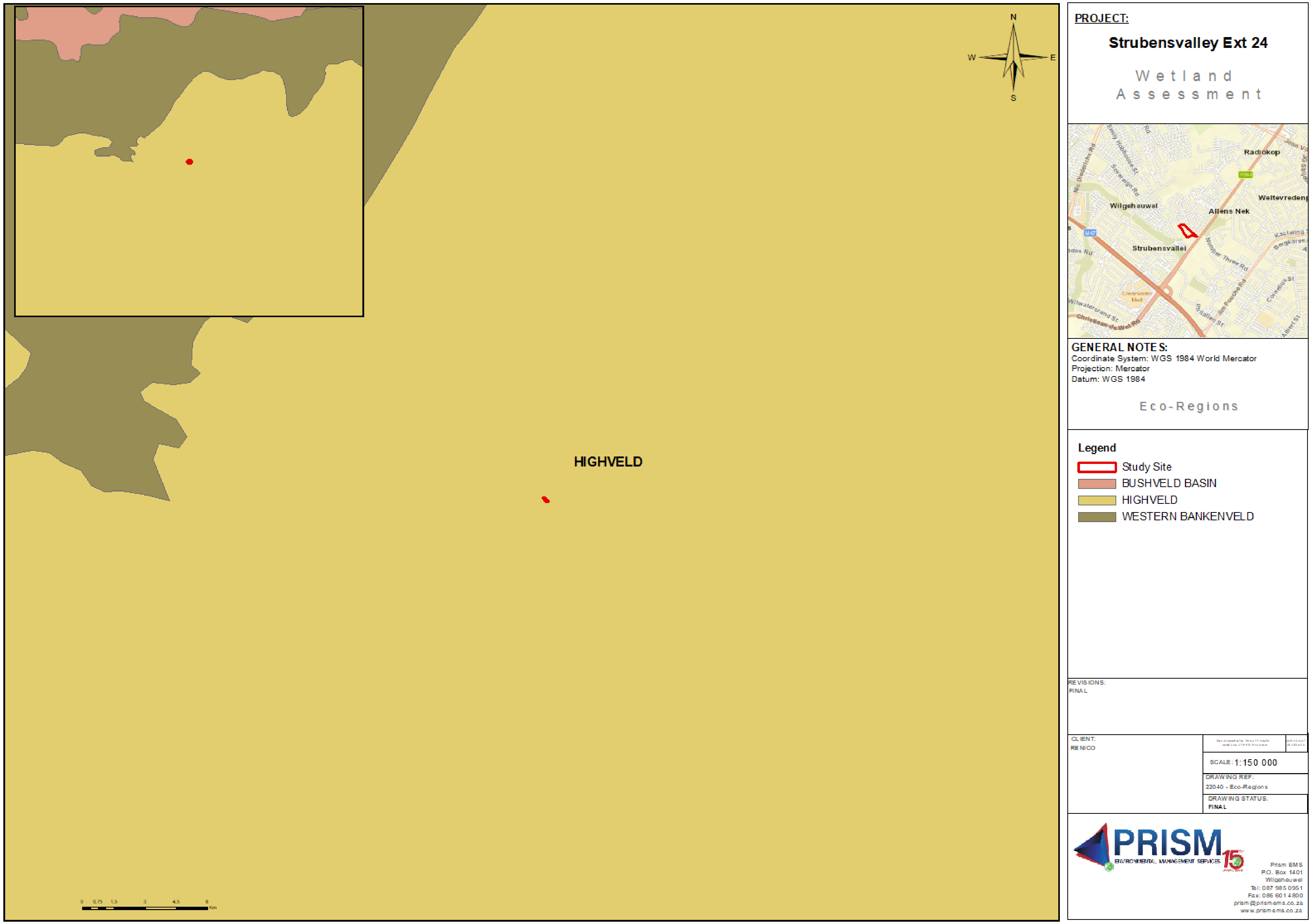


Figure 1-5: Map of the study sites Eco-Regions (DWAF; 2005).

2 REPORT OUTLINE

Appendix 6 of GN 982 of 4 December 2014 were amended by the new minimum requirements of the specialist protocols of GN 320 of 20 March 2020. In particular, the Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Aquatic Biodiversity is applicable. In line with this, Table 2-1 provides an overview of the new specialist protocols together with information on how these requirements have been met.

Table 2-1. Specialist Report Requirements.

Requirement from Section 2.7 of Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Aquatic Biodiversity (GN 320 of 20 March 2020)	Chapter
(2.7.1. Contact details of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae	Chapter 1.3
2.7.2. A signed statement of independence by the specialist	*Declaration of Independence*
2.7.3. A statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	Chapter 4.1
2.7.4. The methodology used to undertake the site inspection and the specialist assessment, including equipment and modelling used, where relevant	Chapter 4.
2.7.6. The location of areas not suitable for development, which are to be avoided during construction and operation, where relevant	Chapter 6
2.7.5. A description of the assumptions made, any uncertainties or gaps in knowledge or data	Chapter 5
2.7.14. A motivation must be provided if there were development footprints identified as per paragraph 2.4 above that were identified as having a "low" aquatic biodiversity sensitivity and that were not considered appropriate (Note: Section 2.4. says: "*The assessment must identify alternative development footprints within the preferred site which would be of a "low" sensitivity as identified by the screening tool and verified through the site sensitivity verification and which were not considered appropriate*"	Chapter 6
2.7.7. Additional environmental impacts expected from the proposed development	Chapter 6 Chapter 7
2.7.8. Any direct, indirect and cumulative impacts of the proposed development on site	Chapter 6 Chapter 7
2.7.9. The degree to which impacts and risks can be mitigated	Chapter 6 Chapter 8.1
2.7.10. The degree to which the impacts and risks can be reversed	Chapter 6

Requirement from Section 2.7 of Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Aquatic Biodiversity (GN 320 of 20 March 2020)	Chapter
2.7.11. The degree to which the impacts and risks can cause loss of irreplaceable resources	Chapter 6
2.7.12. A suitable construction and operational buffer for the aquatic ecosystem, using the accepted methodologies	Chapter 4 Chapter 6
2.7.13. Proposed impact management actions and impact management outcomes for inclusion in the Environmental Management Programme (EMPr);	Chapter 6 Chapter 8
2.7.14. A motivation must be provided if there were development footprints identified as per paragraph 2.4 above that were identified as having a "low" aquatic biodiversity sensitivity and that were not considered appropriate	Chapter 6 Chapter 8
2.7.15. A substantiated statement, based on the findings of the specialist assessment, regarding the acceptability or not of the proposed development and if the proposed development should receive approval or not	Chapter 7 Chapter 8
2.7.16. Any conditions to which this statement is subjected.	Chapter 7 Chapter 8

3 LEGISLATION AND GUIDELINES

3.1 Wetlands

The generic term 'wetland' is used worldwide and includes specific ecosystems such as bogs, coastal lakes, estuaries, fens, floodplains, mangroves, marshes, mires, moors, pans, peatlands, seeps, sloughs, springs, swamps, vlei and wet meadows (Mays, 1996; DWAF, 2005). Regardless of the local name given to wetlands, the driving force of all wetlands is the interplay between land and water, and the consequent characteristics that reflect both (Cowan, 1999). Any part of the landscape where water accumulates for long enough and often enough to influence the plants, animals and soils occurring in that area, is referred to as a wetland (DWAF, 2005). Wetlands comprise approximately 6% (8.5 km^2 x 103) of the world's land surface and are found in every climate from the tropics to the frozen tundra (Mays, 1996).

Several definitions for wetland and wetland areas exist. Two of the most common wetland definitions used in South Africa is the National Water Act (NWA) (Act 36 of 1998) and the Ramsar definition are provided below:

National Water Act, Act No 36 of 1998:

> *"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."

South Africa, being a contracting party to Ramsar, also uses the definition accepted by the convention. Article 1.1 of the convention defines wetlands as (Cowan, 1999; Koester, 1989):

"Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters."

Wetlands are defined as those areas that have water on the surface or within the root zone for long enough periods throughout the year to allow for the development of anaerobic conditions. These conditions create unique soil conditions (hydric soils) and support vegetation adapted to these flood conditions.

Hydric soils develop a grey or sometimes greenish or blue-grey colour, as a result of the chemical reduction of iron (gleying). Hydric soils that are seasonally flooded are characterised by the formation of mottles, which are relatively insoluble, enabling them to remain in the soil long after it has been drained. Consequently, it is possible to identify wetland areas on the basis of soil colour, using a standard colour chart, as matrix hue and chroma decrease, while mottle hue and chroma initially increase and then decrease the more saturated the soils become Table 3-1.

Table 3-1: Relationship between degree of wetness (wetland zone), soil-physiochemistry and vegetation (Kotze *et al*., 1994).

Degree of wetness			
	Temporary	**Seasonal**	**Permanent / Semi-permanent**
Soil Depth (0cm – 10cm)	Matrix chroma: 1-3 Few / no mottles Low / intermediate OM Non-sulphuric	Matrix chroma: 0-2 Many mottles Intermediate OM Seldom sulphuric	Matrix chroma: 0-1 Few / no mottles High OM Often sulphuric
Soil Depth (40cm – 50cm)	Few / many mottles Matrix chroma: 0-2	Many mottles Matrix chroma: 0-2	No / few mottles Matrix chroma: 0-1
Vegetation	Predominantly grass species	Predominantly sedges and grasses	Predominantly reeds and sedges

Vegetation distribution within wetlands is related to the flooding regime. Terrestrial plants are not tolerant of flooding within the root zone for periods long enough to cause anaerobic conditions, and are thus found on drier soil conditions. The distribution of wetland plants is related to their tolerance of different flooding conditions, and their distribution within a system can be used as an indication of the wetness of an area.

Typically, indicators of soil wetness based on soil morphology correspond closely with vegetation distribution, since hydrology affects soils and vegetation in systematic and predictable ways. However, in systems where the hydrological regime has been modified due to human activities, vegetation distribution will not vary systematically with soil morphology. The response of vegetation to alteration of hydrological conditions is rapid (months / years), whereas the response of soil morphology to such alteration is slow (centuries). Therefore, lowering of the water table or reduction of surface flows, may lead to rapid establishment of terrestrial vegetation, whereas the soil morphology will retain indicators of wetness for a lengthy period. Soil morphology forms the basis of wetland delineation nationally, following international protocols, mainly because it provides a long-term indication of the "natural" hydrological regime. However, soil morphology cannot be considered to necessarily reflect the current hydrological conditions of the site where the hydrological regime has been altered, and in such circumstances vegetation provides the best indication of the distribution of wetlands as it best reflects current hydrological conditions (Figure 3.1).

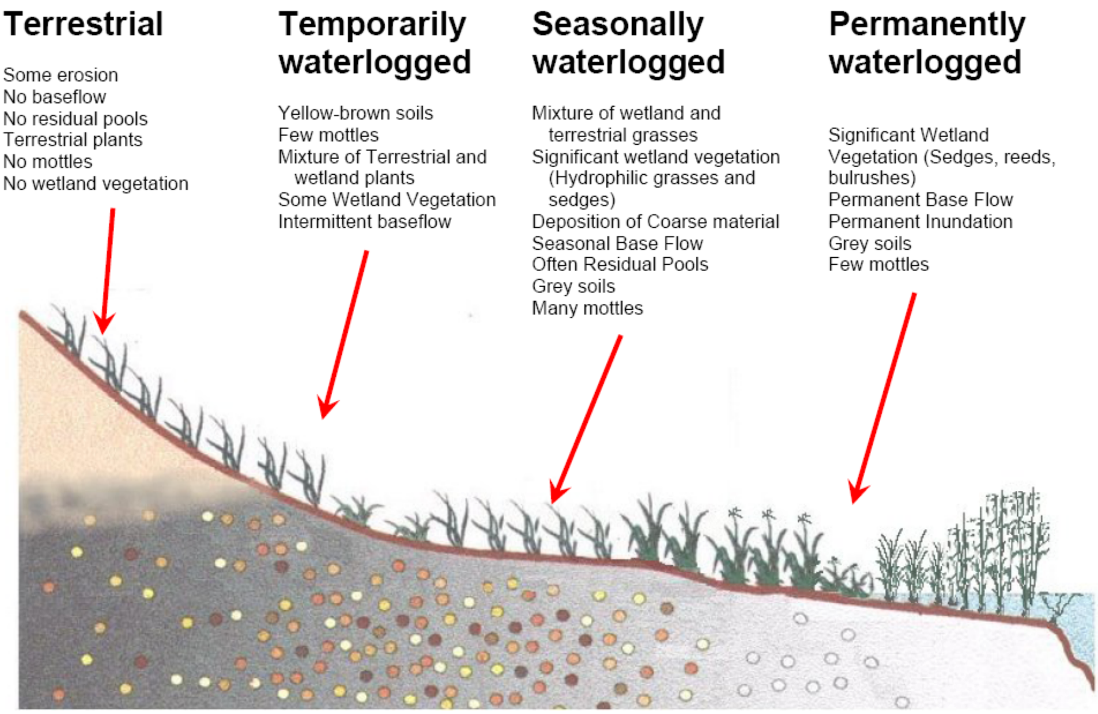


Figure 3-1: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change along a gradient of decreasing wetness, from the middle to the edge of the wetland. (Reproduced by Sivest from Kotze (1996), DWAF Guidelines).

Wetland vegetation is adapted to shallow water table conditions. Due to water availability and rich alluvial soils, wetland areas are usually very productive. Tree growth rate is high and the vegetation under the trees is usually lush and includes a wide variety of shrubs, grasses and wildflowers.

3.2 Protocol for the Specialist Assessment

Procedures for the assessment and minimum criteria for reporting on identified environmental themes in terms of Section 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998 when applying for Environmental Authorisation including the Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impact on Aquatic Biodiversity (GN 320 of 20 March 2020).

The Department of Forestry and Fisheries and the Environment (DFFE) has published a number of protocols for the specialist assessment and minimum report requirements for a number of specific aspects including:

- Agriculture;
- Avifauna (in relation to solar and wind energy generation);
- Noise;
- Defence;
- Civil Aviation;
- Terrestrial Plant Species;
- Terrestrial Animal Species;
- Terrestrial Biodiversity; and
- Aquatic Biodiversity.

Of particular important to this study is the latter, which provides the protocol for specialist assessment and minimum content requirements for environmental impacts on aquatic biodiversity. The protocol defines Aquatic as "*Inland aquatic and estuaries/estuarine systems where plants and animals live*" and as such both wetland and riparian habitats fall within this definition.

In terms of Section 2.3. of the Protocol, the assessment must provide (in summary):

- A description of the aquatic biodiversity and ecosystems on the site.
- The threat status of the ecosystem and species as identified by the screening tools.
- The national and provincial priority status of the aquatic ecosystem.
- A description of the ecological importance and sensitivity of the aquatic ecosystem.
- An assessment of alternative development footprints within the preferred site which would be of a "low" sensitivity as identified by the screening tool and verified through the site sensitivity verification and which were not considered appropriate.
- A detailed assessment of the potential impacts including:

- Consistency with maintaining priority aquatic ecosystems in their current state.
- Consistency with maintaining Resource Quality Objectives.
- Impact on fixed and dynamic ecological processes.
- Impact on the functioning of the aquatic feature.
- Impact on key ecosystem regulating and supporting services.
- Impact on community composition and integrity of faunal and vegetation communities.

3.3 EIA Applicable Legislation

3.3.1 National Environmental Management Act (Act No. 107 of 1998) (NEMA)

The proposed development triggers a number of activities in terms of NEMA. These are listed in Table 3-2.

Table 3-2: Listed Activities in terms of NEMA

Competent Authority	GN	Activity Number	Type of Environmental Assessment	Authority Reference number
Gauteng Department of Agriculture and Rural Development (GDARD)	R 983 of 4 December 2014 (as amended):	12, 19, 27	Basic Assessment Process	GAUT 002/21-22/E2896
	R. 985 of 4 December 2014 (as amended)	4 12 and 14		

3.4 WULA Applicable Legislation

3.4.1 National Water Act (Act No 36 of 1998) (NWA)

The NWA is the primary regulatory legislation; controlling and managing the use of water resources as well as the pollution thereof and is implemented and enforced by the Department of Human Settlements, Water and Sanitation (DHSWS[1]). Section 21 of the NWA lists water uses that must be licensed unless it is listed in the schedule (existing lawful use) and/or is permissible under a general authorisation, or if a responsible authority waives the need for a Water Use Licence.

The following listed water uses that require a Water Use License according to Section 21 of the NWA are triggered for the proposed project:

- Section 21(c): impeding or diverting the flow of water in a watercourse
- Section 21 (i): altering the bed, banks, course or characteristics of a watercourse.

A Water Use Licence Application (WULA) will be undertaken.

[1] Previously referred to as the Department of Water and Sanitation

4 METHODOLOGY

4.1 Wetland Assessment

4.1.1 Desktop Assessment

A preliminary delineation of the Wetland boundary was undertaken using aerial photograph interpretation. Historical records and reports were consulted. The Department of Water and Sanitation (DWS) database was also consulted to obtain historical data for the study area. The National Wetland Map version 5 (NWM5) as presented by South African National Biodiversity Institute (SANBI) was also scrutinised (Van Deventer *et al*, 2019). Historical data and official approvals were also consulted during the assessment.

4.1.2 Field Investigation

The field investigation was undertaken during **November 2020** to assess and corroborate the delineated Wetland zones present on the survey area.

The field procedure for the wetland delineation was conducted according to the Guidelines for delineating the boundaries of a wetland set out by the Department of Water Affairs and Forestry (DWAF 2005/8). Due to the transitional nature of wetland boundaries, the different wetland zones are often not clearly apparent. However, the wetland edge can be determined accurately. The delineations are based on scientifically defensible criteria and are aimed at providing a tool to facilitate the decision-making process regarding the assessment of the significance of impacts that may be associated with the proposed developments.

The wetlands were delineated by considering the following wetland indicators (DWAF 2005/8):

- Terrain unit indicator helps identifying those parts of the landscape where wetlands are most likely to occur. Wetlands occupy characteristic positions in the landscape and can occur on the following terrain units: crest, midslope, footslope, and valley bottom;
- Soil wetness indicator identifies the morphological signatures developed in the soil profile as a result of prolonged and frequent saturation; and
- The vegetation indicator identifies hydrophytic vegetation associated with frequently saturated soils.

The following procedure was followed during the delineation of the wetland boundaries and zones:

- A desktop delineation of the larger wetland area was undertaken using satellite imagery of the study site;
- Areas for verification were identified; and
- Identified areas were then assessed in the field with boundaries being recorded using a GPS.

4.1.3 Mapping

Mapping of the wetland boundaries was done by computerised processing utilising GPS tools, mobile applications and GIS modelling.

4.2 Wetland Classification

SANBI's "Further development of a proposed National Classification System for South Africa" was used to verify the classification of the wetlands within the study area (SANBI, 2009). The wetlands were classified up to level four, which includes the system, regional setting, landscape unit and hydrogeomorphic unit.

Table 4-1: Wetland classification level 1 - 4.

Level 1: System	Level 2: Regional setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit			
Connectivity to open ocean	Ecoregion	Landscape setting	HGM type	Longitudinal zonation / landform	Drainage - outflow	Drainage - inflow
			A	B	C	D
INLAND	DWAF Level 1 Ecoregions	SLOPE	Channel (river)	Mountain headwater stream	Not applicable	Not applicable
				Mountain stream	Not applicable	Not applicable
				Transitional river	Not applicable	Not applicable
				Rejuvenated bedrock fall	Not applicable	Not applicable
			Hillslope seep	Not applicable	With channel inflow	Not applicable
					Without channel inflow	Not applicable
			Depression	Not applicable	Exorheic	With channel inflow
						Without channel inflow
					Endorheic	With channel inflow
						Without channel inflow
					dammed	With channel inflow
						Without channel inflow
		VALLEY FLOOR	Channel (river)	Mountain stream	Not applicable	Not applicable
				Transitional river	Not applicable	Not applicable
				Rejuvenated bedrock fall	Not applicable	Not applicable
				Upper foothill river	Not applicable	Not applicable
				Lower foothill river	Not applicable	Not applicable
				Lowland river	Not applicable	Not applicable
				Rejuvenated foothill river	Not applicable	Not applicable
				Upland floodplain river	Not applicable	Not applicable
			Channelled valley-bottom wetland	Valley-bottom depression	Not applicable	Not applicable
				Valley-bottom flat	Not applicable	Not applicable
			Unchannelled valley-bottom wetland	Valley-bottom depression	Not applicable	Not applicable
				Valley-bottom flat	Not applicable	Not applicable
			Floodplain wetland	Floodplain depression	Not applicable	Not applicable
				Floodplain flat	Not applicable	Not applicable
			Depression	Not applicable	Exorheic	With channel inflow

Level 1: System	Level 2: Regional setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit			
						Without channel inflow
					Endorheic	With channel inflow
						Without channel inflow
					dammed	With channel inflow
						Without channel inflow
			Valleyhead seep	Not applicable	Not applicable	Not applicable
		PLAIN	Channel (river)	Lowland river	Not applicable	Not applicable
				Upland floodplain river	Not applicable	Not applicable
			Floodplain wetland	Floodplain depression	Not applicable	Not applicable
				Floodplain flat	Not applicable	Not applicable
			Unchannelled valley-bottom wetland	Valley-bottom depression	Not applicable	Not applicable
				Valley-bottom flat	Not applicable	Not applicable
			Depression	Not applicable	Exorheic	With channel inflow
						Without channel inflow
					Endorheic	With channel inflow
						Without channel inflow
			Flat	Not applicable	Not applicable	Not applicable
		BENCH (Hilltop/saddle/shelf)	Depression	Not applicable	Exorheic	With channel inflow
						Without channel inflow
					Endorheic	With channel inflow
						Without channel inflow
			Flat	Not applicable	Not applicable	Not applicable

The Hydrogeomorphic wetland units identified will be describe individually as per Marneweck and Batchelor (Marneweck & Batchelor; 2002).

4.3 Present Ecological Status (PES) assessment

WET-Health Version 2 consists of a series of three tools developed to assess the Present Ecological State (PES) or "ecological health" of wetland ecosystems of different hydrogeomorphic types at three different levels of detail/resolution. These tools build on previous assessment methods, including WET-Health Version 1 and Wetland-IHI, in response to the need that was identified to develop a refined and more robust suite of tools for the assessment of the PES of wetland ecosystems in South Africa. (Macfarlane *et al*, 2020).

WET-Health 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. (Macfarlane *et al*, 2020).

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. (Macfarlane *et al*, 2020).

Figure 4-1: Diagram representing the four key components of Wetland PES considered in WET-Health Version 2. (Macfarlane *et al*, 2020).

In WET-Health, the natural reference condition of a wetland is inferred from conceptual models relating to the selected hydro-geomorphic (HGM) wetland type, the selected hydro-geological type setting and knowledge of vegetation attributes of similar wetlands in the region. PES is then assessed by evaluating the extent to which anthropogenic activities have altered wetland characteristics across the four inter-related components of wetland health, as follows:

- **Geomorphology** in this context is assessed by assessing changes to (i) geomorphic processes and (ii) the geomorphic structure of the wetland. Geomorphic processes in this context, refers to those physical processes that are currently shaping and modifying wetland form and evolution, whilst geomorphic structure refers to the three-dimensional shape of sediment deposits on which wetland habitat is established. Whilst catchment drivers (similar to those assessed in the hydrology module) are integrated as part of the assessment, impacts are ultimately assessed based on an understanding of the degree to which within-wetland geomorphic processes and the associated structure of the wetland have been altered by anthropogenic activities. The module also accounts for differences in geomorphic processes in wetlands characterised by clastic (minerogenic) sedimentation and those characterised by organic sediment accumulation (peat).

- **Water quality** is defined as the physico-chemical attributes of the water in a wetland. It is assessed based on considering both potential diffuse runoff from landuses within the wetland and from the areas surrounding the wetland, together with point-source discharges of pollution entering directly into the wetland and/or into streams that flow into that wetland.
- **Vegetation** is defined in this context as the structural and compositional state of the vegetation within a wetland. This module evaluates changes in vegetation composition and structure as a consequence of current and historic on-site transformation and/or disturbance. Whilst the assessor needs to have some knowledge of vegetation in a particular region, the method does not require the assessor to be able to identify all wetland plant species. The emphasis is rather on identifying alien and ruderal (weedy) species that indicate disturbance, and assessing their occurrence relative to common naturally occurring indigenous species, including those that are naturally dominant in the wetland. (Macfarlane *et al*, 2020).

4.3.1 Levels of assessment

Three different levels of assessment have been developed to account for a broad range of user requirements, ranging from regional assessments involving thousands of wetlands through to detailed site-based assessments used to identify specific stressors and impacts on a single wetland for management and rehabilitation planning. In each instance, the assessment is based initially on a landcover assessment that seeks to provide an initial indication of wetland condition based on a generic understanding of the impacts of different landuses on catchment and wetland processes and characteristics. The assessment is refined for more detailed assessments by integrating finer-scale mapping, and a combination of additional desktop and site-based indicators to refine and improve the accuracy of the assessments. The following three levels of assessment are catered for in the method:

- ***Level 1A (desktop-based, low resolution)***, is an entirely desktop-based assessment and uses only pre- existing landcover data (i.e. no interpretation of aerial imagery by an assessor is required) and for which default impact intensity scores have been allocated for each component of wetland PES. In many cases, particularly when applied at a national level, it is not possible to delineate the upslope catchment of each of the individual wetlands. Instead, the landcover types in a GIS buffer around a wetland and within a “pseudo-catchment” selected to represent the true catchment (such as a sub-quaternary catchment) is used as a coarse proxy of the impacts on the wetland arising from its upslope catchment. Impacts arising from the wetland and catchment are then integrated through structured algorithms to provide a coarse indication of wetland health.
- ***Level 1B (desktop-based, high resolution)***, is also largely desktop-based using pre-existing landcover data but makes a few finer distinctions than Level 1A in terms of landcover types and usually requires interpretation of the best available aerial imagery in order to do so. This also allows the pre-defined land- cover types to be mapped more accurately. Furthermore, the upslope

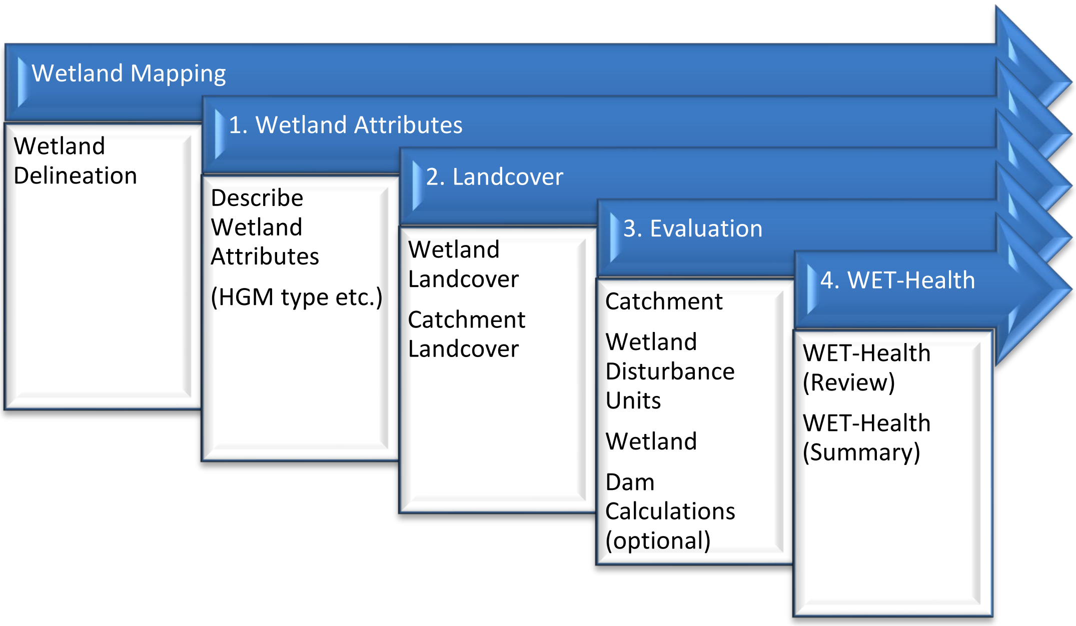
catchment of each wetland can be individually delineated at this level, and landcover in this area is used as a proxy of the impacts on a wetland arising from its upslope catchment. As for Level 1A, impacts arising from within individual wetlands are inferred from landcover types occurring within the delineated wetlands.

- ***Level 2 (rapid field-based assessment)***, starts with landcover mapping, but is refined by assessing a range of catchment and wetland-related indicators that are known to affect wetland health. Impacts arising from the upslope catchment of a wetland are inferred from landcover mapping but are refined based on additional information (e.g. for plantations, the user must indicate whether the trees making up the plantations are eucalypts or pines and/or wattle). Landcover types occurring within the wetland are used as the starting point for assessing human impacts arising from within the wetland. However, this initial assessment is refined considerably by sub-dividing the wetland into relatively homogenous "disturbance units" and answering a suite of site-based wetland questions which provide a more direct assessment of change (e.g. the density, depth and orientation of artificial drainage channels, and the texture of the soil in the wetland). (Macfarlane *et al*, 2020).

A level 2 wetland assessment was undertaken to determine the PES of the wetland system.

The PES assessment is concluded by completing the following process:

Table 4-2: Outline of steps involved in the Level 1 assessment (Macfarlane *et al*, 2020).



The Present Ecological State (PES) categories are given in Table 4-3.

Table 4-3: PES categories (Macfarlane *et al*, 2020).

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

The determination of the probable Trajectory of Change of the wetland is also evaluated. This is rated and presented as indicated in Table 4-4.

Table 4-4: Trajectory of Change classes, scores and symbols used to represent anticipated changes to wetland integrity (Macfarlane *et al*, 2008).

Trajectory class	Description	Symbol
Improve markedly	Likely to improve substantially over the next 5 years	↑↑
Improve	Likely to improve slightly over the next 5 years	↑
Remain stable	Likely to remain stable over the next 5 years	→
Deteriorate slightly	Likely to deteriorate slightly over the next 5 years	↓
Deteriorate markedly	Likely to deteriorate substantially	↓↓

4.4 Wetland Ecological Importance and Sensitivity (EIS)

The ecological importance and sensitivity assessment were conducted according to the guidelines as discussed by DWAF (1999). DWAF defines “ecological importance” of a water resource as an expression of its importance to the maintenance of ecological diversity and function on local and wider scales. “Ecological sensitivity”, according to DWAF (1999), refers to the system’s ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and Sensitivity (EIS) analysis provides a guideline for the determination of the Ecological Management Class (EMC).

In the method outlined by DWAF (1999) a series of determinants for EIS are assessed for the wetlands on a scale of 0 to 4 (Table 4-5), where 0 indicates no importance and 4 indicates very high importance. The median of the determinants is used to determine the EIS and EMC of the wetland unit (Table 4-6).

Table 4-5: Score sheet for the determination of ecological importance and sensitivity (DWAF, 1999).

Determinant	Score	Confidence
Primary determinants		
Rare and endangered species		
Species / taxon richness		
Diversity of Habitat types or features		
Migration route / breeding and feeding site for wetland species		
Sensitivity to changes in the natural hydrological regime		
Sensitivity to water quality changes		
Flood storage, energy dissipation and particulate / element removal		
Modifying determinants		
Protected status		
Ecological integrity		

Score guideline: 4 = Very High; 3 = High; 2 = Moderate; 1 = Marginal / Low; 0 = None. Confidence rating: 4 = Very High Confidence; 3 = High Confidence; 2 = Moderate Confidence; 1 = Marginal / Low Confidence.

Table 4-6: Ecological Importance and Sensitivity (EIS) categories and the interpretation of median scores for biotic and habitat determinants (DWAF, 1999).

Range of Median	EIS Category	Category Description	Ecological Management Class
>3 and ≤4	**Very High**	Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	**A**
>2 and ≤3	**High**	Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water in major rivers.	**B**
>1 and ≤2	**Moderate**	Wetlands that are to be considered 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.	**C**
>0 and ≤1	**Low/ Marginal**	Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	**D**

4.5 Recommended Ecological Category (REC)

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability, but carries a higher risk of ecosystem failure." (DWAF, 1999).

The Recommended Ecological Category (REC) is determined based on the results obtained from the Present Ecological State (PES), reference conditions and Ecological Importance and Sensitivity (EIS) of the aquatic resource. This is then followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

A system may receive the same class for the PES, as the REC if the system is deemed to be in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as to enhance the PES of the riparian system (Table 4-7).

Table 4-7: Recommended Ecological Category (REC) classes.

Class (% of total)	Description
A	Unmodified, natural.
B	Largely natural with few modifications.
C	Moderately modified.
D	Largely modified.

4.6 Impact Assessment Methodology

As standardized impact assessment methodology was utilized to determine the impacts associated with the proposed installation. A summary of this methodology is provided below.

The **significance** of an impact is defined as the combination of the **consequence** of the impact occurring and the **probability** that the impact will occur. The nature and type of impact may be direct or indirect and may also be positive or negative, refer to Table 4-8: below for the specific definitions.

Table 4-8: Nature and type of impact.

	Nature and Type of Impact:		
IMPACT	Direct	Impacts that are caused directly by the activity and generally occur at the same time and place as the activity	✓/✗
	Indirect	Indirect or induced changes that may occur as a result of the activity. These include all impacts that do not manifest immediately when the activity is undertaken or which occur at a different place as a result of the activity	✓/✗
	Cumulative	Those impacts associated with the activity which add to, or interact synergistically with existing impacts of past or existing activities, and include direct or indirect impacts which accumulate over time and space	✓/✗
	Positive	Impacts affect the environment in such a way that natural, cultural and / or social functions and processes will benefit significantly, and includes neutral impacts (those that are not considered to be negative	✓
	Negative	Impacts affect the environment in such a way that natural, cultural and/or social functions and processes will be comprised	✗

Table 4-9 presents the defined criteria used to determine the **consequence** of the impact occurring which incorporates the extent, duration and intensity (severity) of the impact.

Table 4-9: Consequence of the Impact occurring.

CONSEQUENCE	**Extent of Impact:**		
	Site	Impact is limited to the site and immediate surroundings, within the study site boundary or property (immobile impacts)	
	Neighbouring	Impact extends across the site boundary to adjacent properties (mobile impacts)	
	Local	Impact occurs within a 5km radius of the site	
	Regional	Impact occurs within a provincial boundary	
	National	Impact occurs across one or more provincial boundaries	
	Duration of Impact:		
	Incidental	The impact will cease almost immediately (within weeks) if the activity is stopped, or may occur during isolated or sporadic incidences	
	Short-term	The impact is limited to the construction phase, or the impact will cease within 1 - 2 years if the activity is stopped	
	Medium-term	The impact will cease within 5 years if the activity is stopped	
	Long-term	The impact will cease after the operational life of the activity, either by natural processes or by human intervention	
	Permanent	Where mitigation either by natural process or by human intervention will not occur in such a way or in such a time span that the impact can be considered transient	
	Intensity or Severity of Impact:		
	Low	Impacts affect the environment in such a way that natural, cultural and/or social functions and processes are not affected	
	Low-Medium	Impacts affect the environment in such a way that natural, cultural and/or social functions and processes are modified insignificantly	
	Medium	Impacts affect the environment in such a way that natural, cultural and/or social functions and processes are altered	
	Medium-High	Impacts affect the environment in such a way that natural, cultural and / or social functions and processes are severely altered	
	High	Impacts affect the environment in such a way that natural, cultural and / or social functions and processes will permanently cease	

The probability of the impact occurring is the likelihood of the impacts actually occurring, and is determined based on the classification provided in Table 4-10.

Table 4-10: Probability and confidence of impact prediction.

PROBABILITY	**Probability of Potential Impact Occurrence:**		
	Improbable	The possibility of the impact materialising is very low either because of design or historic experience	
	Possible	The possibility of the impact materialising is low either because of design or historic experience	
	Likely	There is a possibility that the impact will occur	
	Highly Likely	There is a distinct possibility that the impact will occur	
	Definite	The impact will occur regardless of any prevention measures	

The significance of the impact is determined by considering the consequence and probability without taking into account any mitigation or management measures and is then ranked according to the ratings listed in Table 4-11.

Table 4-11: Significance rating of the impact.

SIGNIFICANCE	Significance Ratings:	
	Low	Neither environmental nor social and cultural receptors will be adversely affected by the impact. Management measures are usually not provided for low impacts
	Low-Medium	Management measures are usually encouraged to ensure that the impacts remain of Low-Medium significance. Management measures may be proposed to ensure that the significance ranking remains low-medium
	Medium	Natural, cultural and/or social functions and processes are altered by the activities, and management measures must be provided to reduce the significance rating
	Medium-High	Natural, cultural and/or social functions and processes are altered significantly by the activities, although management measures may still be feasible
	High	Natural, cultural, and/or social functions and processes are adversely affected by the activities. The precautionary approach will be adopted for all high significant impacts and all possible measures must be taken to reduce the impact

The level of confidence associated with the impact prediction is also considered as low, medium or high (Table 4-12:).

Table 4-12: Level of confidence of the impact prediction.

CONFIDENCE	Level of Confidence in the Impact Prediction:	
	Low	Less than 40% sure of impact prediction due to gaps in specialist knowledge and/or availability of information
	Medium	Between 40 and 70% sure of impact prediction due to limited specialist knowledge and/or availability of information
	High	Greater than 70% sure of impact prediction due to outcome of specialist knowledge and/or availability of information

Once significance rating has been determined for each impact, management and mitigation measures must be determined for all impacts that have a significance ranking of Medium and higher in order to attempt to reduce the level of significance that the impact may reflect.

The EIA Regulations, 2014 specifically require a description is provided of the degree to which these impacts:

- can be reversed;
- may cause irreplaceable loss of resources; and
- can be avoided, managed or mitigated.

Based on the proposed mitigation measures, the mitigation efficiency is also determined (Table 4-13) whereby the initial significance is re-evaluated and ranked again to effect a significance that incorporates the mitigation based on its effectiveness. The overall significance is then re-ranked and a final significance rating is determined.

Table 4-13: Mitigation efficiency.

MITIGATION EFFICIENCY	Mitigation Efficiency	
	None	Not applicable
	Very Low	Where the significance rating stays the same, but where mitigation will reduce the intensity of the impact. Positive impacts will remain the same
	Low	Where the significance rating reduces by one level, after mitigation
	Medium	Where the significance rating reduces by two levels, after mitigation
	High	Where the significance rating reduces by three levels, after mitigation
	Very High	Where the significance rating reduces by more than three levels, after mitigation

The reversibility is directly proportional to the "Loss of Resource" where no loss of resource is experienced, the impact is completely reversible; where a substantial "Loss of resource" is experienced there is a medium degree of reversibility; and an irreversible impact relates to a complete loss of resources, i.e. irreplaceable (Table 4-14).

Table 4-14: Degree of reversibility and loss of resources.

DEGREE REVERSABILITY & LOSS OF RESOURCES	Loss of Resources:	
	No Loss	No loss of social, cultural and/or ecological resource(s) are experienced. Positive impacts will not experience resource loss
	Partial	The activity results in an insignificant or partial loss of social, cultural and/or ecological resource(s)
	Substantial	The activity results in a significant loss of social, cultural and/or ecological resource(s)
	Irreplaceable	The activity results in the complete and irreplaceable social, cultural and/or ecological loss of resource(s)
	Reversibility:	
	Irreversible	Impacts on natural, cultural and/or social functions and processes are irreversible to the pre-impacted state in such a way that the application of resources will not cause any degree of reversibility
	Medium Degree	Impacts on natural, cultural and/or social functions and processes are partially reversible to the pre-impacted state if less than 50% resources are applied
	High Degree	Impacts on natural, cultural and/or social functions and processes are partially reversible to the pre-impacted state if more than 50% resources are applied
	Reversible	Impacts on natural, cultural and/or social functions and processes are fully reversible to the pre-impacted state if adequate resources are applied

4.7 Consultation Process

Consultation as part of the overall environmental authorization process is being undertaken by Prism EMS (EAP). Prism EMS, wetland specialist consulted with:

- The EAP
- Department of Human Settlements, Water and Sanitation (DHSWS)
- City of Johannesburg (CoJ)
- The Professional Team

4.8 Wetland Buffer Determination

The assessment procedure has been structured in an eight-step process as outlined in Figure 4-2. This provides a broad overview of the process followed:

- Step 1: Define Objectives and Scope to Determine the Most Appropriate Level of Assessment
- Step 2: Map and Categorise Water Resources in The Study Area
- Step 3: Refer to The DWA Management Objectives for Mapped Water Resources or Develop Surrogate Objectives
- Step 4: Assess the Risks from Proposed Developments and Define Mitigation Measures Necessary to Protect Mapped Water Resources in The Study Area
- Step 5: Assess Risks Posed by Proposed Development on Biodiversity and Identify Management Zones for Biodiversity Protection
- Step 6: Delineate and Demarcate Recommended Final Buffer Zone Requirements
- Step 7: Document Management Measures Necessary to Maintain the Effectiveness of Final Buffer Zone Areas
- Step 8: Monitor Implementation of Buffer Zones

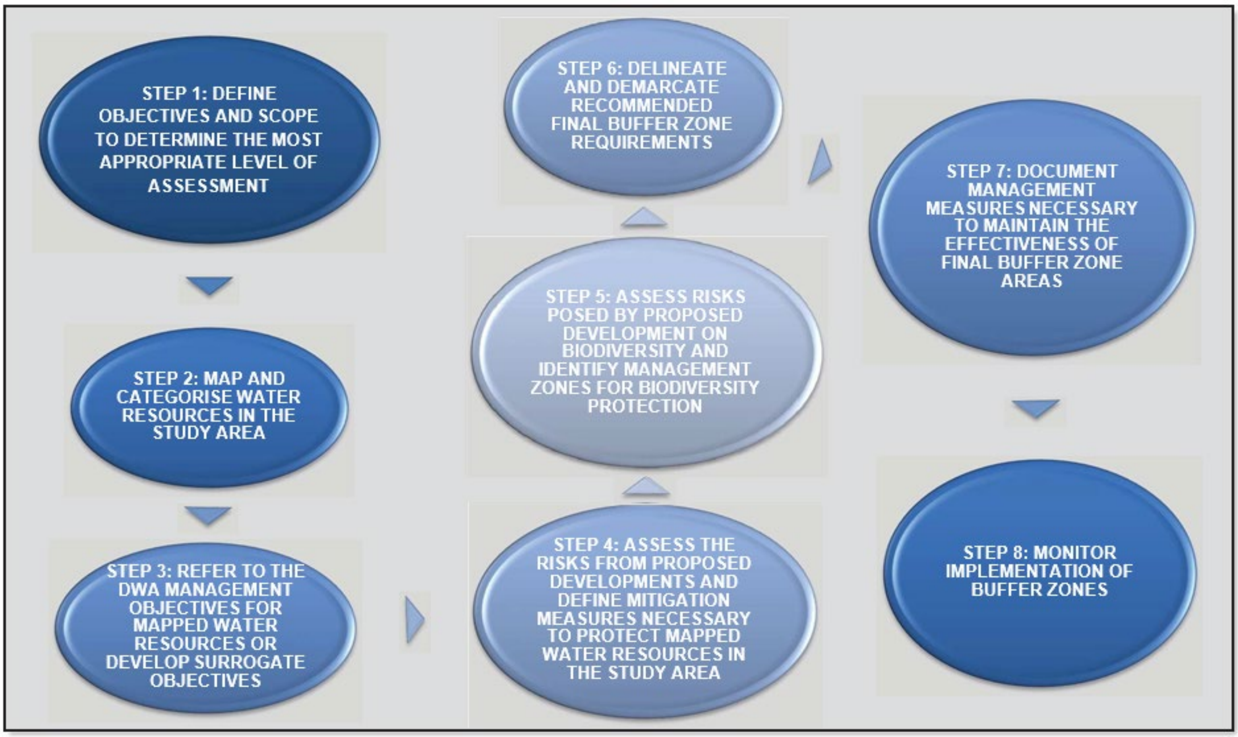


Figure 4-2: Overview of the step-wise assessment process for buffer zone determination (Macfarlane, Bredin; 2017)

5 ASSUMPTIONS, GAPS AND LIMITATIONS

The study was limited to a snapshot view during a few site visits. The field investigations were undertaken during **November 2020** to assess and confirm the delineated Wetland zones present on the survey area. Weather conditions during the survey were favourable for recordings. The delineations were recorded by handheld GPS.

It must be noted that, during the process of converting spatial data to final output drawings, several steps are followed that may affect the accuracy of areas delineated. Due care has been taken to preserve accuracy. Printing or other forms of reproduction may also distort the scale indicated in maps. It is therefore suggested that the wetland areas identified in this report be pegged in the field in collaboration with the surveyor for precise boundaries.

It is unlikely that more surveys would alter the outcome of this study radically.

6 RESULTS AND FINDINGS

6.1 Wetland Assessment

6.1.1 Desktop Assessment

During the desktop investigation, one (1) possible area where wetlands could occur was identified on or in close proximity to the study site that would be affected by the proposed development activities.

The National Wetland Map version 5 (NWM5) as presented by SANBI was also scrutinised and one wetland area were identified (refer to Figure 6.3) on or in close proximity to the study site that could be affected by the proposed activities. The wetland as indicated by the NWM5 wetland layers were further investigated on site.

6.1.2 Field Assessment

The field investigations were undertaken during **November 2020** to assess and confirm the delineated Wetland zones present on the survey area.

The field investigations concluded that one natural wetland unit could be recorded as per the DWAF, 2005 guidelines (Figure 6.6)

6.1.2.1 Wetland Indicators

6.1.2.1.1 Terrain Unit Indicator

Terrain unit indicator helps identify those parts of the landscape where wetlands are most likely to occur. Wetlands occupy characteristic positions in the landscape and can occur on the following terrain units:

- crest,
- midslope,
- footslope, and
- valley bottom.

The wetlands identified were also assessed in respect to its location in the landscape. The wetland found:

- SV24_UCVB was found on the valley floor close to at the head of the catchment, draining towards the West

Refer to Table 6-1 and section 4.2 Wetland Classification for the classification of the terrain unit.

Table 6-1: Wetland Classification

Level 1: System	**Level 2: Regional setting**	**Level 3: Landscape unit**	**Level 4: Hydrogeomorphic (HGM) unit**	
Connectivity to open ocean	**Ecoregion**	**Landscape setting**	**HGM type**	**Longitudinal zonation / landform**
			A	**B**
INLAND	DWAF Level 1 Ecoregions	VALLEY FLOOR	Unchanneled valley-bottom wetland	Valley-bottom flat

6.1.2.1.2 Soil Form and Soil Wetness Indicator

Soil erodibility in hydrologically transformed environments contributes to the difficulties to precisely determining wetland boundaries. This investigation focussed on the delineation of the wetland features based on soil hydro-morphology and landscape hydrology as observed in the catchment and on the site.

Soils were found to be of a low clay content in general. Mostly sandy soils were present especially in the top 150mm. The wetland seasonal and permanent zones reflected clayey soils. Typical wetland soils were observed (Figure 6.1).

Figure 6-1: Soil samples.

6.1.2.1.3 Vegetation Indicator

Upon the assessment of the area, the various wetland vegetation components were assessed and recorded. Dominant species were characterised as either wetland species or terrestrial species. Hydrophytic vegetation species were observed. Predominantly grass, rushes and sedge species were recorded. This unit was predominantly utilised to delineate the wetland.

Figure 6-2: Wetland vegetation.

Table 6-2: Wetland indicator species noted during the assessment.

Riparian / Wetland vegetation	
Pycreus species	*Fuirena Species*
Paspalum species	*Imperata cylindrica*
Andropogan species	*Cyperus species*
Berkheya radula	*Leersia hexandra*

**Not all species listed, only most common/dominant indicators*

6.3 Wetland Classification

SANBI's classification for wetlands was used to classify the wetland units within the study area (SANBI, 2009). The wetland units were classified up to level four, which includes the system, regional setting, landscape unit and Hydrogeomorphic (HGM) unit. Figure 6.8 conceptually present the HGM units (Marneweck and Batchelor, 2002).

One natural wetland entity was identified during the field investigation.

The following Hydrogeomorphic wetlands were identified during the site evaluation:

- SV24_UCVB – Unchanneled Valley Bottom Wetland

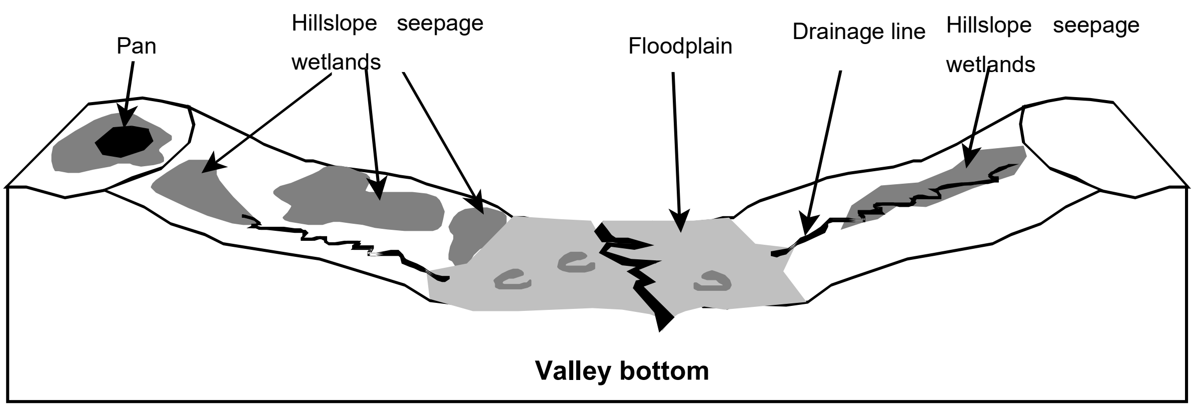


Figure 6-3: Wetland hydrogeomorphic (HGM) classification (Marneweck and Batchelor, 2002).

6.3.1 Unchanneled Valley Bottom Wetland

One Unchanneled Valley Bottom Wetland Unit at the head of the catchment was identified in the study area. Figure 6.9 diagrammatically illustrates the HGM unit.

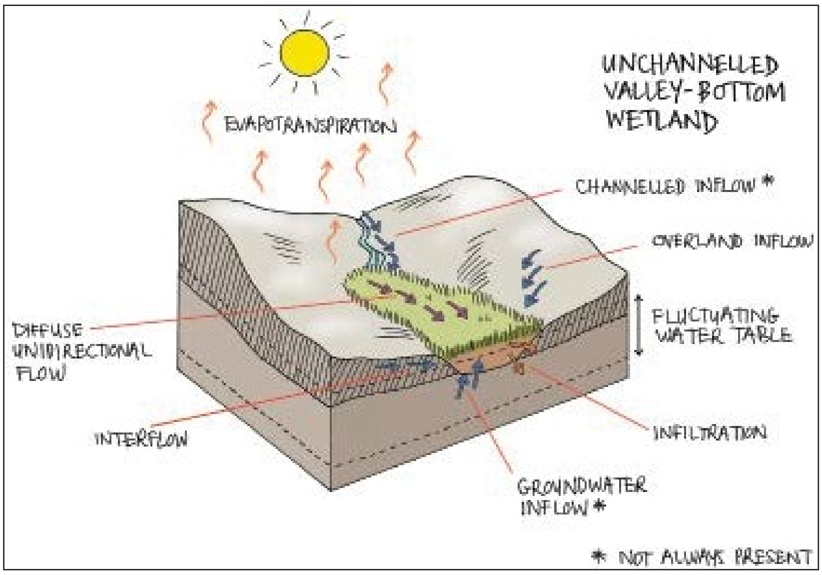


Figure 6-4: Unchanneled Valley Bottom Wetland (SANBI; 2013)

6.3.2 Wetland Unit classification

SANBI's "Further development of a proposed National Classification System for South Africa" was used to verify the classification of the wetlands within the study area (SANBI, 2009). The wetlands were classified up to level four, which includes the system, regional setting, landscape unit and hydrogeomorphic unit (Table 4-1).

The wetland was classified as per Table 6-3.

Table 6-3: Wetland Units classification

Unit	System	Regional setting	Landscape unit	Hydrogeomorphic unit
SV24_UCVB	Inland	Highveld	Valley Floor	Unchanneled Valley Bottom Wetland

6.4 Present Ecological Status (PES)

A WET-Health Version 2 wetland assessment was undertaken to determine the PES of the wetland system.

6.4.1 SV24_UCVB – Unchanneled Valley Bottom Wetland

SV24_UCVB was found to be moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact (Table 6-4). This wetland system is impacted by historical activities both in the catchment as well as directly on the wetland system where the impacts are continues. It forms part of a larger wetland system. The trajectory of change for the wetland ecological status is predicted that conditions are likely to deteriorate slightly over the next 5 years without major intervention (Table 6-5).

Table 6-4: PES – SV24_UCVB

PES Assessment	Hydrology	Geomorphology	Water Quality	Vegetation
Impact Score	4,7	4,5	2,7	2,0
PES Score (%)	53%	55%	73%	80%
Ecological Category	D	D	C	C
Combined Impact Score	3,6			
Combined PES Score (%)	64%			
Combined Ecological Category	C			
Hectare Equivalents	1,9 Ha			
Confidence (modelled results)	MODERATE-TO-HIGH: Field-based assessment including information about the regional aquifer			

Table 6-5: Trajectory of change of SV24_UCVB

Trajectory class	Description	Symbol
Deterioration slightly	Condition is likely to deteriorate slightly over the next 5 years	↓

6.5 Ecological Importance and Sensitivity (EIS)

The ecological importance and sensitivity assessment were conducted according to the guidelines as discussed by DWAF (1999). DWAF defines “ecological importance” of a water resource as an expression of its importance to the maintenance of ecological diversity and function on local and wider scales. “Ecological sensitivity”, according to DWAF (1999), refers to the system’s ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and Sensitivity (EIS) analysis provides a guideline for the determination of the Ecological Management Class (EMC).

6.5.1 SV24_UCVB – Unchanneled Valley Bottom Wetland

The SV24_UCVB, Unchanneled Valley Bottom Wetland is considered ecologically important and sensitive on a local scale. The biodiversity of this wetland is generally not sensitive to flow and habitat modifications. It plays a small role in moderating the quantity and quality of water of major rivers. The system drains into further downstream wetland and streams before reaching major rivers. The Ecological Importance and Sensitivity (EIS) for this system is thus considered to be Moderate (Refer to Table 6-6).

Table 6-6: EIS – SV24_UCVB

Score	EIS Category	Category Description	Ecological Management Class
Score =1,67 *Range* *(>1 and <=2)*	**Moderate**	Wetlands that are to be considered ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands 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.	**C**

6.6 Recommended Ecological Category (REC)

The Recommended Ecological Category (REC) is determined based on the results obtained from the Present Ecological State (PES), reference conditions and Ecological Importance and Sensitivity (EIS) of the aquatic resource. This is then followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

6.6.1 SV24_UCVB – REC

The wetland will be impacted to some extent by the proposed development activities, but a major impact is envisaged for the future road upgrades planned. This impact will be localised and at the transitional point leading from the development and infrastructure installations into the wetland and buffer area. It will in all likelihood regress slightly in terms of its current Ecological Category if not managed in specific during the construction period. Stormwater management for the site is required in specific the construction phase. This will mitigate the impact on the wetlands. Rehabilitation of the impacts and maintenance of the system will further mitigate the impacts and could improve the sustainability of the system. It is thus rated that the Recommended Ecological Category (REC) should fall into:

- Category C for SV24_UCVB (Table 6-7).

Table 6-7: REC

Wetland Unit	Class (% of total)	Description
SV24_UCVB	**C**	Moderately modified.

6.7 Wetland Buffer Assessment

The assessment procedure has been structured in an eight-step process. The site assessment-based buffer tool was utilized to assess the buffer requirements for SV24-UCVB wetland.

Due to the site and wetland conditions, the wetland PES and the ongoing anthropogenic impacts it was concluded that the required buffer for the wetland in terms of the proposed development and perceived future impacts would require the following buffering requirements:

- Construction Phase Buffer Required – 15m – [*specific mitigation is required during this phase – main focus on siltation and erosion control*] (Table 6-8).
- Operational Phase Buffer Required – 15m (Table 6-8).

Table 6-8: Wetland Buffers

SITE-BASED TOOL: DETERMINATION OF BUFFER ZONE REQUIREMENTS FOR WETLAND ECOSYSTEMS	
	SV24-UCVB
Final aquatic impact buffer requirements (including practical management considerations)	
Construction Phase	**15**
Operational Phase	**15**
Final aquatic impact buffer requirement	**15**

6.8 Mapping

Figure 6.3 indicates the National Wetland Map version 5 (NWM5) as presented by SANBI (Van Deventer *et al.,* 2019). NWM5 indicates one wetland to the west of the study site.

Figure 6.4 illustrates the Flow Accumulation Model that indicates the accumulation of water in the wetland system.

Figure 6.5 illustrates the Quantitative Flow Model that indicates the flow quantitively through the wetland system.

Figure 6.6 serves to conceptually present the location of the wetland that could be affected by the proposed development activities on the site.

Figure 6.7 presents the conservation buffer zones (Table 6-8) that are applicable and should be considered during the development to ensure appropriate mitigation and management of the activities.

This wetland is largely disturbed due to historical impacts and is of low ecological importance. Furthermore, the wetland will be affected by the road's intersection upgrade linking Christiaan DeWet Drive and the proposed Metro Boulevard. This will impact the wetland system dramatically and alter the total functioning of the wetland. Be that as it may, it was still suggested that a 15m buffer on the current wetland be accommodated to buffer the development from the wetland. The buffer will suffice in the required management of the development impacts and continuation and maintenance of the wetland drivers. This conservation buffer should be utilised as the control area and will be adequate to assist with management and mitigation during the construction and operation phase.

Also, refer to the associated digital files presenting the wetland boundaries to allow for further planning of the layout of the proposed activity.

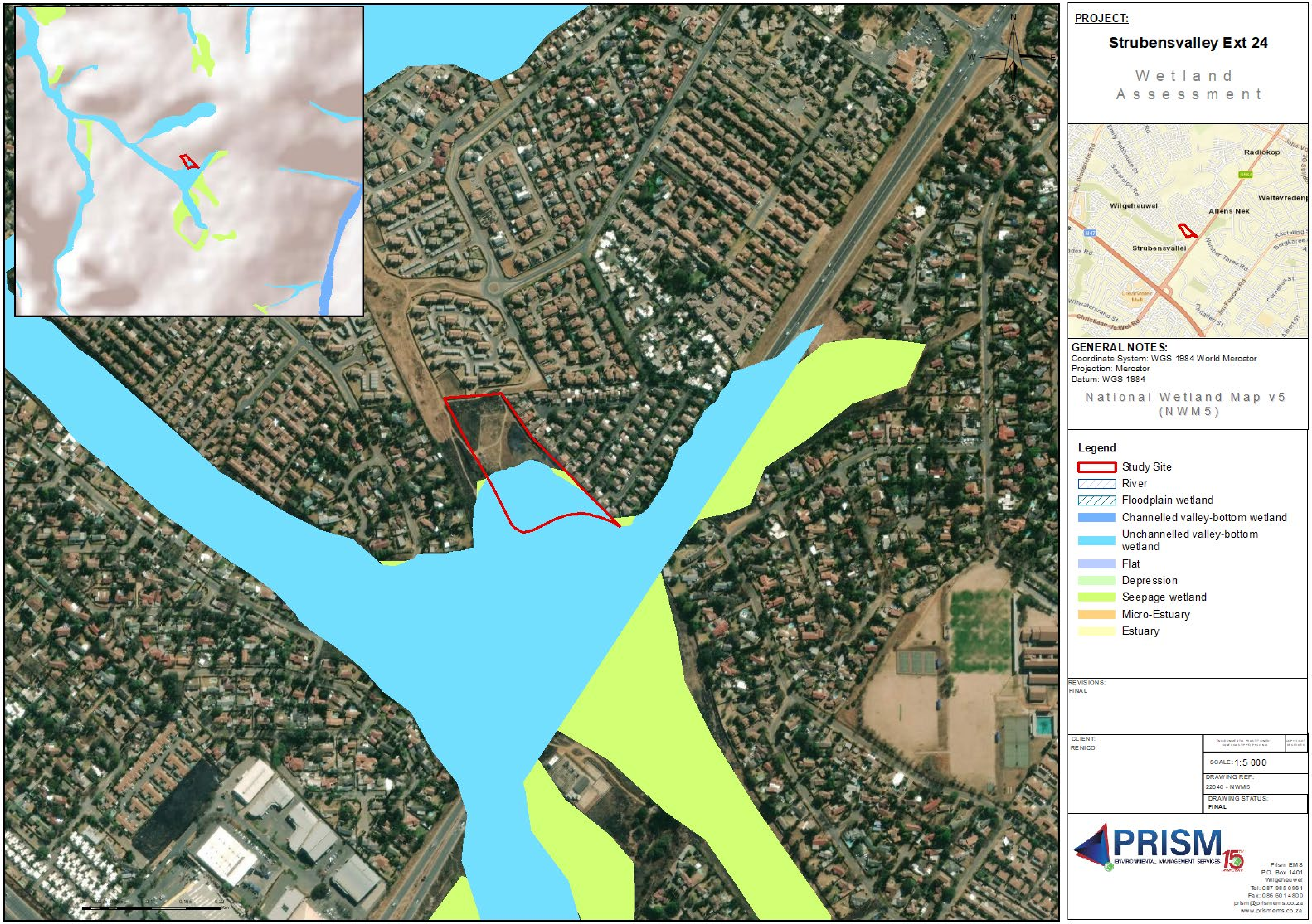


Figure 6-5: National Wetland Map version 5 (NWM5) (Van Deventer *et al.*, 2019).

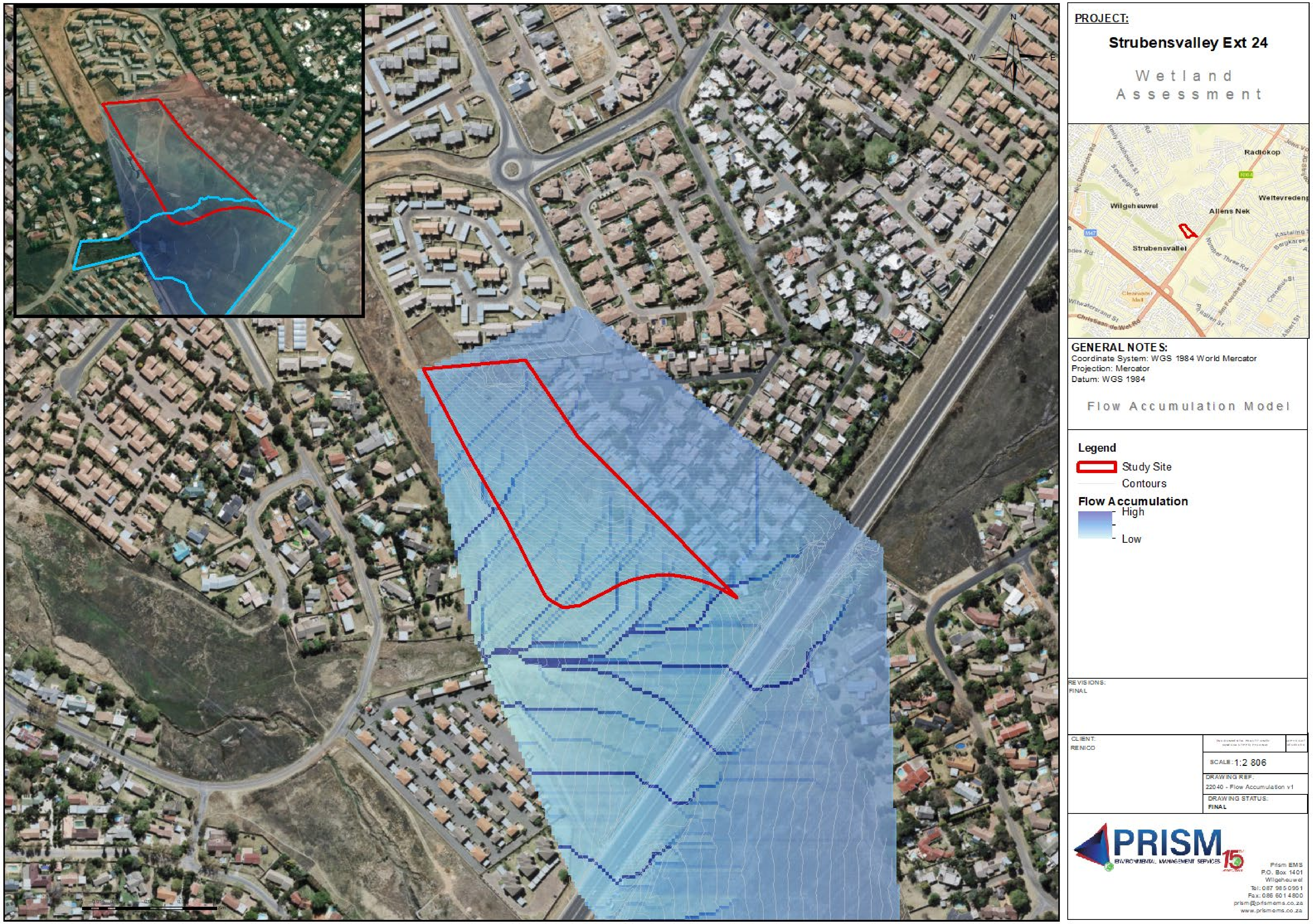


Figure 6-6: Flow Accumulation Model.

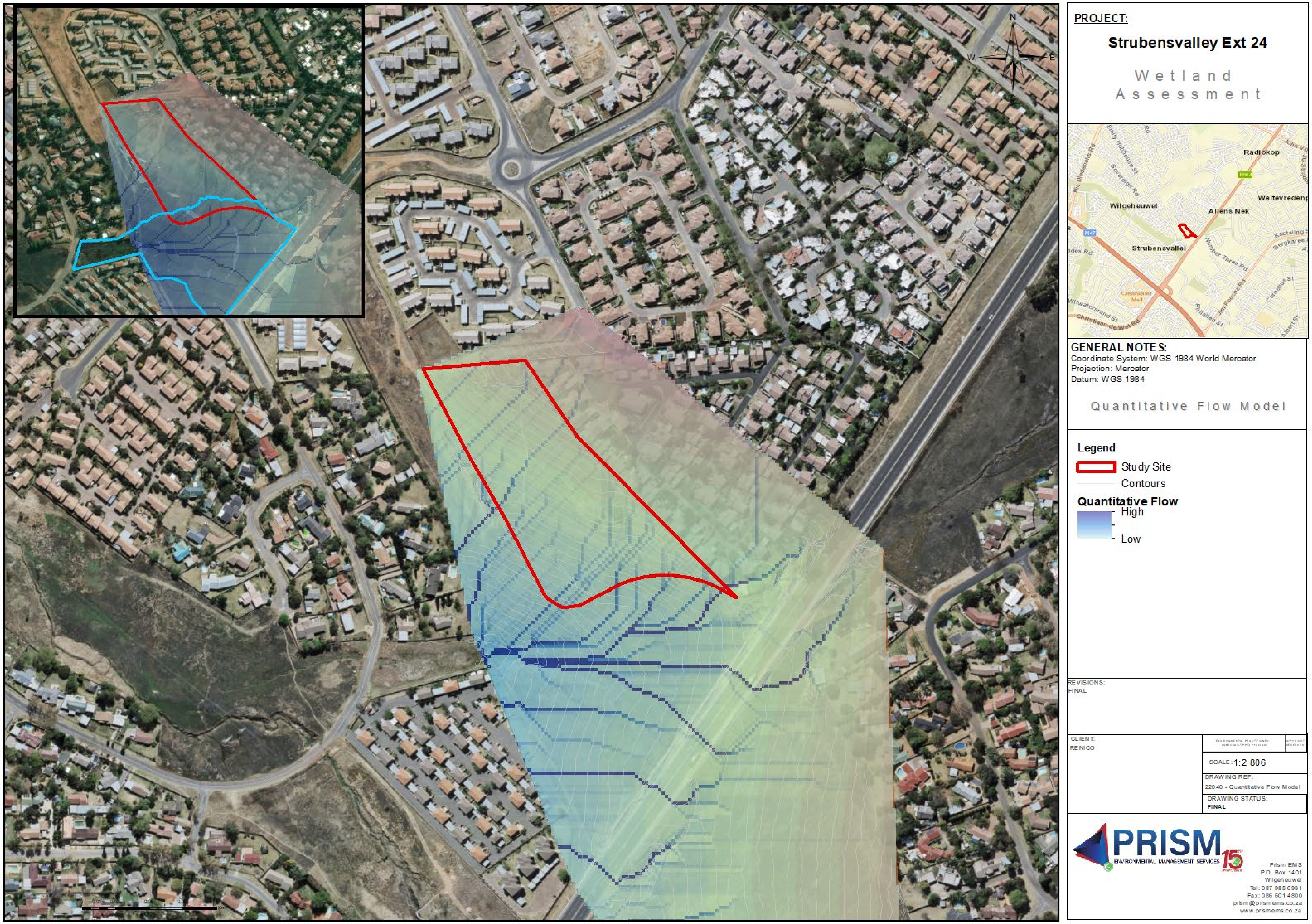


Figure 6-7: Quantitative Flow Model.

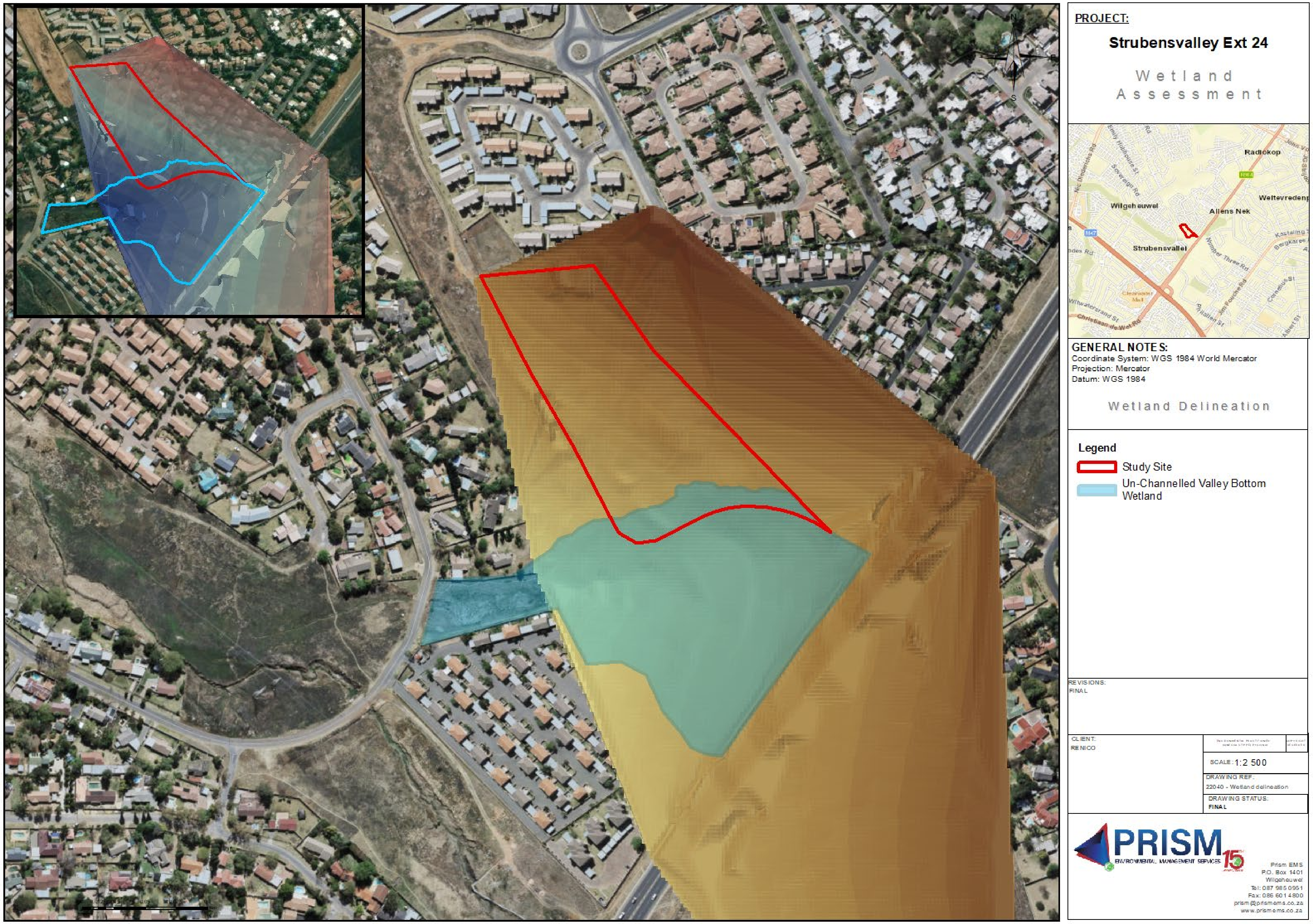


Figure 6-8: Wetland Delineation.

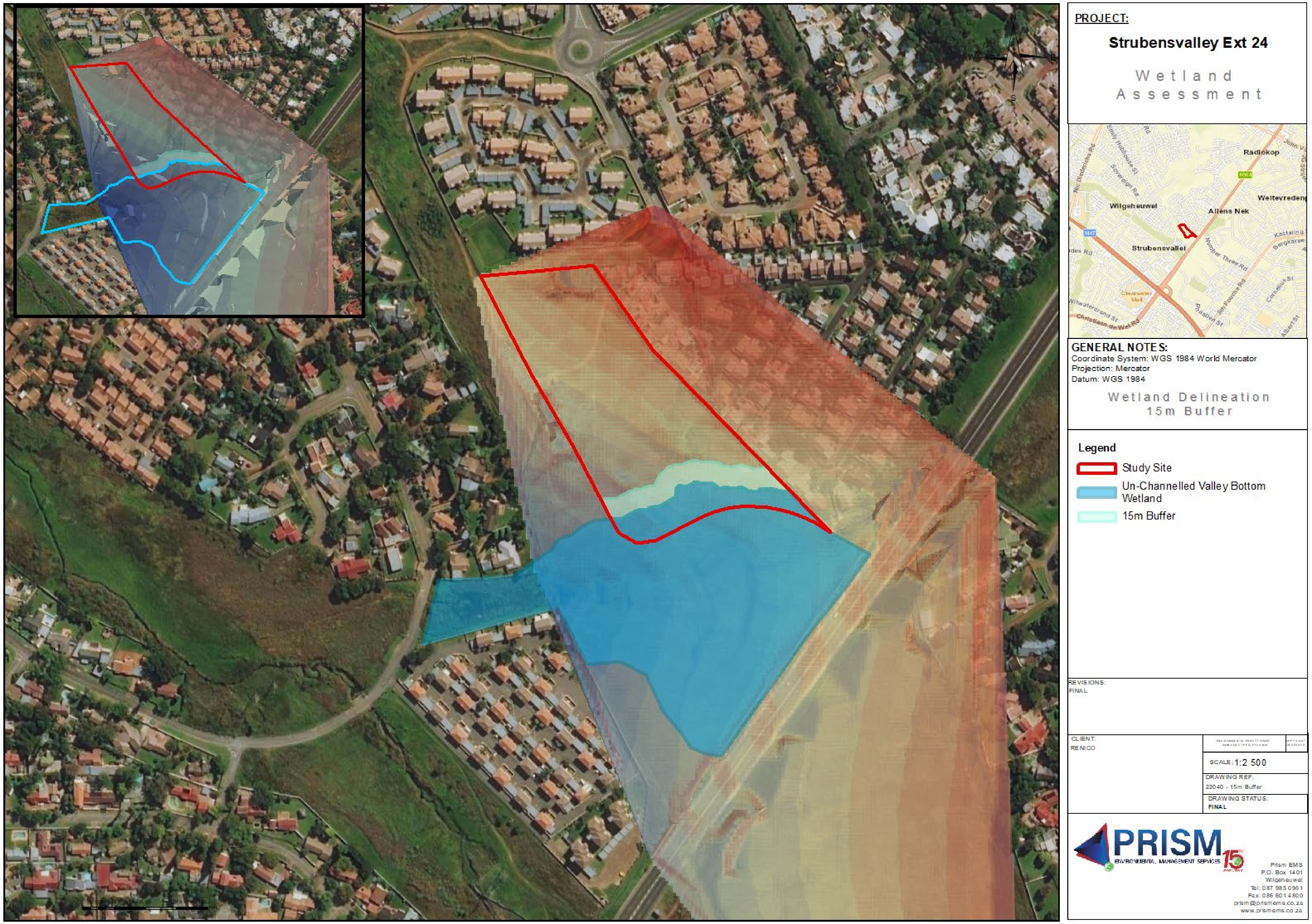


Figure 6-9: Wetland Buffer Zones.

7 IMPACT ASSESSMENT

	IMPACTS			CONSEQUENCE			PROBABILITY	RANKING WITHOUT MITIGATION	CONFIDENCE	IMPLEMENTATION OF MANAGEMENT MEASURES		RANKING WITH MITIGATION	DEGREE REVERSABILITY & LOSS OF RESOURCE	
	Type	Description	Nature	Extent (A)	Duration (B)	Intensity (C)	Probability (P)	Significance (A + B + C) X P	Confidence	Mitigation and/or Management Measures	Mitigation Effectiveness	Significance	Loss of Resources	Reversibility
CONSTRUCTION PHASE														
Wetland	Direct	Water quality	Negative	Neighbouring	Incidental	Low-Medium	Likely	Low	High	Stock piling outside the wetland area, stormwater management, dry season construction, filtration.	High	Low	No Loss	Reversible
	Direct	Flow Regime	Negative	Local	Short-term	Low-Medium	Highly Likely	Low-Medium	High	Stock piling outside the wetland area, stormwater management, dry season construction, filtration.	High	Low	No Loss	Reversible
	Direct	Habitat	Negative	Site	Medium-term	Low-Medium	Likely	Low	High	Stock piling outside the wetland area, minimal ingress and egress.	High	Low	No Loss	Reversible
	Indirect	Biota	Negative	Neighbouring	Medium-term	Medium	Likely	Low	High	Stock piling outside the wetland area, minimal ingress and egress.	High	Low	No Loss	Reversible
	Direct	Geomorphology	Negative	Neighbouring	Medium-term	Low-Medium	Highly Likely	Low-Medium	High	Stormwater management design and erosion control measures.	High	Low	No Loss	Reversible
OPERATIONAL PHASE														
Wetland	Direct	Water quality	Negative	Neighbouring	Incidental	Low-Medium	Possible	Low	High	Rehabilitation of construction impacted area, continuous monitoring. Storm water management.	High	Low	No Loss	Reversible
	Direct	Flow Regime	Negative	Neighbouring	Incidental	Low-Medium	Possible	Low	Medium	Rehabilitation of construction impacted area, continuous monitoring and maintenance. Storm water management.	High	Low	No Loss	Reversible
	Direct	Habitat	Negative	Site	Incidental	Low-Medium	Improbable	Low	High	Rehabilitation of construction impacted area, continuous monitoring, storm water management.	High	Low	No Loss	Reversible
	Indirect	Biota	Negative	Neighbouring	Incidental	Low-Medium	Possible	Low	High	Rehabilitation of construction impacted area, continuous monitoring, storm water management.	High	Low	No Loss	Reversible
	Direct	Geomorphology	Negative	Site	Incidental	Low	Improbable	Low	High	Rehabilitation of construction impacted area.	High	Low	No Loss	Reversible

8 REASONED OPINION AND RECOMMENDATIONS

The Wetland identified is highly transformed and impacted by historical and ongoing anthropogenic activities. The Present Ecological Status (PES) for the wetland scored in the mid-range for the Unchanneled Valley Bottom Wetland. The Ecological Importance and Sensitivity (EIS) falls in the mid-range and has minimal functionality in respect of bio-diversity conservation. The Recommended Ecological Category (REC) for the wetlands were categorised as moderate. It will thus require some rehabilitation to enhance the ecological function of the system. The wetland is not considered to be sensitive and of any major importance. It must also be noted that the wetland will in all likelihood be majorly impacted by the proposed Metro Boulevard Interchanges that is planned to cross over this section of the wetland (Refer to APPENDIX A). The wetland (SV24) is a small-scale wetland unit that interconnects to a larger wetland system to the west. The wetland (SV24) was also historically impacted by old farming activities and more recently by the construction or Christiaan DeWet Drive and associated stormwater infrastructure.

For this reason, it can be supported that the development may go-ahead if the required buffers are maintained and the resource drivers preserved by well-constructed stormwater infrastructure for the Township development. In respect of the construction phase, it is important to ensure that the required erosion protection measures linked to the intersecting sections be carefully designed and installed. It is further important to carefully design the storm water outlet structures to assist with dispersed flow release into the wetland. This should be designed to mimic the natural sheet flow into the wetland and avoid concentrated flow patterns into the wetland area.

The project can be supported, should all the mitigation measures be implemented and monitored against to ensure compliance.

8.1 Mitigation and Monitoring Requirements

Monitoring programmes can measure the success of mitigation implementations, monitor unforeseen impacts, and can be used as a feedback system to adjust or correct management of the wetlands.

The following are recommended:

- It should be attempted to enhance the current wetland function.
    - Wetland drivers should be protected as far as possible.
    - Water quality preservation is key. Silt protection measure to be implemented in consultation with the wetland specialist (ECO).
- Mitigation measures for the proposed development activities should be implemented, managed and monitored according to:
    - The following wetland ecosystem impact assessment conclusions, based on the results of the baseline survey:

        - Runoff from the construction areas may result in contamination of wetland and downstream aquatic habitat;
        - On site storm water management must be implemented.
    - The following impacts may result in changes to the soil structure:
        - Heavy construction vehicles moving within the wetland areas;
            - Ingress and Egress must be managed to minimise impacts in respect of compaction of the wetland soils.
            - Single entry and exit points must be established.
            - These areas must be scarified as part of the rehabilitation plan.
        - Stock piling;
            - Stock piling must be located outside the delineated wetland and buffer boundaries.
        - Spills from machinery;
            - To be managed as per the Environmental Management Programme (EMPr).
        - The mixing of concrete;
            - To be managed as per the Environmental Management Programme (EMPr) outside of the demarcated buffer areas with no flow into the control area.
    - The following aspects may result in reduction of ecosystem habitat integrity:
        - Dust and sediment runoff from construction activities;
        - Diesel and oil spill from equipment and machinery; and
        - Higher and faster water flow from the site that could cause soil erosion.
    - The following aspects may result in sedimentation of the associated aquatic systems:
        - Sedimentation due to increase runoff and dispensed soil particles and runoff from the affected areas; and
        - Increase in the velocity of the runoff from the exposed soil, due to construction.
    - The proposed activities must be initiated and constructed in such a way to prevent the reduction of natural water flow into the wetland and downstream which, in essence, is the driving factor in terms of water provision.
        - An approved stormwater management plan must be implemented.
        - Velocity dissipation structures and sheet flow structures (such as reno mattresses) must also be installed to prevent water flowing through culverts to gain velocity and be released uncontrolled.
        - Dispersed flow must be attained post formal structures.
        - Sheet flow must be promoted to mimic natural flow patterns.
- The wetland integrity should be improved during the rehabilitation phase. This may entail the following:
    - Removal of alien and invasive plant species during the construction and operational phases.

- Stabilisation of gullies and drainage lines to prevent erosion.
- Implementation of topsoil management (stockpiling, topography shaping) and erosion control (berms, geotextiling, silt fences, hay bales and gabion structures).
- Re-vegetation with indigenous plant species.

9 CONCLUSION

The field investigations concluded that one natural wetland system was identified in the study area.

The following Hydrogeomorphic wetland was identified during the site evaluation:

- SV24_UCVB – Unchanneled Valley Bottom Wetland - was found on the valley floor close to the head of the catchment, draining towards the West.

The wetland recorded was assessed and the following results were attained:

- The wetland attained a moderate overall PES (Present Ecological State)
  - SV24_UCVB was found to be moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact. This wetland system is impacted by historical activities both in the catchment as well as directly on the wetland system where the impacts are continues. It forms part of a larger wetland system. The trajectory of change for the wetland ecological status is predicted that conditions are likely to deteriorate slightly over the next 5 years without major intervention.
- The wetland attained a Moderate Ecological Importance and Sensitivity (EIS) score.
  - The SV24_UCVB, Unchanneled Valley Bottom Wetland is considered ecologically important and sensitive on a local scale. The biodiversity of this wetland is generally not sensitive to flow and habitat modifications. It plays a small role in moderating the quantity and quality of water of major rivers. The system drains into further downstream wetland and streams before reaching major rivers. The Ecological Importance and Sensitivity (EIS) for this system is thus considered to be Moderate.
- The wetland Recommended Ecological Classification (REC) classification was rated as:
  - The wetland will be impacted to some extent by the proposed development activities, but a major impact is envisaged for the future road upgrades planned (Metro Boulevard Intersection). This impact will be localised and at the transitional point leading from the development and infrastructure installations into the wetland and buffer area. It will in all likelihood regress slightly in terms of its current Ecological Category if not managed in specific during the construction period. Stormwater management for the site is required in specific the construction phase. This will mitigate the impact on the wetlands. Rehabilitation of the impacts and maintenance of the system will further mitigate the impacts and could improve the sustainability of the system. It is thus rated that the Recommended Ecological Category (REC) should fall into:
    - Category C for SV24_UCVB

Table 9-1: Findings and Conclusion

Study	Findings and Conclusions										
Wetland Assessment	The development site is affected by the wetland, and the development will slightly impact on the wetland. Hence, the recommendation of a buffer area (15m).										
	It must further be noted that a major part of this small wetland unit will be severely impacted on by the proposed Metro Boulevard Intersection with Christiaan DeWet Drive. It will alter the wetlands present status and thus change the future existence. Thus, a further reason for the reduced buffer (15m) recommendations.										
	The buffer area could be used to assist with storm water management and flow management at the transitional point leading from the development and infrastructure installations into the wetland area.										
	The infrastructure installations and connections to the external services will impact on the wetland and must be managed carefully during construction.										
	Careful design and interdisciplinary consultation between the professional team would be required. Interflows and sheet flow must be managed at the contact points.										
	Wetland	**Wetland HGM**	**Wetland**		**15m Buffer**		**PES**		**EIS**		**REC**
			On site	**External linked to services**	**On site**	**External linked to services**	**Category**	**Trajectory of change**	**Category**	**Trajectory of change**	**Category**
	SV24_UCVB	**UCVB**	**Yes**	**Yes**	**Yes**	**Yes**	C - Moderate	↓	C - Moderate	↓	C - Moderately modified.
	Recommended Monitoring Requirements			**Wetland Assessment** ➡			Wetland Specialist		*Monthly Visual Inspections*		
				Environmental Control Officers ➡			ECO		*Bi-Weekly Visual Inspections*		
				Closure Audit ➡			Wetland Specialist		*Closure Audit*		

Concluded from the results presented in this document, the construction activities will in all likelihood impact slightly on the wetland system but can be mitigated to satisfactory standards if all mitigatory actions are implemented with due care. It is key to preserve water quality and supply to the downstream aquatic resources.

In respect of the construction phase, it is important to ensure that the required erosion protection measures linked to the wetland intersecting sections be carefully designed and installed.

The project can be supported, should all the mitigation measures be implemented and monitored against to ensure compliance and protection of the aquatic resource.

10 REFERENCES AND BIBLIOGRAPHY

CARA (Conservation of Agricultural Resources Act – 1983).

Constitution (Act 108 – 1996).

Cowan, J.I. 1999. The development of a national policy and strategy for wetland conservation in South Africa. PhD, University of Pretoria, Faculty of Science.

DEA-SANBI 2012. *National Biodiversity Assessment 2011: An assessment of South Africa's biodiversity and ecosystems. Synthesis Report.* South African National Biodiversity Institute and Department of Environmental Affairs, Pretoria.

DWAF. 1996. South African Water Quality Guidelines. Volume 7: Aquatic Ecosystems.

DWAF, 1999. *Resource Directed Measures for Protection of Water Resources. Volume 4. Wetland Ecosystems*.

DWAF, 1999. *Version 1.0 of Resource Directed Measures for Protection of Water Resources*.

DWAF, 2003: Final draft: *A practical field procedure for identification and delineation of wetlands and Wetland areas*.

DWAF 2005. *A practical field procedure for identification and delineation of wetlands and wetland areas.* DWAF, Republic of South Africa.

DWAF 2005. *A Level I River Ecoregional Classification System for South Africa, Lesotho and Swaziland.* Department of Water Affairs and Forestry Resource Quality Services. Republic of South Africa.

DWAF 2006. Position paper for the management of the physical and ecological properties of a water resource. Wetlands, watercourses and estuaries. Draft 2. DWAF, Republic of South Africa.

DWAF 2007. *Manual for the assessment of a Wetland Index Habitat Integrity for South African floodplain and channelled valley bottom wetland types.* M. Rountree (ed); C.P. Todd, C.J. Kleynhans, A.L. Batchelor, M.D. Louw, D. Kotze, D. Walters, S. Schroeder, P. Illgner, M. Uys. And G.C. Marneweck. Report no. N/0000/00/WEI/0407.

DWAF, 2008. Wetland and Wetland Delineation Course for Consultants – Module 1 course notes. Directorate: Water Abstraction & Instream Use; Sub-directorate: Stream Flow Reduction, Pretoria, South Africa.

Gauteng Department of Agriculture, Conservation and Environment (GDACE), 2005. Gauteng Wetlands Guideline Document. Version 1.4 of 2005. Gauteng Provincial Government.

Kleynkans CJ. 1996. A qualitative procedure for the assessment of the habitat integrity status of the Luvuvhu River (Limpopo System, South Africa) Journal of Aquatic Ecosystem Health 5:41-54.

Kleynhans, C. J. (2007). *Fish Response Assessment Index in River Ecoclasification*

Kleynhans C J, Thirion C and Moolman J A Level I River Ecoregion classification System for South Africa, Lesotho and Swaziland. [Report]. - Pretoria : Department of Water Affaris and Forestry, 2005.

Koester, V. 1989. The Ramsar Convention on the Conservation of Wetlands. Ramsar Convention Bureau. International Union for Conservation of Nature and Natural Resources (IUCN).

Kotze D.C. 1996. How wet is a wetland? WETLAND-USE booklet 2. Share-Net. Umgeni Valley

Kotze, D.C. and Marneweck, G.C. 1999. *Draft guidelines for delineating the boundaries of a wetland and the zones within a wetland in terms of the South African Water Act.* As part of the development of a protocol for determining the Ecological Reserve for Wetlands in terms of the Water Act Resource Protection and Assessment Policy Implementation Process. Department of Water Affairs and Forestry, South Africa

Kotze, D., Marneweck, G. C., Batchelor, A. L., Lindley, D. S., & Collins, N. B. (2005). *WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands.* Free State: Department of Tourism, Environmental and Economic Affairs

Kotze, D., Marneweck, G. C., Batchelor, A. L., Lindley, D. S., & Collins, N. B. (2008). *WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands.* Water Research Commission. WRC Report TT 339/08. Republic of South Africa.

Low, A.B. & Rebelo, A.G. 1998. (Eds.) *Vegetation of South Africa, Lesotho and Swaziland*. Dept. Environmental Affairs and Tourism, Pretoria

Macfarlane, D. M., Kotze, D. C., Ellery, W. N., Walters, D., Koopman, V., Goodman, P., et al. (2008). *WET-Health: a technique for rapidly assessing wetland health. WRC report TT340/08.* South Africa: WRC

Mays, L.W. 1996. Water Resource Handbook. McGraw-Hill. USA.

McMillan PH. 1998. An Invertebrate Habitat Assessment System (IHAS, version 2) for the Rapid Biological Assessment of Rivers and Streams. A CSIR research project, number ENV-P-I 98132 for the Water Resources Management Programme, CSIR. ii + 44pp.

National Environmental Management Act (NEMA) 1998.

National Water Act (Act 36, 1998).

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. K5/1801.* SANBI.

Ollis, D., Snaddon, K., Job, N., Mbona, N. (2013). *Classification System for Wetlands and other Aquatic Ecosystems in South Africa. SANBI Biodiversity Series 22. USER MANUAL: Inland Systems.*

Van Deventer, H. et al., 2019. *National Wetland Map 5 - and improved spatial extent and representation of inland aquatic and estuarine ecosystems in South Africa*. Water SA, 46(1), pp. 66-79.

APPENDIX A


STRUBENS VALLEY EXT. 24
ACCESS POINT
PROPOSED METRO BOULEVARD
CHRISTIAAN DE WET
CHRISTIAAN DE WET ROAD
STRUBENS VALLEY EXT. 25
STRUBENS VALLEY EXT. 8
STRUBENS VALLEY EXT. 18
SOVEREIGN ROAD
HUNTER THERON INC.
TOWN PLANNERS
STRUBENSVALLEI
EXTENSIONS 24 AND 25
PROPOSED ACCESS SPACING
ALONG
METRO BOULEVARD
LdT
FMG
GMH
1:1500
SHEET 1 OF 1
196-68-01
0