Cato Ridge Land Development & Release Project, eThekwini Municipality, KwaZulu-Natal

Wetland & Aquatic Ecosystem Impact Assessment

(Draft Report)

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Eco-Pulse Environmental Consulting Services

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I, **Shaun McNamara**, hereby declare that this report has been prepared independently of any influence or prejudice as may be specified by the relevant environmental authorities (DMRE, DHSWS, DEA).

Signed: ______________________ Date: 21 October 2022

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Details of Specialist Team

The relevant experience of specialist team members involved in the compilation of this report is briefly summarized below. *Curriculum Vitae* of the specialist team are available on request.

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EXECUTIVE SUMMARY

This report sets out the findings of a **Wetland & Aquatic Impact Assessment** to inform the identification of environmental constraints for a proposed Light Industrial development within the Cato Ridge Area, eThekwini Municipality. An assessment of the wetlands, rivers and streams on the property and in adjacent/downstream areas was undertaken by Eco-Pulse Environmental Consulting. The main findings of the impact assessment and planning recommendations have been summarized below.

Catchment Context:

The study area is located within the upper reaches of DWS quaternary catchments U20L, U20J and U60C. The watercourses within the study area comprise seeps, unchanneled valley bottom wetlands, mountain headwater streams, mountain streams and one transitional river, which ultimately feed into the Sterkspruit River (in the case of watercourses located in Quaternary Catchment U60C) and the uMgeni river (for those watercourses located with Quaternary Catchment U20J and U20L) further downstream. There are several minor farm dams along many of the onsite watercourses. Two major water supply dams, namely Inanda Dam and Shongweni Dam are located along the major rivers which drain the study area (i.e., the uMgeni and Sterkspruit, respectively).

Baseline Assessment:

A total of thirty-nine (39) watercourse units were delineated within the study area through a combination of desktop mapping and selective infield sampling. The impact potential screening assessment indicates that a total of nine (9) individual wetland HGM units and ten (10) river/stream units are at risk of being potentially measurably impacted during the construction and operational phases of the proposed development. These watercourse units were taken forward for detailed infield assessment.

The PES of the wetland units assessed ranged from largely modified ('D' category) to moderately modified ('C' category). Streams units IHI categories ranged from 'D' (severely modified) to 'B' (largely natural). EIS ratings for wetland process units ranged from Low to High. High EIS ratings were typically driven by the importance of wetland units in contributing to biodiversity maintenance, as these units are categorised as a critically endangered ecosystem type according to the latest national biodiversity assessment. The most important wetlands were typically in fair condition, with large intact or semi-intact buffer areas that make them important priority areas for meeting regional, provincial, and national ecosystem conservation targets. EIS ratings for stream process units assessed ranged from Low to Moderate. Moderate EIS categories were assigned to those stream units that were moderately modified/largely intact, had moderate to high connectivity to upstream watercourses and retained relatively intact buffer zones. All these factors collectively contribute to the likelihood that these units play an important role in biodiversity maintenance or act as important wildlife corridors.

Impact Significance & DWS Risk Assessment:

Eco-Pulse undertook an impact significance assessment for the proposed project using a methodology provided by Zutari. Overall, under a realistic poor mitigation scenario construction phase impacts for Phase 3 of the project were assessed as being 'Major – Negative'. This is because development Phase 3 encroaches into a large seep wetland (W15 – Figure 9). W15 was assessed as being in the C PES category but is of High ecological importance and sensitivity. The total area of wetland impacted by the encroachment is approximately 3.12ha. Under a realistic poor mitigation scenario construction phase impacts for Phases 1 and 2 were assessed as being 'Minor – Negative'. Under a realistic good mitigation scenario, the construction significance of each phase of the proposed project is 'Minor – Negative'. This is however contingent on direct physical impacts to W15 being avoided during Phase 3 of the development. The key operation phase concern is stormwater management and the potential alteration of watercourse hydrological and geomorphological processes, and the discharge of treated wastewater into the environment from the proposed package sewerage treatment plant and the potential impacts on surface water quality. Under a realistic poor mitigation scenario these impacts are considered 'Moderate – Negative' for each project phase. The significance of these impacts can however be reduced to 'Minor – Negative' under a realistic good mitigation scenario. Mitigation to reduced operational phase impact significance should focus on adhering to recommended watercourse buffer zones, wetland rehabilitation and operation phase management, stormwater management design, and the design of the proposed onsite sewage package treatment plant.

Eco-Pulse also undertook a DWS Risk Assessment to inform the water use licencing requirements for the project. Whilst some risks associated with proposed project can be managed to 'low' overall levels through mitigation, the overall project risk is still likely to remain at least a 'moderate'. This suggests that the project cannot be generally authorised under the GA for Section 21 c and i water uses. Therefore, a full WULA is likely to be required. Additionally, General Notice (GN) 509. GN 509, published in Government Gazette (GG) no. 40229 under Section 39 of the National Water Act (Act no. 36 of 1998) in August 2016, allows for Section 21 (c) and (i) water uses to be generally authorised if risks and be reduced to acceptable level, there is however no GA notice for the remaining Section 21 water uses. This project, including the proposed wetland rehabilitation measures, will trigger several waters uses beyond (c) and (i), and will require a full WULA on that basis, also.

Key Planning & Design Measures:

Watercourse Buffer Zone Recommendations:

The buffer model by Macfarlane and Bredin (2016) produces an output for two scenarios based on potential risks associated with the proposed project type, in conjunction with the sensitivity of wetlands and rivers. These two scenarios are (i) without specific mitigation, and (ii) with specific impact/risk mitigation. The tool was used to produce preliminary buffer zone recommendations for watercourses delineated and assessed within the study area.

The results of the buffer tool assessment for this land-use option are presented in Table A below

Table A: Summary of the outcomes of the buffer model (Macfarlane and Bredin, 2016) as it applies to the mixed-use medium impact land-use scenario.

Watercourse Type	Project Phase	Recommended Buffer Width	
		Mitigation	
		Without	With
Rivers/ Streams	Construction	33 m	33 m
	Operation	29 m	29 m
	Final	**33 m**	**33 m**
Wetlands	Construction	31 m	31 m
	Operation	26 m	26 m
	Final	**31 m**	**31 m**

Wetland Rehabilitation and Management:

Wetlands have been highly degraded, particularly in response to sand mining and artificial drainage activities which have compromised their conservation and functional values. Opportunities for rehabilitating and managing wetlands should be investigated as part of the development planning process. This is especially pertinent in instances where aspects of the proposed development could exacerbate existing wetland impacts and result in further degradation of onsite wetlands. For example, the release of effluent and stormwater into wetlands associated with erosion channels or drains could aggravate existing erosion issues. It is also noted that wetlands occur within proposed on-site offset areas, and as such, there is a strong motivation to ensure that conservation values are enhanced.

To help guide wetland rehabilitation and management efforts Eco-Pulse have highlighted key impacts to wetlands associated with the study area and have given an indication of the nature of rehabilitation and management efforts required to prevent further degradation of these watercourses during the development operational phase (Table B). This table should be used to guide further investigations into wetland rehabilitation and management opportunities. Ultimately a wetland rehabilitation and management plan should be compiled for the prosed development.

Table B. Recommended rehabilitation and management efforts for wetlands within the study area

Wetland unit	Priority for rehab efforts	Reason for priority rating	Recommended rehabilitation and management efforts
W01	Low	Limited notable impacts that are likely to worsen during the operational phase of the proposed development.	• Ongoing IAP clearing.

W07	Low	Limited notable impacts that are likely to worsen during the operational phase of the proposed development.	• Ongoing IAP clearing.
W11	Medium	Notable IAP pressure that is likely to worsen rapidly/	• Ongoing IAP clearing.
W12	High	Wetland set to receive stormwater and package treatment plant inputs. This could worsen erosion along the existing incised central drain. Without rehabilitation the effluent discharged into this unit will enter the existing drain and quickly flow downstream without receiving any secondary treatment known to be associated with well vegetated wetlands characterised by diffuse flow. The likelihood of the package sewerage treatment plant affecting the water quality of the wetland and watercourses downstream of the wetland is therefore significantly higher if no onsite rehabilitation takes place.	• Structural interventions at strategic locations along the existing drainage channel to promote diffuse flow along the wetland. • Ongoing IAP clearing.
W14	High	The lower reaches of this wetland have experienced notable disturbance due to sand mining activity. The poorly vegetated and unnaturally steepened nature of the wetland in its current state leaves the unit susceptible to notable erosion impacts due to additional stormwater flows into the watercourse during the development operational phase.	• Shaping and revegetation of highly disturbed wetland areas. • Ongoing IAP clearing.
W15	Medium	Notable IAP pressure that is likely to worsen rapidly/	• Ongoing IAP clearing.
W23	Medium	Notable IAP pressure that is likely to worsen rapidly/	• Ongoing IAP clearing.
W24	Medium	Notable IAP pressure that is likely to worsen rapidly/	• Ongoing IAP clearing.
W42	Medium	Notable IAP pressure that is likely to worsen rapidly/	• Ongoing IAP clearing.

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1. INTRODUCTION

1.1 Project Background and Locality

Cato Ridge Development Company (CRDC) appointed Zutari (Pty) Ltd (Zutari) to provide environmental advisory services for the proposed Cato Ridge Land Development & release Project within the eThekwini Municipality 'Outer West' region in KwaZulu-Natal (Figure 1). The project area is north of the N2 highway between the cities of Pietermaritzburg and Durban.

During the project pre-feasibility study (PFS) phase, Eco-Pulse was appointed to undertake rapid infield delineations and a baseline assessment for freshwater ecosystems within the study area (Eco-Pulse, 2021). Based on the PFS conducted, light industry, general industry, warehousing, and logistics land uses are the most viable land use options from a market perspective. A preliminary development footprint was provided to Eco-Pulse (Annexure B). In November 2021 Eco-Pulse delivered a draft Wetland and Aquatic Ecosystem Impact Assessment report for the preliminary layout. This and other ecological specialist reports, and discussion with KZN Department of Economic Development, Tourism and Environmental Affairs (EDTEA) were used to refine the development layout to avoid sensitive areas as far as practically possible. On 27th September 2022 Eco-Pulse were provided with a final refined development layout (Figure 2) and asked to complete a Wetland and Aquatic Ecosystem Impact Assessment to inform the environmental authorization processes.

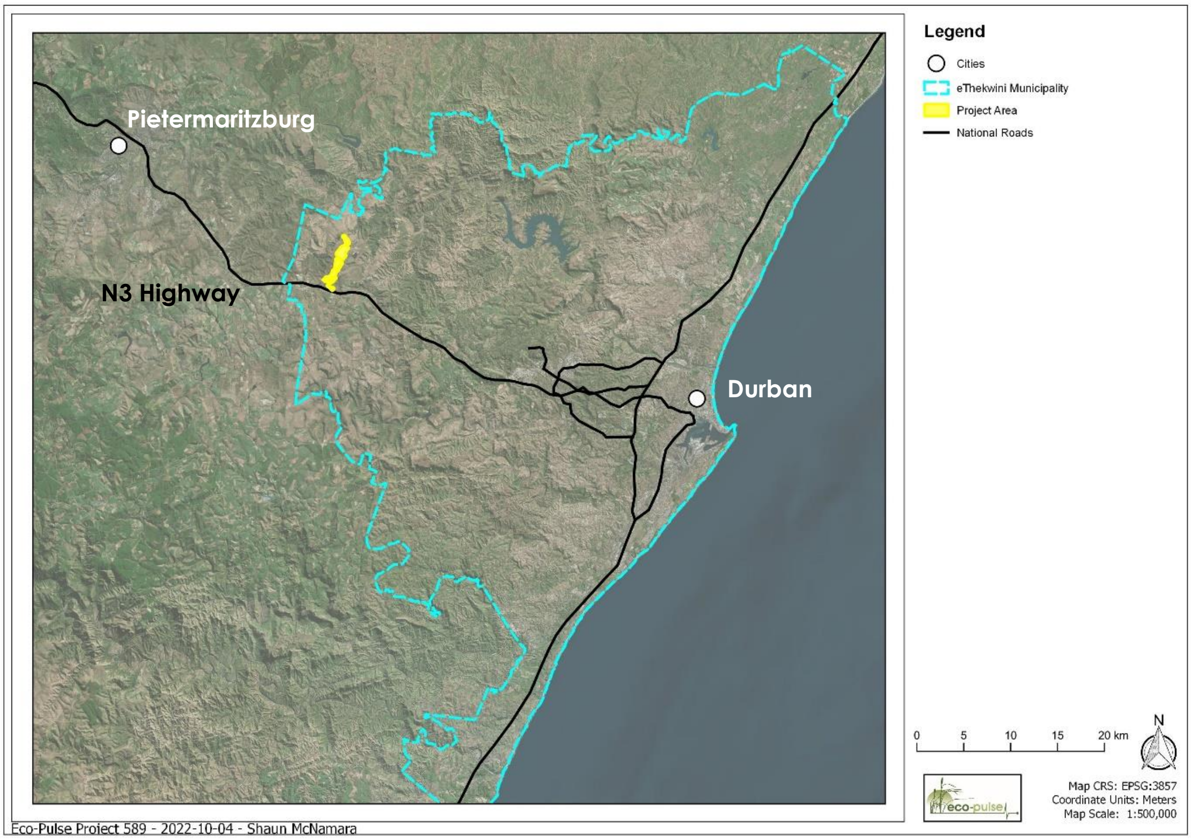

Figure 1. Location of the proposed Cato Ridge Land Development & Release Project.

1.2 Project Description

The development is set to consist of mixed light industry, general industry, warehousing, and logistics land uses. The proposed development and land release project has been phased in line with bulk services provisioning over a 25-year period as follows:

- Phase 1: 1 -10 Years
- Phase 2: 11 -20 Years
- Phase 3: 21 - 25 Years

Total Footprint for the project is 358.4 ha divided between the three phases as follows:

- Phase 1: 138 ha
- Phase 2: 177 ha
- Phase 3: 49 ha

An onsite sewerage package plant will be established at the intersection of the R103 and Eddie Hagen (within the Phase 1 area). The plant will be used to treat waste water for all proposed development phases. The plant will have a treatment capacity of approximately 2 Mℓ / day. The effluent will be discharged in the environment via a pipeline, leading from Portion 50, across the R103, into the North eastern corner of Phase 3. To service the sewerage requirements for Phases 2 and 3, a collection sump and pumpstation will be required in each of these project areas. These pumpstations will deliver effluent to the package plant.

To meet the water requirements for the development, eThekwini Metro will need to construct a 38Mℓ above ground reservoir within the central parts of Phase 2 development area. This reservoir will be subject to its own environmental authorisation process and has not been addressed in this assessment report. Although most of the development will be serviced by underground powerlines, a small section of above ground powerlines will be required along the northern border of Phase 1 development area. Stormwater management will be completed per site, with the required infrastructure.

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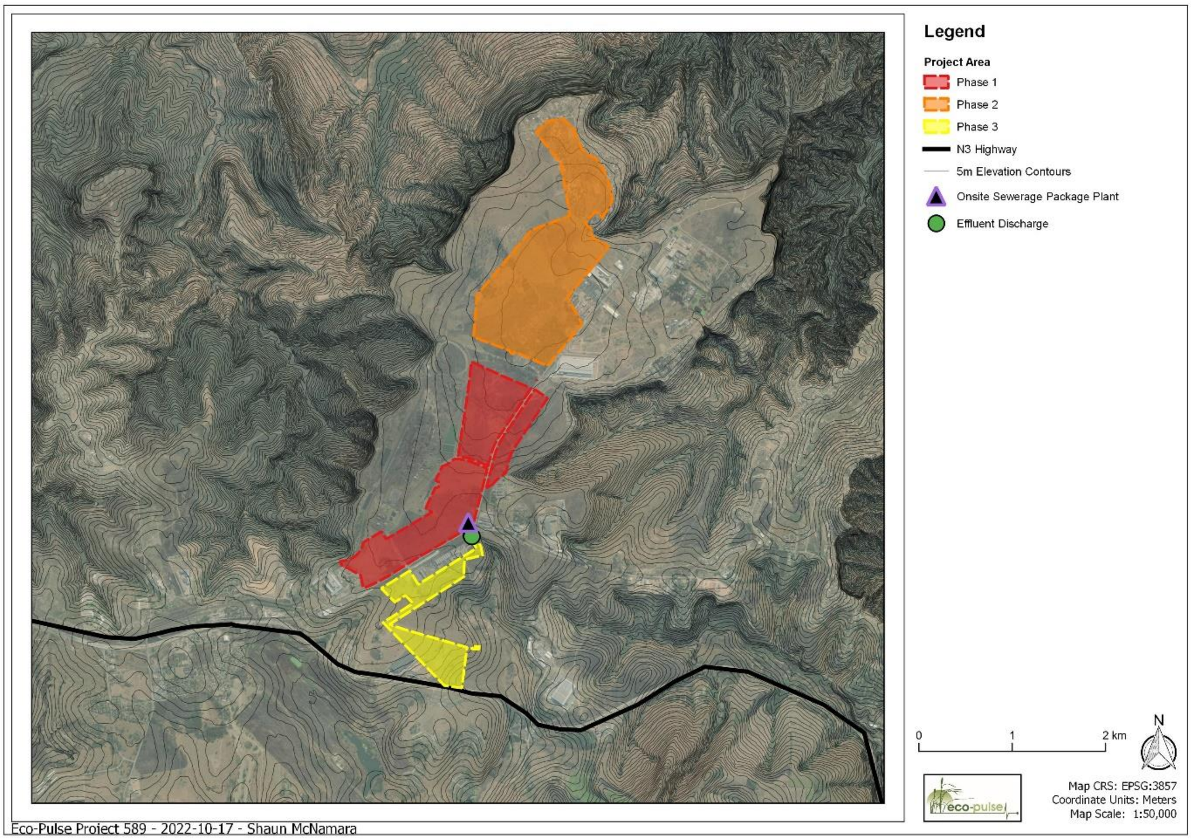

Figure 2. Cato Ridge Land Development & Release layout, including phasing.

1.3 Scope of Work

This wetland and aquatic ecosystem impact assessment which is an update and refinement of the initial Wetland & Aquatic Ecosystem Impact Assessment was undertaken according to the following scope of work:

1. A detailed contextualization of the study area in terms of important biophysical characteristics and conservation planning.
2. A desktop 'impact likelihood assessment' based on the development footprints provided to Eco-Pulse upon appointment, to identify watercourses mapped within the 500 m area surrounding the development (DWS regulated area for Section 21 c and i water use') which are likely to be measurably affected by the proposed development activities. This constitutes the study area for this updated baseline assessment and the impact assessment to follow.
3. Site visits were conducted using the following sampling procedures and assessment measures for watercourses in the study area:
   - Detailed infield delineation of the freshwater ecosystem (wetlands and rivers) to be measurably affected by the proposed development activities (according to the development footprint provided at the time of the assessment).

        - All delineations were undertaken according to the methods contained in the manual 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005).
        - Parts of the study area which are densely vegetated and extremely steep and proved to be inaccessible were assessed at a desktop level due to access constraints.
    - Delineated watercourses were sub-divided into hydrogeomorphic (HGM) and/or assessment unit groups based on onsite sampling.
    - Key biophysical characteristics of the delineated watercourses were recorded based on onsite observations and soil sampling (i.e., soils, plant communities, general hydrology, and morphology).
    - An update and refinement of the present ecological state (PES) assessments (from the previous assessment) of the delineated watercourse units in the study area using the following assessment tools:
        - Rivers - Qualitative Index of Habitat Integrity (Q-IHI) (Kleynhans, 1996)
        - Wetlands – Level 1a/b WET-Health assessment tool (Macfarlane et al., 2020).
    - An update and refinement (from the previous assessment) of the assessment of the supply, demand and importance of the direct and indirect ecosystem services provided by wetland units using an updated version of the Level 2 WET-EcoServices tool (Kotze et al., 2020).
    - An update and refinement (from the previous assessment) of the Ecological Importance and Sensitivity (EIS) ratings of the delineated watercourse units using the river and wetland EIS assessment tools developed by Eco-Pulse (2021) adapted from the DWAF Resource Directed Measures River and Wetland EIS tools (Kleynhans, 1999; Duthie, 1999), and based on guidance provided in the WET-EcoServices technical document (Kotze et al., 2020).
    - Determination of the Recommended Ecological Category (REC) and recommended management objectives for the assessed watercourses using the updated PES & EIS assessments.
4. Description and assessment of the significance of wetland and aquatic impacts (construction and operation).
5. Identification of broad cumulative impacts to wetland and aquatic resources in the region.
6. Application of the "DWS Risk Assessment Matrix" at a project level, as detailed in the General Authorization in terms of Section 39 of the National Water Act No. 36 of 1998 for Water Uses as defined in Section 21 I or Section 21 (i), as contained in Government Gazette No. 40229, 26 August 2016 and contained within the DWS document titled 'Section 21I and (i) Risk-based assessment and authorization, October 2014, Edition 2' to inform water licensing requirements for the project (i.e. full WULA vs GA).
7. Provision of planning and project design recommendations, including wetland and aquatic buffer zones at a broad desktop level using national guidelines (Macfarlane & Bredin, 2016).

8. Provision of impact and risk mitigation measures and management recommendations for the various project phases.
9. Identification of assumptions, limitations, and information gaps.
10. Scientific Reporting: Compilation of a single combined Specialist Wetland & Aquatic Assessment Report including all relevant maps and supporting information.

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2. APPROACH AND METHODS

2.1 Assessment Methods

2.1.1 Data Sources Consulted

The data and GIS spatial information listed in Table 1 were consulted to inform aspects of this assessment. The data type, relevance to the project and source of the information has been provided.

Table 1. Data sources and GIS information consulted as part of the assessment.

DATA/COVERAGE TYPE	RELEVANCE	SOURCE
Biophysical Context		
Colour Aerial Photography	*Desktop mapping of drainage network, wetlands, etc.*	NGI (online)
5m Elevation Contours	*Desktop mapping of drainage network, wetlands, etc.*	NGI (online)
Latest Google Earth ™ imagery	*To supplement available aerial photography where needed*	Google Earth™ (online)
DWA Eco-regions (GIS Coverage)	*Classification of local Ecoregions*	DWA (2005)
South African Vegetation Map (GIS Coverage)	*Classify vegetation types and determination of reference primary vegetation*	Mucina and Rutherford (2006)
NFEPA: river and wetland inventories (GIS Coverage)	*Highlight potential onsite and local rivers and wetlands*	WRC (2011)
Conservation Context		
Inland Aquatic (Freshwater) Realm of the 2018 SANBI National Biodiversity Assessment (GIS Coverage)	*Provides insight into the national conservation planning status of watercourses in the study area*	Van Deventer et al. (2019)
NFEPA: River, wetland, and estuarine FEPAs (GIS Coverage)	*Shows location of national aquatic ecosystems conservation priorities*	WRC (2011)
KZN Aquatic Conservation Plan (GIS Coverage)	*Provincial conservation planning importance of aquatic and terrestrial resources.*	(EKZNW, 2007)

2.1.2 Desktop Watercourse Mapping and Classification

The desktop delineation of all watercourses (rivers / riparian zones and wetlands) within 500 m of the full extent of the study area was undertaken by analysing available 5 m digital elevation contours and colour aerial photography. Digitization and mapping were undertaken using QGIS 2.10 GIS software. All mapped watercourses were then classified in terms of their HGM type (in the case of wetland units) or longitudinal zonation (in the case of river/stream units) in accordance with the national wetland and river classification system defined by Ollis et al. (2013). Desktop watercourse delineations and classifications were refined following infield sampling.

2.1.3 'Likelihood of Impact' Screening Assessment

Following the desktop identification and mapping exercise, watercourses were assigned preliminary 'likelihood of impact' ratings based on the likelihood that activities associated with the proposed development will result in measurable direct or indirect changes to the mapped watercourse units within 500 m of the proposed development. The 'likelihood of impact' ratings were refined following the completion of the field work. Each watercourse unit was ascribed a qualitative rating according to the ratings and descriptions provided in Table 2 below.

Table 2. Qualitative 'likelihood of impact' ratings and descriptions.

Likelihood of Impact Rating	Description of Rating Guidelines
Likely	These resources are likely to require impact assessment and a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located **within the footprint** of the proposed development activity and will definitely be impacted by the project; and/or ➢ resources located **within 15 m upstream and/or upslope** of the proposed development activity and trigger requirements for Environmental Authorisation according to the NEMA: EIA regulations; and/or ➢ resources located **within 15 m or downslope** of the development and trigger requirements for Environmental Authorisation according to the NEMA: EIA regulations; and/or ➢ resources located downstream within the following parameters: o **within 15 m downstream** of a low risk development; o **within 50 m downstream** of a moderate risk development; and/or o **within 100 m downstream** of a high risk development e.g. mining, large industrial land uses.
Possible	These resources may require impact assessment and a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located **within 32 m but greater than 15 m upstream, upslope or downslope** of the proposed development; and/or ➢ resources located within a range at which they are likely to incur indirect impacts associated with the development (such as water pollution, sedimentation and erosion) based on development land use intensity and development area. This generally relates to resources located downstream within the following parameters: o **within 32 m downstream** of a low risk development; o **within 100 m downstream** of a moderate risk development; and/or o **within 500 m downstream** of a high risk development (note that the extent of the affected area downstream could be greater than 500 m for high risk developments or developments that have extensive water quality and flow impacts e.g. dams/abstraction and treatment plants);
Unlikely	These resources are unlikely to require impact assessment or Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located a distance upstream, upslope or downslope (> 32 m) of the proposed development and which are unlikely to be impacted by the development project; and/or ➢ resources located downstream but well beyond the range at which they are likely to incur impacts associated with the development (such as water pollution, sedimentation and erosion). This is generally resources located downstream within the following parameters: o **greater than 32 m downstream** of a low risk development; o **greater than 100 m downstream** of a moderate risk development; and/or o **greater than 500 m downstream** of a high risk development (note that the extent of the affected area downstream could be greater than 500 m for high risk developments or developments that have extensive water quality and flow impacts e.g. dams/abstraction and treatment plants);
None	These resources will not require impact assessment or a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located within another adjacent sub-catchment and which will not be impacted by the development in any way, shape or form.

2.1.4 Infield Watercourse Delineations

The infield watercourse delineation focused on watercourse units rated as 'Likely' or 'Possible' in terms of 'likelihood of impact' as per Table 2. Over the course of five (5) days, Eco-Pulse undertook a formal sampling process for selected desktop mapped watercourses with sampling being conducted according to the methods outlined in the South African national delineation guideline manual (A Practical Field Procedure for Identification and Delineation of Wetlands and Riparian Areas) (DWAF, 2005). Sampling was undertaken systematically across selected desktop mapped watercourses with the following wetland/watercourse indicator information being captured at each sample site.

- **Terrain unit indicator** – The location of the sample point in the landscape was recorded based on visual observations i.e., valley bottom, foot slope etc.
- **Soil wetness indicator** – The texture, colour, and presence/absence of redoximorphic features[1] within the top 50cm of the soil profile was sampled and recorded using a Dutch (clay) auger. Texture was recorded based on feel and professional experience, soil matrix colour was recorded in terms of hue[2], value[3] and chroma[4] using a Munsell Soil Colour Chart[5] and the degree of mottling[6] was recorded qualitatively in terms of colour, size and abundance based on visual observation.
- **Vegetation indicator** – The presence and relative abundance of facultative (wet) and obligate hydrophilic vegetation species was recorded.

Following onsite sampling and investigations, the desktop watercourse delineations were refined, and their classifications adjusted based on the collected infield data. This refinement process included a data extrapolation process for watercourses that were not visited and sampled during the fieldwork exercise. A large portion of the study area, located immediately west of the Assmang plant, is extremely steep and heavily vegetated. This area of the study site was not visited during field visits (except for the main collecting river – R05 on which a more detailed assessment was conducted). Watercourses in this portion of the study area, are primarily steep streams and rivers. These watercourse units were only delineated at a desktop level and appear as linear features on all watercourse maps (Refer to Annexure A – Figure 17 and 18, for further detail on sampling intensity across the study area).

[1] Colour patterns within soil formed by the oxidation/reduction of iron and/or manganese
2 The dominant spectral colour
3 The lightness of colour of a soil
4 The relative purity of the spectral soil colour, which decreases with increasing greyness.
5 A standardised colour chart which can be used to describe hue, value and chroma.
6 Soils with variegated colour patterns are described as being mottled with the background soil colour being referred to as the 'matrix' and the spots of colour being referred to as 'mottles' (DWAF, 2005)

2.1.5 Baseline Watercourse Assessment and Process Unit Approach

The baseline habitat assessment focused on watercourse units rated as 'Likely' or 'Possible' in terms of 'likelihood of impact' as per Table 2 above. These watercourses formed the primary focus of the baseline assessment. Given the extent and the numerous watercourses associated with the study area (> 120 watercourses were mapped), it was not feasible to conduct baseline assessments on each watercourse unit. Instead, a 'Process Unit' based approach was adopted for this project.

'Process Unit' in this context refers to <u>wetlands or rivers/streams of the same general type</u> in terms of their HGM/zonation classification, impacts to ecosystem health, dominant hydrological and geomorphological processes, and ecological functions. Using a 'Process Unit' type approach can be particularly useful when required to assess numerous watercourses at a rapid and efficient level and where conditions allow for similar wetlands/rivers to be grouped to make the baseline assessment of PES/EIS more efficient.

This approach involved assigning each of the mapped watercourses to a 'Process Unit' group according to the following criteria:

- Wetland HGM type
- River longitudinal zonation
- Watercourse and catchment biophysical characteristics (i.e., size, slope, vegetation cover)
- Level of watercourse and catchment disturbance/impact

The general biophysical characteristics of all Process Unit groups in the greater study area (all 3 Proposed Development Areas) were summarised and described as part of the baseline assessment. All Process Unit groups associated with watercourses on the property were taken forward for desktop PES and EIS assessments.
The assessments undertaken as part of the baseline study are listed in Table 3, along with the relevant published guidelines and assessment tools/methods/protocols utilised.

Table 3. Summary of methods used in the baseline assessment.

	Method/Technique	Reference for Methods/Tools Used
Rivers/Streams	**Present Ecological State (PES)**	Index of Habitat Integrity (IHI) (after Kleynhans, 1996).
	Riparian Ecological Importance and Sensitivity (EIS)	Aquatic EIS tool (Eco-Pulse, 2017)
Wetlands	**Present Ecological State (PES)**	Level 1B WET-Health assessment (Macfarlane *et al.*, 2020).
	Functional Importance (Eco-services assessment)	WET-EcoServices assessment (Kotze *et al.*, 2020).
	Wetland Ecological Importance and Sensitivity (EIS)	Wetland EI was informed by the outcomes of the WET-EcoServices assessment. ES was assessed by rating key sensitivity indicators. EI and ES scores were then combined in a structured manner and a final EIS score was assigned to each process unit group based on the schematic

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Method/Technique		Reference for Methods/Tools Used
		diagram and matrix presented below (Figure 3), which are extracted from the WET-EcoServices technical manual WET-EcoServices assessment (Kotze *et al.*, 2020).

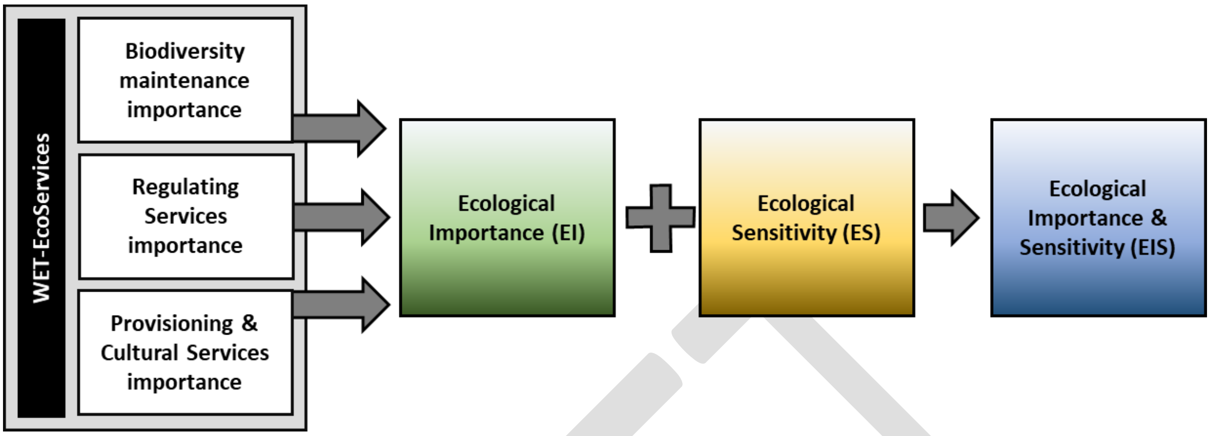

Figure 3. Schematic diagram of the recommended Wetland EIS framework, as presented in the WET-EcoServices technical manual (Kotze et al., 2020).

Table 4. Table for integrating EI and ES into a composite EIS score, as presented in the WET-EcoServices technical manual (Kotze et al., 2020).

		Ecological Importance (EI)				
		Very Low	Low	Moderate	High	Very High
Ecological Sensitivity (ES)		0	1	2	3	4
Very Low	0	0.00 Low	0.00	1.00	2.00	3.00
Low	1	0.00	0.50	1.50	2.50	3.50
Moderate	2	0.00	1.00	2.00	3.00	4.00
High	3	0.50	1.50	2.50	3.50	4.00
Very High	4	1.00	2.00	3.00	4.00	4.00

2.1.6 Impact Assessment Framework and Methodology

The impact assessment for this project was completed separately for each development phase (Phases 1, 2, and 3). The significance of the potential impacts of the proposed development on freshwater ecosystems was assessed for the following scenarios:

- **Realistic "poor mitigation" scenario** – this is a realistic worst-case scenario involving the poor implementation of construction mitigation, bare minimum incorporation of recommended design mitigation, poor operational maintenance, and poor onsite rehabilitation.
- **Realistic "good mitigation" scenario** – this is a realistic best-case scenario involving the effective implementation of construction mitigation, incorporation of the majority of design mitigation, good operational maintenance and successful rehabilitation. Please note that this realistic

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scenario does not assume that unrealistic mitigation measures will be implemented and/or measures known to have poor implementation success (>90% of the time) will be effectively implemented.

The general approach to impact significance assessment is to identify the ultimate ecological consequences associated with each impact type (group) and then rate intensity as the realistic worst-case consequence (end point) of an activity. The four ultimate ecological consequences considered by Eco-Pulse in this assessment are:

1. **Water resource management:** The inter-connected nature of water resources is emphasised here by recognising that an impact at a site will ultimately affect downstream users and the ability to meet user requirements. An understanding of the catchment context, with emphasis on the existing use of and reliance on water resources by downstream communities is therefore required. Key concerns therefore relate to any direct impacts on water quantity and quality together with habitat-related impacts that could exacerbate downstream impacts by undermining the ability of wetlands and riparian areas to attenuate floods, trap sediments and assimilate pollutants (regulating & supporting services).
2. **Ecosystem conservation:** The focus here is specifically on understanding the significance of impacts in relation to the ability to meet habitat conservation targets. This is informed by an understanding of conservation significance that is influenced by factors such as the ecosystem threat status, regional conservation context, condition of habitat, and connectivity to other intact habitats.
3. **Species conservation:** The focus here is specifically on species of special or notable conservation importance or concern, including Red Data Book or Red List taxa in threatened or conservation concern categories, Threatened or Protected Species listed under the National Environmental Management: Biodiversity Act, endemic taxa, locally threatened taxa and/ or any particular taxa of special management concern. Includes both fauna and flora.
4. **Direct use values:** The emphasis here is specifically on understanding and assessing the social impacts of the development based on an understanding of the impacts on provisioning (water supply, harvestable natural resources, cultivated foods or food for livestock) and cultural services available to local communities. This assessment is therefore based on an understanding of the current importance of water resources for local users and supporting local livelihoods, including religious ceremonies, tourism & recreation, or educational activities.

Zutari Standardised Method of Assessing the Significance of Potential Environmental Impacts

Zutari prescribed a standard impact significance assessment method for use in this project. This methodology is outlines below.

For each predicted impact, criteria are applied to establish the significance of the impact based on likelihood and consequence, both without mitigation being applied (pre-mitigation) and with the implementation of the recommended mitigation measure(s) (post-mitigation). The criteria that contribute to the consequence of the impact are:

- Intensity (the degree to which pre-development conditions are changed), which also includes the type of impact (being either a positive or negative impact);
- Duration (length of time that the impact will continue);
- Extent (spatial scale) of the impact.
- The sensitivity of the receiving environment and/or sensitive receptors are incorporated into the consideration of consequence by appropriately adjusting the thresholds or scales of the intensity, duration and extent criteria based on expert knowledge.

For each impact, the specialist applies professional judgement to ascribe a numerical rating for each criterion according to the guidance provided in Table 5, Table 6, and Table 7 below. The consequence is then established using the formula:

Consequence = type x (intensity + duration + extent)

Depending on the numerical result, the impact's consequence would be extremely highly, moderately, or slightly detrimental, or neutral, or slightly, moderately, highly, or extremely beneficial. These categories are provided in Table 9.

To determine the significance of an impact, the probability (or likelihood) of that impact occurring is also considered. In assigning probability, the specialist considers the likelihood of occurrence and takes cognisance of uncertainty and detectability of the impact. The most suitable numerical rating for probability is selected from Table 8 below and applied with the consequence according to the following equation:

Significance = consequence x probability

Depending on the numerical result of this calculation, the impact would fall into a significance category of negligible, minor, moderate, or major, and the type would be either positive or negative. These categories are provided in Table 10.

Once the significance of an impact occurring without mitigation has been established, the specialist must apply their professional judgement to assign ratings for the same impact after the proposed mitigation has been implemented.

Table 5. Definition of Intensity ratings

Rating	Criteria	
	Negative Impact (Type of impact = -1)	**Positive Impact (Type of impact = +1)**
7	Complete destruction (irreversible and irreplaceable loss) of natural or social systems, resources (e.g. species) and human health. No chance of these processes or resources ever being restored to their pre-impact condition.	Noticeable, sustainable benefits that improve the quality and extent of natural or social systems or resources, including formal protection.
6	Very high degree of damage to natural or social systems or resources. These processes or resources may restore to their pre-project condition over very long periods of time (more than a typical human lifetime).	Great improvement to ecosystem or social processes and services or resources.
5	Serious damage to components of natural or social systems or resources and the contravention of legislated standards.	Ongoing and widespread benefits to natural or social systems or resources.
4	High degree damage to natural or social system components, species or resources.	Average to intense positive benefits for natural or social systems or resources.
3	Moderate damage to natural or social system components, species or resources.	Average, ongoing positive benefits for natural or social systems or resources.
2	Minor damage to natural or social system components, species or resources. Likely to recover over time. Ecosystems and valuable social processes are not affected.	Low positive impacts on natural or social systems or resources.
1	Negligible damage to individual components of natural or social systems or resources, such that it is hardly noticeable.	Limited low-level benefits to natural or social systems or resources.

Table 6. Definition of Duration ratings

Rating	Criteria
7	**Permanent:** The impact will remain indefinitely.
6	**Beyond project life**: The impact will remain for some time after the life of the project.
5	**Project life:** The impact will cease after the operational life span of the project
4	**Long-term**: The impact will continue for 6-15 years.
3	**Medium-term:** The impact will continue for 2-5 years.
2	**Short-term:** The impact will continue for between 1 month and 2 years.
1	**Immediate**: The impact will continue for less than 1 month.

Table 7. Definition of Extent ratings

Rating	Criteria
7	**International:** The effect will occur across international borders.
6	**National:** The impact will affect the entire country.
5	**Province/ Region:** The impact will affect the entire province or region
4	**Municipal Area:** The impact will affect the whole municipal area.
3	**Local:** The impact will extend across the study area and the LAP area.
2	**Limited:** The impact will be limited to the study area.
1	**Very limited:** The impact will be limited to the footprint of the development and will not extend to the boundaries of the study area.

Table 8. Definition of probability ratings

Rating	Criteria
7	**Certain/ Definite:** There are sound scientific reasons to expect that the impact will definitely occur.
6	**Almost certain/Highly probable:** It is most likely that the impact will occur.
5	**Likely:** This impact has occurred numerous times here or elsewhere in a similar environment and with a similar type of development and could very conceivably occur.
4	**Probable:** This impact has occurred here or elsewhere in a similar environment and with a similar type of development and could conceivably occur.
3	**Unlikely:** This impact has not happened yet but could happen.
2	**Rare/ improbable:** The impact is conceivable, but only in extreme circumstances. The possibility of the impact manifesting is very low due to the design, experience or implementation of adequate mitigation measures
1	**Highly unlikely/None:** The impact is expected never to happen or has a very low chance of occurring.

Table 9. Application of consequence ratings

Range		Significance rating
-21	-18	Extremely detrimental
-17	-14	Highly detrimental
-13	-10	Moderately detrimental
-9	-6	Slightly detrimental
-5	5	Negligible
6	9	Slightly beneficial
10	13	Moderately beneficial
14	17	Highly beneficial
18	21	Extremely beneficial

Table 10. Application of significance ratings

Range		Significance rating
-147	-109	Major - negative
-108	-73	Moderate - negative
-72	-36	Minor - negative
-35	-1	Negligible - negative
0	0	Neutral
1	35	Negligible - positive
36	72	Minor - positive
73	108	Moderate - positive
109	147	Major - positive

Table 11. Definition of Confidence ratings

Rating	Criteria
Low	Judgement is based on intuition, and some major assumptions are used to assess the impact that may prove untrue.
Medium	Determination is based on common sense and general knowledge. The assumptions made, whilst having a degree of uncertainty, are fairly robust.
High	Substantive supportive data or evidence exists to verify the assessment.

2.2 Assumptions, Limitations, and Information Gaps

The following limitations and assumptions apply to this assessment:

2.2.1 General assumptions and limitations

- This report deals exclusively with a defined area and the extent and nature of wetland and aquatic habitat and ecosystems in that area.
- Additional information used to inform the assessment was limited to desktop data and GIS coverages available for the province at the time of the assessment.
- All field assessments were limited to day-time assessments.

2.2.2 Sampling limitations and assumptions

- Due to time and access constraints, not all watercourse units were visited and sampled during the field investigations.
- Watercourses that were visited during field investigations were not uniformly or intensively sampled, either due to time constraints or access constraints. Refer to **'Annexure A: Maps Showing Field Sample Locations'** for an indication of sampling intensity across the study area.
- The outer boundary of the riparian and wetland zones identified can be considered accurate in the vicinity of visited and sampled locations. Between transects, the outer boundary had to be extrapolated using aerial photography and 5m elevation contours and, as such, the accuracy of such extrapolated sections has limitations and is open to the interpretation of the delineator.

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- A Soil Munsell Colour Chart was used to determine the soil matrix colour of the soil sampled. However, it is important to note that the recording of the colours using the soil chart is subjective and varies somewhat depending on soil moisture and the prevailing light conditions. In this case, soils sampled were both moist and dry and sampling was undertaken in sunny and partly cloudy conditions.
- Soil wetness indicators (i.e. soil mottles, grey soil matrix), which in practice are primary indicators of hydromorphic soils, are not seasonally dependent (wetness indicators are retained in the soil for many years) and therefore seasonality does not influence the delineation of wetland areas.
- The accuracy of the delineations is based solely on the recording of the onsite wetland and riparian indicators using a GPS. GPS accuracy will therefore influence the accuracy of the mapped sampling points and therefore water resource boundaries, and an error of 1-5 m can be expected. All soil/vegetation/terrain sampling points were recorded using a Garmin Montana™ Global Positioning System (GPS) and captured using Geographical Information Systems (GIS) for further processing.
- All vegetation information recorded was based on the onsite visual observations of the author and no formal vegetation sampling was undertaken. Furthermore, only dominant, and noteworthy plant species were recorded. Thus, the vegetation information provided has limitations for true botanical applications.
- Although every effort was made to correctly identify the plant species encountered onsite, wetland plants, particularly the *Cyperaceae* (sedge) family, are notoriously difficult to identify to species level. Every effort was made to accurately identify plants species, but where identification to species level could not be determined, such species were only identified to genus level.
- With ecology being dynamic and complex, there is a likelihood that some aspects (some of which may be important) may have been overlooked.
- While disturbance and transformation of habitats can lead to shifts in the type and extent of freshwater ecosystems, the report reflects the current extent and classification.

2.2.3 Site-specific limitations and assumptions

- Given the high degree of land transformation that has taken place i.e., infilling for development, sand mining, dam construction, vegetation clearing, and historical drains it is possible that areas of wetland may have been overlooked (due to lack of evidence in terms of soil, terrain unit and vegetation indicators available in some places e.g., large berms where wetland soils have been buried by fill and where wetland vegetation is no longer evident).
- A large portion of the study area, located immediately west of the Assmang plant, is extremely steep and heavily vegetated. This area of the study site was not visited during the field visit. Watercourses in this portion of the study area are primarily steep streams and rivers. These watercourse units were therefore only delineated at a desktop level and appear as line features on all watercourse maps.
- Vegetation indicators were often not useful in determining the edge of watercourse units given the high degree of transformation and alien plant invasion which means that soil and terrain unit indicators were relied upon to estimate the edge of the wetland.
- Large portions of the site are underlain by Natal Group Sandstone (which has strong groundwater-surface water linkages) and the remainder of the site is underlain primarily by Dwyka Tillite. Interpretations of soil indicators were occasionally difficult, as the presence of very faint mottling in

the Dwyka Tillite context, and the occasional absence of distinct mottling in the Natal Group Sandstone context made it difficult to determine whether an area is temporarily saturated or considered to be dryland/terrestrial.

2.2.4 'Seasonality' of the Assessment

Eco-Pulse undertook an infield watercourse delineation in November 2021 (summer) to supplement sampling undertaken previously in December 2020 and February 2021 (summer), during the study region's rainy season. The infield visits (5 days in total) conducted during the summer season do not fully cover the seasonal variation in conditions at the site. Seasonality may be a key factor for certain wetlands in the target study area surveyed that still retain some level of integrity and diversity. For these units, an interrogation of the terrestrial ecosystems report would be recommended to indicate whether sufficient vegetation sampling has been undertaken or whether further sampling is required. However, for the most part in the remainder of the wetland units assessed, no further seasonal surveys will be required, for the following reasons:

- Seasonality can influence the species of flora encountered at the site, with the flowering time of many species often posing a challenge to species identification. Since most of the wetland vegetation in the study area was found to be largely secondary/degraded with low native plant diversity, seasonality is not a significant limitation when compared with a vegetation community that is largely natural or high in native plant diversity (with the exception being those units that have retained some level of diversity, as mentioned above).
- Soil wetness indicators (i.e., soil mottles, grey soil matrix), which in practice are primary indicators of hydromorphic soils, are not seasonally dependent (wetness indicators are retained in the soil for many years) and therefore seasonality does not influence the delineation of wetland areas where soil sampling was used to determine wetland extent.

2.2.5 Baseline Ecological Assessment

- The mapping, description, and assessment of wetland/river PES and EIS was undertaken at the desktop level with limited field verification. This data was then extrapolated for the broader project area.
- The PES and EIS assessments make use of qualitative assessment tools and thus the results are open to professional opinion and interpretation. Eco-Pulse has tried to substantiate all claims where applicable and necessary.
- The EIS assessment did not specifically address all fine-scale ecological aspects of the water resources (e.g., lists of aquatic fauna such as invertebrates, amphibians, and fish) that occur within and make use of these systems).
- The vegetation information provided is based on observation and not on formal vegetation plots. As such species documented in this report should be considered as a list of dominant and/or indicator wetland/riparian species and only provide a general indication of the composition of the wetland/riverine vegetation communities.

2.2.6 Impact Assessment

- The impact significance assessment was undertaken for four ultimate consequences.
- The impact assessment was undertaken for two mitigation scenarios referred to as the 'realistic poor mitigation' and 'realistic good mitigation' scenarios.
- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological concerns arising from the field survey and based on the assessor's working knowledge and experience with similar development projects.
- The impact descriptions and assessment are based on the author's understanding of the proposed development based on information provided.
- Evaluation of the significance of impacts with mitigation considers mitigation measures provided in this report and standard mitigation measures included in the Environmental Management Programme (EMPr).

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3. DESKTOP ASSESSMENT

3.1 Biophysical and Conservation Context

3.1.1 Biophysical Setting and Context

A summary of key biophysical details for the study area is presented in Table 12 below.

Table 12. Key details of the study area.

Freshwater Ecosystem Assessment Summary	
Ecoregion (DWAF, 2007)	16.03 – South Eastern Uplands
Geology	Sandstone with subordinate quartz arenite, mudrock, granulestone and conglomerate (Natal Group) Diamictite with varved shale, mudstone, and fluvioglacial gravel (Dwyka Group, Karoo Super Group) Several plutons comprising very coarse-grained, porphyritic rapakivi granite and charnockite (Oribi Gorge Granitoid)
National Water Act Water Management Area (WMA)	uMvoti to uMzimkhulu
Quaternary Catchment	U60C, U20L and U20J
Main Collecting River in the Quaternary Catchment	Sterkspruit and uMgeni Rivers
Study Watercourse Type(s)	Rivers, streams, and wetlands
NFEPA Planning Unit (CSIR, 2011)	4555 and 4556 (Southern/Eastern Properties) 4488 and 4435 (Northern Property)
NFEPA Planning Unit Status (CSIR, 2011)	4555 and 4556 (Not a FEPA) 4488 and 4435 (Not a FEPA)

3.1.2 Drainage Setting

The southern portion of the study area is located within DWS Quaternary Catchment U60C, which is drained by the large perennial Sterkspruit River. Most watercourses in the southern portion of the study area, therefore, flow in a general south-easterly direction towards the Sterkspruit system. In the northern portion of the study area, most watercourses fall within DWS Quaternary Catchment U20J with a smaller fraction located within DWS Quaternary Catchment U20L. Both these quaternary catchments are ultimately drained by the uMgeni River with watercourses in U20J first feeding into the Mshwati River, which merges with the Msunduzi before this system's confluence with the uMgeni river. There are several minor farm dams along many of the onsite watercourses. One major water supply dam, namely Inanda Dam is located along the uMgeni River approximately 40km downstream of the site.

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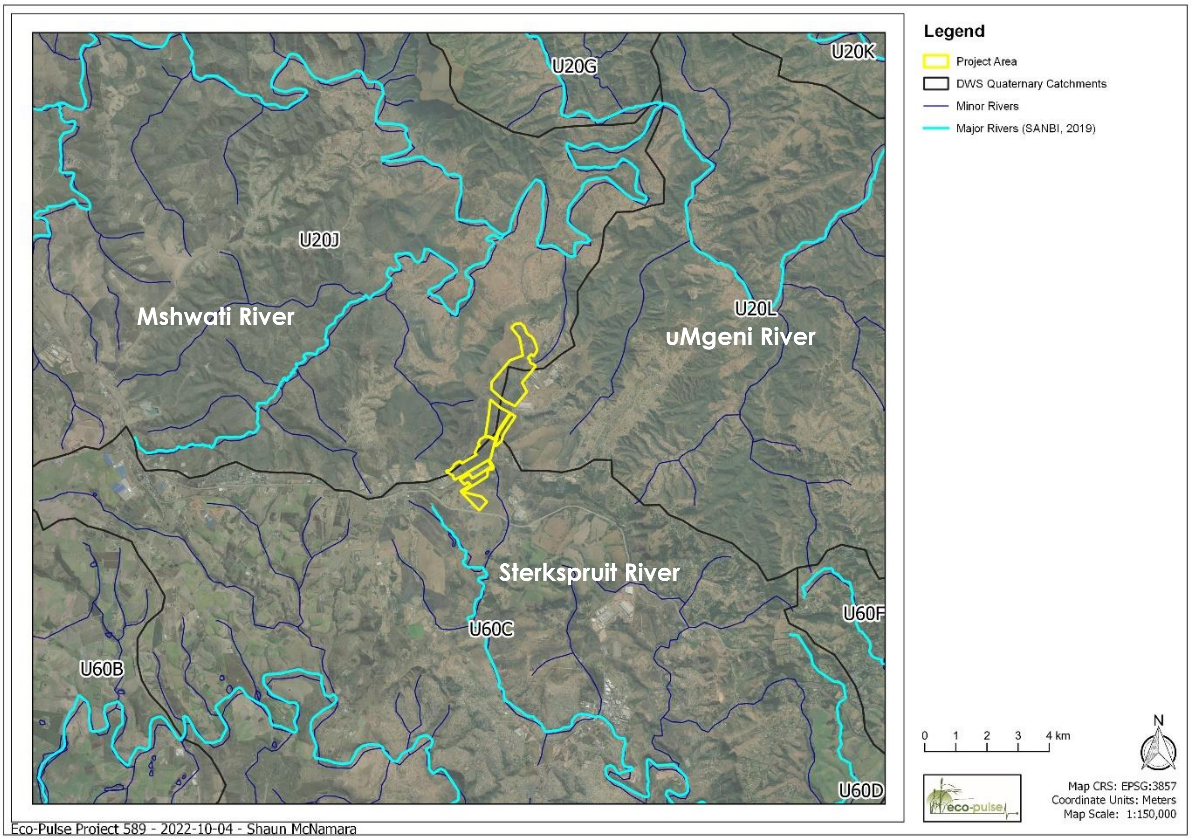

Figure 4. Study area drainage context

3.1.3 Freshwater Conservation Context

National, provincial, and regional conservation datasets were screened for the study area, the results of which are presented in Table 13.

Of noteworthy importance is the following:

1. Several seep and valley bottom wetlands are highlighted as Ecological Support Areas (ESA) and Critical Biodiversity Areas (CBA) in the 2016 Durban Systematic Conservation Assessment (SCA) (McLean et al., 2016).
2. Most of the northern part of the study area has been 'earmarked' for conservation in terms of the Provincial Freshwater Conservation Plan (EKZNW, 2007).
3. Several wetlands in the study area are identified as wetland Freshwater Ecosystem Priority Areas (FEPAs) by the National Freshwater Ecosystem Priority Areas (NFEPA) project (CSIR, 2011). These are generally grassy seeps that are in natural/good to fair condition according to the NFEPA assessment protocol.
4. Wetlands in the study area (seeps and valley bottom wetlands) belong to the Sub-Escarpment Grassland Bioregion vegetation type and are 'Critically Endangered' according to the freshwater realm on the latest National Biodiversity Assessment (Van Deventer et al., 2019). This ecological threat status means that < 20% of these ecosystem types remain in natural or near-natural condition in the country.

Table 13. Key freshwater conservation context details for the study area.

NATIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset		**Relevant Conservation Feature**	**Conservation Planning Status**
National Freshwater Ecosystem Priority Areas (NFEPA) (CSIR, 2011)	River	4555 and 4556 (Southern portion of study area) 4488 and 4435 (Northern portion of study area)	Non-FEPA catchments
	Wetlands	Onsite FEPA Wetlands	Wetland FEPA
		Sub-Escarpment Savanna	Seeps - Endangered Valley Head Seeps – Critically Endangered UCVB – Critically Endangered
2018 National Biodiversity Assessment – Inland Aquatic / Freshwater Realm (GIS Coverage)	River	Main Rivers Draining the study area Classification: South Eastern Uplands Perennial/Seasonal transitional/upper Foothill Rivers	Endangered
		Streams within the study area Classification: South Eastern Uplands, Ephemeral Mountain Headwater Streams or Mountain Streams	Endangered
	Wetlands	Onsite wetlands Classification: Sub-Escarpment Grassland Bioregion – Seep and Valley Bottom Wetlands	Critically Endangered
PROVINCIAL AND REGIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset		**Relevant Conservation Feature**	**Conservation Planning Status**
KZN Aquatic Conservation Plan (EKZNW, 2007)		Planning Units 3316, 3530, 3535, 3539, 3541	'Earmarked' for conservation (3530, 3535, 3539, 3541)
Durban's Systematic Conservation Assessment (McLean et al., 2016)		Several onsite seep and valley bottom wetlands	Several seep and valley bottom wetlands are highlighted as Ecological Support Areas (ESA) and Critical Biodiversity Areas (CBA) by the 2016 SCA assessment.

4. BASELINE HABITAT ASSESSMENT

4.1 Desktop Watercourse Mapping

All watercourses (rivers/streams and wetlands) within 500m of the proposed development project were mapped at a desktop level using available digital imagery and 5m elevation contour data. All mapped watercourses were then classified in terms of their HGM type in accordance with the national wetland/river classification defined by Ollis *et al.* (2013). This led to the desktop delineation and classification of the following watercourse units:

- Twenty-Six (26) Mountain Headwater Streams
- Two (2) Mountain Streams
- Six (6) Seep Wetlands
- Five (5) Unchanneled Valley-Bottom Wetlands

The delineated watercourses are shown in Figures 5.

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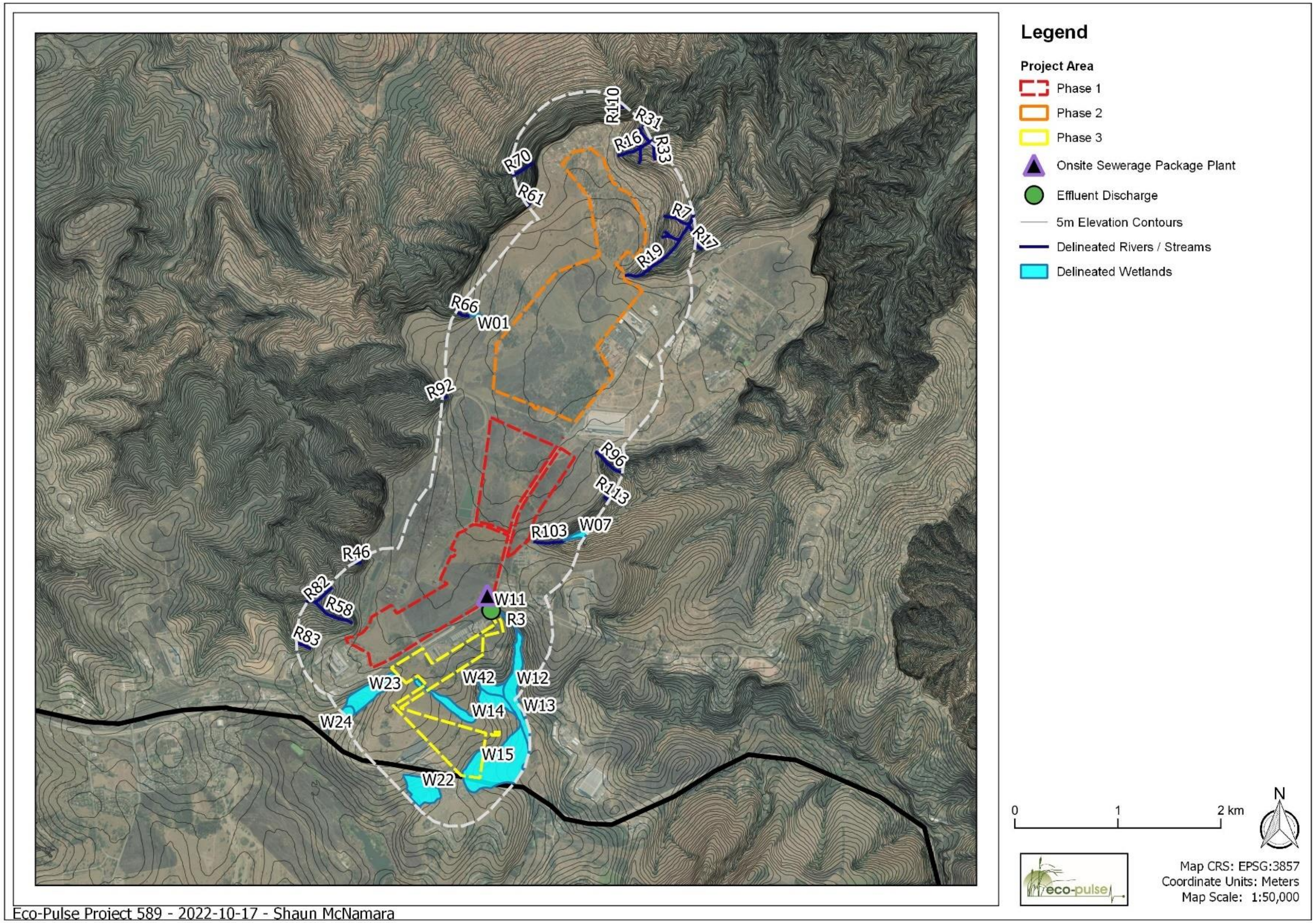

Figure 5. Delineated study area watercourses

4.2 Impact Potential Screening

The impact potential screening assessment indicates that a total of nine (9) individual wetland HGM units and ten (10) river/stream units are at risk of being potentially measurably impacted during the construction and operational phases of the proposed development (Figure 6). These watercourse units were taken forward for detailed infield assessment.

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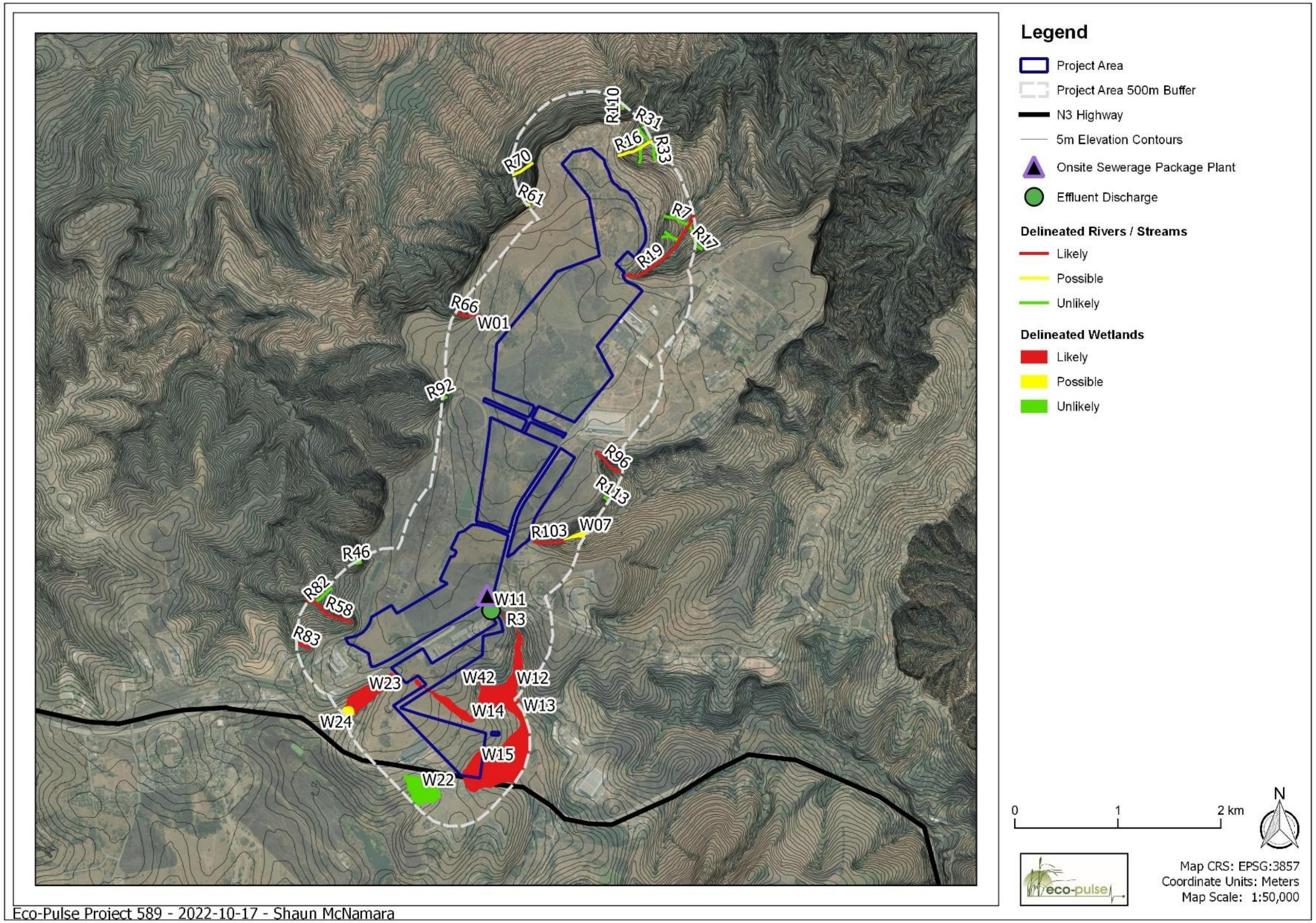

Figure 6. Watercourse impact potential screening outcome

4.3 Present Ecological State (PES) Assessment

This section of the report documents the findings of the wetland and river PES assessments for the watercourse units that were rated as either 'possible' or 'likely' to be affected by impacts associated development and provides descriptions of key impacts and PES scores and ratings.

4.3.1 Wetland PES Assessment

Wetland PES was assessed using the WET-Health (Macfarlane *et al*., 2020) assessment method and tool at the rapid 1B assessment level. This is a wetland and catchment landcover-based assessment method that models the deviation of wetland hydrology, geomorphology, vegetation condition and water quality from its perceived reference state using impact scores assigned to defined landcover classes. The results of this assessment are presented in Table 14 below.

Based on the outcomes of the PES assessment along with infield observations, the main sources of impacts to unchanneled valley bottom wetlands include artificial drainage linked to historical agriculture which has affected hydrology, and to a lesser extent the vegetation and geomorphology of these systems. Impacts on geomorphological processes of wetlands are primarily associated with increased runoff volumes and velocities from watercourse catchment areas. This is linked to reduced catchment vegetation basal cover and an increase in hardened catchment surface areas (buildings, roads etc.). This has resulted in the initiation of erosion and the formation of channels in systems that were historically unchanneled. Where old drains occur in valley bottom wetlands, these have increased rates of wetland erosion and incision. Many valley-bottom wetlands are also associated with small farm dams. These dams have altered natural water movement and sediment accumulation regimes. They also cause a reduction in watercourse connectivity as they act as impeding structures. Alteration to hydrology and geomorphology associated with the aforementioned impacts either result in complete loss or degradation of indigenous vegetation cover through erosion, sedimentation, infilling and deep flooding allowing for encroachment or, in most cases, severe infestation of invasive alien plants (IAPs), which have markedly reduced the integrity of the vegetation across small to large portions of these unchanneled valley bottom wetlands.

Major sources of impacts on the integrity of seeps are overgrazing and over burning by local communities, which has resulted in reduced surface water infiltration, increased runoff, and increased likelihood of erosion, as well as a reduction in plant species diversity and vegetative cover. As with the unchanneled valley bottom wetlands, drainage linked with historical agriculture is negatively affecting the hydrology of these systems by creating concentrated flow paths and reducing the residence time of water flowing through these systems. Sand mining is also a major issue in some of the seeps assessed, especially those seeps underlain by Natal Group Sandstone to the east of the site. Collectively these disturbances and impacts have resulted in the loss of indigenous vegetation cover in some areas, with woody IAPs such as *Acacia mearnsii*, *Eucalyptus sp*, *Lantana camara* and *Rubus cuneifolius* colonising disturbed areas prolifically.

Table 14. Summary of the PES assessment for each of the delineated wetland HGM units.

HGM Unit	HGM Type	PES Score (%)				Combined PES Score (%)	Combined Ecological Category
		Hydrology	Geomorphology	Water Quality	Vegetation		
W01	Seep	61%	81%	94%	60%	73%	C
W07	UCVB	78%	85%	65%	67%	74%	C
W11	Seep	52%	81%	62%	46%	59%	D
W12	UCVB	56%	67%	68%	36%	57%	D
W14	Seep	49%	50%	68%	38%	51%	D
W15	Seep	67%	75%	65%	54%	66%	C
W23	Seep	52%	81%	62%	46%	59%	D
W24	UCVB	41%	61%	66%	23%	47%	D
W42	UCVB	56%	74%	67%	45%	60%	C

4.3.2 Stream PES Assessment

The IHI was used to ascertain stream PES (ecological condition).

Stream PES assessments were largely desktop-based (based on examination of aerial imagery (Google Earth Imagery © 2020 and 2021) due to lack of accessibility and / or time constraints. Stream units in the study area assessed at a rapid desktop-level were broadly grouped into one of two categories namely:

- Mountain Headwater Streams / Mountain Streams with upstream catchments that were largely degraded (R16, R19, R3).
- Mountain Headwater Streams / Mountain Streams with upstream catchments that were largely intact (R103, R58, R66, R83, R96, R61, R70, R82).

The results of the rapid desktop-based IHI assessment show that the assessed stream units range from '**poor**' / '**severely modified**' condition to '**good**' / '**largely-natural**' **condition ('D' to 'B' PES Category)** (Table 15).

The most prominent sources of impacts for streams within the project area include increased erosion/sedimentation, altered flow regimes and alien plant invasion. These impacts are largely linked to residential and commercial development, tree plantations and farming and the consequences associated with these activities (i.e. an increase in hardened surfaces in their upstream catchments leading to increased runoff and erosion, artificial stormwater inputs and artificial impoundment [in-stream] associated with small farm dams contributing to altered hydrology, and lastly clearing and degradation of indigenous vegetation both within the catchment and the riparian zone of units assessed). These impacts have modified streams and rivers along the northern periphery of the project area to a moderate or severe degree. The remainder of the streams assessed (just less than half) are considered to be largely natural. These include streams that occur within the centre of the northern

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portion of the property, which remain largely untouched. The precipitous topography and lack of accessibility are likely contributing factors to their better condition. Streams within the south-eastern-most portion of the project area are likewise relatively intact due to the absence of any major developments within their upstream catchments.

Table 15. PES summary for the river units assessed based on examination of aerial imagery at a desktop level.

Units	HGM	Instream Habitat Integrity	Riparian Habitat Integrity	Combined Habitat Integrity	PES	Key Impact(s)
R16 R19 R3	Mountain Headwater Stream/ Mountain Stream	58% (poor)	56% (poor)	57% (poor)	**D: Severely Modified**	Key impacts to these streams include altered hydrology with increased water inputs from stormwater discharge in the catchment as well as increased surface runoff in the catchment associated with hardened surfaces leading to erosion. The vegetation of these streams has been heavily impacted by IAP invasion with most of the vegetation cover dominated by invasive trees and shrubs with limited remnant indigenous species present. Rubbish dumping and point source pollution from untreated effluent are also potential impacts experienced across some of these streams.
R103, R58, R66, R83, R96, R61, R70	Mountain Headwater Stream/ Mountain Stream	88% (good)	82% (good)	86% (good)	**B: Largely Natural**	Minimal key impacts associated with these streams, with their upstream catchments largely untransformed aside from a few dirt roads or some grazing taking place potentially.

4.4 Process Unit Classification and Habitat Characteristics

Once PES was assessed for all delineated watercourses, individual watercourse units were assigned to different 'process unit groups' to assist with the efficient assessment of the EIS of the remaining watercourses in the study area (see Box 1 below for further information on the 'process unit' approach).

Box 1. 'Process Units' assessment approach

'Process Units' refer to wetlands or rivers of the same general type in terms of their classification, with similar existing impacts to ecosystem health, drivers and response, similar processes, and ecological functions. Using a 'Process Unit' type approach can be particularly useful when required to assess numerous wetlands at a rapid and efficient level and where conditions allow for similar wetlands/rivers to be grouped to make the baseline assessment of EIS more efficient.

Process units were defined and differentiated based on the following criteria: wetland/river HGM type, longitudinal slope, vegetation characteristics and existing catchment land use and on-site impacts to the fundamental drivers of aquatic ecosystems.

The various process units associated with the greater study area are listed in Table 21. Watercourses indicated in "black" were rated as being unlikely to be affected by impacts associated with the proposed development during the impact potential rating process (refer to Figures 6 and 7) and were not included as part of the baseline assessment.

The process unit groups associated with the study area are described in this section of the report. A summary of the key biophysical characteristics of each process unit is presented in the tables that follow.

4.4.1 Wetlands

A total of seven (7) wetland process unit groups were identified. Each of these is briefly characterised by key variables in Tables 16-22, which follow.

Table 16. Summary of key features of wetland 'Process Unit' group S4, including general biophysical characteristics of wetlands associated with this process unit group.

Wetland Process Unit S4	
Applicable Units *Units sampled in **'Bold'***	**W11, W23**
HGM Classification	Seep
General Unit Description	**Hygrophilous grassland seep with moderate longitudinal slope.** *This seep is moderate in size, located in a catchment with moderately steep gradients. The seep is characterised by hygrophilous grassland with scattered woody IAP tree cover (largely Eucalyptus)*
General Catchment Description	Catchment of the seep in this process unit is predominantly characterised by semi-natural grassland with some patches of *Eucalyptus* woodlots and other anthropogenic impacts present to a more minor extent.
Biophysical Characteristics	
Dominant wetness zone	Temporary
Dominant water input	Diffuse sub-surface flow
Low flow pattern	Diffuse sub-surface flow
General soil characteristics	<u>Temporary Soils:</u> *Natal Group Sandstone* 0-10cm: Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). No mottles 40-50cm Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Low abundance of small faint orange mottles.
General vegetation characteristics	Hygrophilous grassland communities are dominated by dryland/facultative dryland species such as Aristida *junciformis*, *Digitaria eriantha, Sporobolus africanus* and *Sporobolus pyramidalis* with scattered *Acacia mearnsii/Eucalyptus* sp. cover along with other IAPs (e.g. *Lantana camara*, *Rubus cuneifolius*). In areas more heavily invaded by IAPs *Eucalyptus sp* and *Acacia mearnsii.*

Table 17. Summary of key features of wetland 'Process Unit' group S9, including general biophysical characteristics of wetlands associated with this process unit group.

Wetland Process Unit S9	
Applicable Units *Units sampled in* ***'Bold'***	**W01**
HGM Classification	Seep
General Unit Description	**Small seep above drainage line** *This seep has a very small micro-catchment and transitions into a bedrock stream.*
General Catchment Description	Grassland and a portion of a Eucalyptus woodlot at the head of its catchment.
Biophysical Characteristics	
Dominant wetness zone	Temporary
Dominant water input	Diffuse subsurface flow
Low flow pattern	Diffuse subsurface flow
General soil characteristics	<u>Temporary Soils:</u> 0-10 cm: Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). No mottles 40-50 cm Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Low abundance of small faint orange mottles
General vegetation characteristics	This seep is dominated by species such as *Aristida junciformis*, *Sporobolus pyramidalis* and *Digitaria eriantha* with scattered sedges.

Selected Photos of Wetlands associated with Process Unit S9 are included below:

Photo 01: Downslope facing photo of W01

Photo 02: Photo looking across the head of W01

Table 18. Summary of key features of wetland 'Process Unit' group S10, including general biophysical characteristics of wetlands associated with this process unit group.

Wetland Process Unit S10	
Applicable Units *Units sampled in* ***'Bold'***	**W15**
HGM Classification	Seep
General Unit Description	**Moderately sloped seep in grassland dominated catchment** *This seep is moderately sloped with a catchment that largely comprises semi-natural grassland.*
General Catchment Description	Grassland and some buildings and roads.
Biophysical Characteristics	

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Wetland Process Unit S10	
Dominant wetness zone	Temporary to Seasonal
Dominant water input	Diffuse subsurface flow
Low flow pattern	Diffuse subsurface flow
General soil characteristics	Temporary Soils: *Natal Group Sandstone* 0-10cm: Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). No mottles 40-50cm Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Low abundance of small faint orange mottles. Seasonal Soils: *Natal Group Sandstone* 0-10cm: Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Low abundance of orange mottles. 40-50cm Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Moderate abundance of faint to distinct orange mottles.
General vegetation characteristics	This seep was visited in the field and comprised grass cover throughout with scattered sedge cover. Sedge cover increased within the seasonal saturation zone at the centre of this seep and outnumbered the grass cover in this central zone. Frequently encountered grasses included *Sporobolus pyramidalis* and *Aristida junciformis*, commonly encountered sedges included *Pyrceus polystachyos*, *Cyperus sphaerospermus*, *Fimbrostylis dichotoma* and *Kyllinga sp*. Scattered forbs included *Hypoxis hemerocallidea* and *Cyanotis speciosa*.

Selected Photos of Wetlands associated with Process Unit S10 are included below:

Photo 03: View of W15 looking downslope

Table 19. Summary of key features of wetland 'Process Unit' group S11, including general biophysical characteristics of wetlands associated with this process unit group.

Wetland Process Unit S11	
Applicable Units *Units sampled in **'Bold'***	**W14**
HGM Classification	Seep
General Unit Description	***Seriously modified grassy seep*** *This seeps has a moderate gradient and moderately steep slopes in its upstream catchment and has been affected by extensive wetland sand mining impacts.*

Wetland Process Unit S11	
General Catchment Description	W14 has primarily semi-natural grassland cover in its upstream catchment.
Biophysical Characteristics	
Dominant wetness zone	Temporary/Seasonal
Dominant water input	Diffuse subsurface flow
Low flow pattern	Diffuse subsurface flow
General soil characteristics	<u>Temporary Soils:</u> *Natal Group Sandstone* 0-10cm: Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). No mottles 40-50cm Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Low abundance of small faint orange mottles. <u>Seasonal Soils:</u> *Natal Group Sandstone* 0-10cm: Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Low abundance of orange mottles. 40-50cm Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Moderate abundance of faint to distinct orange mottles.
General vegetation characteristics	Hygrophilous grassland and sedgeland

Selected Photos of Wetlands associated with Process Unit S11 are included below:

Photo 04: View looking east across the toe of W14 where artificial pools of water collect due to sand mining impacts.

Photo 05: View looking west across the toe of W14 where artificial pools of water collect due to sand mining impacts.

Table 20. Summary of key features of wetland 'Process Unit' group UCVB2, including general biophysical characteristics of wetlands associated with this process unit group.

Wetland Process Unit UCVB2	
Applicable Units *Units sampled in **'Bold'***	**W42**
HGM Classification	Unchanneled Valley Bottom
General Unit Description	**Reedland/Sedgeland Dominated Unchanneled Valley Bottom Wetland**

Wetland Process Unit UCVB2	
General Catchment Description	*This unit occurs in a moderately steep catchment and has been moderately to severely modified.* Key impacts in upstream catchments include tree plantations, IAPs, grazing and commercial development and lastly sand mining in the case of W42.
Biophysical Characteristics	
Dominant wetness zone	Seasonal
Dominant water input	Diffuse surface flow and subsurface flow from catchment
Low flow pattern	Diffuse surface flow with some concentrated flow paths due to increased runoff
General soil characteristics	<u>Temporary Soils:</u> *Natal Group Sandstone* 0-10cm: Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). No mottles 40-50cm Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Low abundance of small faint orange mottles. <u>Seasonal Soils:</u> *Natal Group Sandstone* 0-10cm: Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Low abundance of orange mottles. 40-50cm Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Moderate abundance of faint to distinct orange mottles.
General vegetation characteristics	Sedgeland (Common species encountered included *Cyperus dives* and *Gunnera perpensa*) and reedland covers approximately half of these units with woody vegetation (mixture of some indigenous with larger proponent assumed to comprise IAPs).

Selected Photos of Wetlands associated with Process Unit UCVB2 are included below:

Photo 06: Looking towards W42 in the background.

Table 21. Summary of key features of wetland 'Process Unit' group UCVB3, including general biophysical characteristics of wetlands associated with this process unit group.

Wetland Process Unit UCVB3	
Applicable Units *Units sampled in '**Bold**'*	**W24**
HGM Classification	Unchanneled Valley Bottom

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Wetland Process Unit UCVB3	
General Unit Description	**IAP Dominated Unchanneled Valley Bottom Wetland** *This unit has been largely transformed by within wetland impacts, including deep flooding associated with a small dam, infilling from roads and subsequent invasion by a plethora of IAPs.*
General Catchment Description	Within its catchment commercial development, alien plant invasion and grazing are the key impacts affecting the integrity of this unit further.
Biophysical Characteristics	
Dominant wetness zone	Seasonal
Dominant water input	Diffuse surface flow and subsurface flow from catchment
Low flow pattern	Diffuse surface flow with some concentrated flow paths due to increased runoff
General soil characteristics	<u>Temporary Soils:</u> 0-10cm: Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). No mottles 40-50cm Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Low abundance of small faint orange mottles. <u>Seasonal Soils:</u> 0-10cm: Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Low abundance of orange mottles. 40-50cm Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Moderate abundance of faint to distinct orange mottles.
General vegetation characteristics	This Unchanneled Valley Bottom Unit is characterised by significant IAP woody cover with facultative/dryland grassland species occurring along the periphery.

Table 22. Summary of key features of wetland 'Process Unit' group UCVB4, including general biophysical characteristics of wetlands associated with this process unit group.

Wetland Process Unit UCVB4	
Applicable Units *Units sampled in **'Bold'***	**W07**, **W12**
HGM Classification	Unchanneled Valley Bottom
General Unit Description	**Narrow Unchanneled Valley Bottom Wetlands with Large Upstream Catchments** *These units are set in a narrow valley bottom setting and fed for the most part by narrow steeply sloping seeps (except W12 which is also fed by some broader seeps).*
General Catchment Description	Approximately 30 – 50% semi-natural grassland that is grazed with other key impacts including IAP cover/tree plantations, commercial development and in some cases sand mining.
Biophysical Characteristics	
Dominant wetness zone	Seasonal
Dominant water input	Diffuse surface flow and subsurface flow from catchment
Low flow pattern	Diffuse surface flow with some concentrated flow paths due to increased runoff
General soil characteristics	<u>Temporary Soils:</u> *Dwyka Tillite* 0-10cm: Grey-brown clay loam (7.5YR 4/2). No mottles 40-50cm: Grey-brown clay loam (7.5YR 4/2). Moderate abundance of small faint orange mottles.

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Wetland Process Unit UCVB4	
	Or *Natal Group Sandstone* 0-10cm: Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). No mottles 40-50cm Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Low abundance of small faint orange mottles. Seasonal Soils: Dwyka Tillite 0-10cm: Grey-brown clay loam (7.5YR 4/2). Low abundance of orange mottles. 40-50cm: Grey-brown clay loam (7.5YR 4/2). Moderate/High abundance of distinct orange mottles. Or *Natal Group Sandstone* 0-10cm: Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Low abundance of orange mottles. 40-50cm Grey-brown sandy loam and sand (7.5YR chroma 2/3 and value 5/6). Moderate abundance of faint to distinct orange mottles.
General vegetation characteristics	Hygrophilous grassland, sedgeland and reedland with woody cover comprising mostly indigenous species.

Selected Photos of Wetlands associated with Process Unit UCVB4 are included below:

Photo 07: View of W12

Photo 8: View of W12 looking downslope

Photo 9: View of W07 in the middle ground

Photo 10: View of the middle reaches of W07 looking downstream

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4.4.2 Streams

A total of two (2) riverine process unit groups were identified. Each of these is characterised by the key variables presented in Tables 23 and 24, which follow.

Table 23. Summary of key features of river 'Process Unit' group R3, including general biophysical characteristics of streams associated with this process unit group.

River Process Unit 3	
Applicable Units *Units sampled in 'Bold'*	R3, R19, R16
Longitudinal zone	Mountain Headwater Stream or Mountain Stream
General Unit Description	**Steep stream or moderately steep streams/rivers with relatively small or moderately sized catchments**. *Flows are only expected along these units either for a short period following high rainfall events (ephemeral) in the case of Mountain Headwater Streams and on a seasonal basis during the summer rainfall season for Mountain Streams.*
General Catchment Description	A mixture of semi-natural/secondary grassland areas interspersed with human settlement, dirt roads, bare areas and a small to larger proportion of IAPs.
Expected Biophysical Characteristics	
Expected Perenniality	Ephemeral/Seasonal
Expected Substrate type	Bedrock
Expected Instream biotopes	• Riffles, rapids and runs • Pools • Marginal vegetation
Expected Riparian features	➢ Active channel banks ➢ Macro channel bank
Expected Vegetation characteristics	**Macro Bank** ➢ Dominated by invasive alien vegetation with moderate to low abundance of indigenous woody vegetation or herbaceous vegetation. **Active Channel:** ➢ Limited instream vegetation expected due to bedrock nature of the channel bed.

Table 24. Summary of key features of river 'Process Unit' group R4, including general biophysical characteristics of streams associated with this process unit group.

River Process Unit 4	
Applicable Units *Units sampled in 'Bold'*	R103, R58, R66, R83, R96, R61, R70
Longitudinal zone	Mountain Headwater Stream or Mountain Stream
General Unit Description	**Steep stream or moderately steep streams/rivers with relatively small or moderately sized catchments**. *Flows are only expected along these units either for a short period following high rainfall events (ephemeral) in the case of Mountain Headwater Streams and on a seasonal basis during the summer rainfall season for Mountain Streams.*
General Catchment Description	Either a mixture of primary and semi-natural grassland areas or intact eastern valley bushveld with one or two dirt roads present.
Expected Biophysical Characteristics	
Expected Perenniality	Ephemeral/Seasonal

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River Process Unit 4	
Expected Substrate type	Bedrock
Expected Instream biotopes	• Riffles, rapids and runs • Pools • Marginal vegetation
Expected Riparian features	➢ Active channel banks ➢ Macro channel bank
Expected Vegetation characteristics	**Macro Bank** ➢ Dominated by indigenous eastern valley bushveld or herbaceous/primary grassland vegetation with very low abundance of IAPs. **Active Channel:** ➢ Limited instream vegetation expected due to bedrock nature of the channel bed.

Photo 11: View of R103 in the background.

Photo 12: View of R96 downstream of dam.

4.5 Wetland Ecosystem Services Assessment

An assessment of wetland ecosystem services (i.e., wetland functionality) was conducted using the WET-Ecoservices method (Kotze *et al.*, 2019). This was done for each process unit group rather than per individual wetland unit.

4.5.1 Regulating Ecosystem Services (Functional) Assessment

A summary of the regulating services importance scores and ratings for the wetlands assessed is provided in Table 25 below. Key outcomes include:

➢ All seep process units assessed were assigned Low to Moderately Low overall regulating service importance ratings. This was typically linked to seep wetlands having steep longitudinal slopes, small catchments, these wetlands being dominated by a temporary saturation zone, as well the generally low demand for regulating services within the context of the study area landscape.

➢ Unchanneled Valley Bottom Process Units were either assigned Moderately High (UCVB4), Moderate (UCVB2) or Moderately Low (UCVB3) importance ratings. The Moderately High Importance rating assigned to process unit UCVB4 was driven by the toxicant assimilation importance rating, with both demand for this service and the ability of wetland units to supply this service informing this rating. Demand for this service is linked to the presence of industrial and

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commercial areas in upstream catchments likely contributing to increased levels of toxicant inputs flowing into these wetland units through stormwater runoff. Within these wetland systems, the moderately high level of vegetation cover, surface roughness, moderately gentle gradients and seasonal saturation levels contribute to diffuse flows, longer residence times and anoxic conditions which optimise the assimilation of any toxicants received from upstream.

Table 25. Summary of regulating services importance scores and overall importance rating for each wetland process unit.

Process Unit	Regulating Services Scores (0-4)								Overall Rating
	Flood attenuation	Streamflow regulation	Sediment trapping	Erosion control	Phosphate removal	Nitrate removal	Toxicant removal	Carbon storage	
S4	0.5	0.6	0.9	0.8	0.4	0.6	0.9	0.7	**Low**
S9	0.0	1.2	0.6	1.2	0.0	0.0	0.2	0.7	**Low**
S10	0.5	1.5	1.1	1.1	1.1	1.1	1.7	0.9	**Moderately Low**
S11	0.5	0.2	1.6	1.2	1.1	0.9	1.6	0.8	**Moderately Low**
UCVB2	0.8	1.1	1.8	0.9	0.6	1.1	1.8	1.5	**Moderate**
UCVB3	0.6	0.0	0.9	0.6	0.3	0.9	1.5	1.5	**Moderately Low**
UCVB4	1.2	0.9	1.8	0.2	1.6	1.9	2.4	1.5	**Moderately High**

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4.5.2 Provisioning and Cultural Services Assessment

A summary of the provisioning and cultural services importance scores and ratings are provided in Table 26 below. Key outcomes include:

- The unchanneled valley bottom wetland process units assessed were assessed as being of Very Low or Low importance for provisioning and cultural services, due to their limited grazing value, degraded ecological state, and lack of accessibility (i.e., on private land or situated in topographically steep catchments).
- Four of the seep process units assessed were assessed as being of Moderate importance for provisioning and cultural services. In each case, this was primarily linked to the availability of grassland within these units for livestock grazing.

Table 26. Summary of provisioning and cultural services importance scores and overall importance rating for each Process Unit.

Wetland Process Units	Provisioning and Cultural Services Scores (0-4)							Overall Rating
	Water supply	Harvestable natural resources	Food for livestock	Cultivated foods	Tourism and recreation	Education and research	Cultural significance	
S4	0.0	0.4	1.8	1.0	0.0	0.0	0.0	**Moderate**
S9	0.0	0.0	1.5	1.0	0.0	0.0	0.0	**Moderately Low**
S10	0.0	0.0	2.2	0.6	0.0	0.0	0.0	**Moderate**
S11	0.2	0.0	2.2	0.6	0.0	0.0	0.0	**Moderate**
UCVB2	0.9	1.2	0.0	0.2	0.0.	0.0	0.0	**Low**
UCVB3	0.7	0.5	0.0	0.2	0.0	0.0	0.0	**Very Low**
UCVB4	0,9	0.8	0.0	0.2	0.0	0.0	0.0	**Low**

4.6 Ecological Importance and Sensitivity (EIS) Assessment

The Ecological Importance (EI) of wetlands and rivers is an expression of the importance of the water resource for the maintenance of biological diversity and ecological functioning on local and wider scales; whilst Ecological Sensitivity (ES) (or fragility) refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans and Louw, 2007).

4.6.1 Wetland EIS Assessment

The EIS ratings for the assessed wetland process unit groups is presented in Table 27, below. Key outcomes include:

- Seep wetland process unit group S11 are considered to have a moderate EIS rating which can be largely attributed to their moderately high to high importance in terms of biodiversity maintenance and their minimally impacted state which allows them to contribute to certain regulating services as well as provisioning services within their catchment context.
- Due to their largely degraded state and limited regulation and provisioning services importance scores, wetland process unit groups S4, S9 and UCVB3 were rated as having limited overall EIS. Seeps were also typically considered to be of low overall sensitivity to changes in flood regimes, sediment input patterns, and were not deemed to host intolerant or dependent biota. Therefore, the general sensitivity of the two seep wetland process unit groups (S4 and S9) was limited.
- Seep wetland process unit group S10, and valley bottom wetland process unit groups UCVB2 and UCVB4 were all rated as being of High EIS. This score was driven by the biodiversity maintenance importance scores associated with wetlands in these groups. These wetlands belong to a critically endangered ecosystem type according to the latest national biodiversity assessment, with these units being in at least 'fair' ecological condition. These wetland units are also associated with large intact or semi-intact buffer areas, making them ecologically viable wetland ecosystems with the ability to contribute towards meeting regional, provincial, and national ecosystem conservation targets.

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Table 27. Summary of EIS scores and overall EIS rating for wetland process unit groups.

Process Unit	S4	S9	S10	S11	UCVB2	UCVB3	UCVB4
Biodiversity Maintenance	2.20	2.00	3.30	2.70	3.00	0.50	2.50
Regulating functions	0.90	1.20	1.70	1.60	1.80	1.50	2.40
Provisioning Services	1.80	1.50	2.20	2.20	1.20	0.70	0.90
Ecological Importance	2.20	2.00	3.30	2.70	3.00	1.50	2.50
Ecological Sensitivity	0.90	0.90	0.90	0.90	1.70	1.70	1.70
Combined EIS Score	**1.65**	**1.45**	**2.75**	**2.15**	**2.85**	**1.35**	**2.35**
Combined EIS Category	**Low**	**Low**	**High**	**Mod**	**High**	**Low**	**High**

4.6.2 Stream EIS Assessment

Stream EIS was assessed for two Process Units (R3 and R4).

For this assessment, EIS was based on rating the importance and sensitivity of riparian and in-stream biota (including fauna and flora) and habitat using both desktop and on-site indicators. A summary of the results of the EIS assessment for process units R2 – R5 is shown in Table 28. Key outcomes include:

- Mountain Headwater Streams and Mountain Streams associated with Process Units R3 were assigned a **'Low' EIS** rating, driven by their poor ecological condition and low habitat diversity.
- Mountain Headwater and Mountain Streams in Process Unit R4 were assigned a **'Moderate'** EIS rating due to their largely natural condition and the high likelihood that these streams play host to threatened plant species. These intact watercourse networks also likely act as important wildlife migration corridors, with buffers around these units remaining largely intact.

Table 28. Summary of EIS for the stream Process Units.

Variables	Scores (Out of 4) and Rating	
	R3	**R4**
Rare and endangered species	0.0 (None)	1.0 (Low)
Unique species (endemic, isolated, etc.)	0.0 (None)	1.0 (Low)
Intolerant species sensitive to flow/water quality modifications	0.0 (None)	1.0 (Low)
Species/taxon richness	1.0 (Low)	1.0 (Low)
Diversity of habitat types	1.0 (Low)	1.0 (Low)
Refugia for biota	1.0 (Low)	1,5 (Moderately Low)
Sensitivity to flow changes	2.0 (Moderate)	2.0 (Moderate)
Sensitivity to flow related water quality changes	2.0 (Moderate)	2.0 (Moderate)
Migration route/corridor (instream and riparian)	1.0 (Low)	2.0 (Moderate)
Importance of conservation and natural areas	0.0 (None)	2,0 (Moderate)
EIS Score	**1.0**	**1.3**
EIS Rating	**Low**	**Mod**

4.6.3 Recommended Ecological Category (REC) & Management Objectives (RMOs)

The recommended ecological category (REC) is the target or desired state of resource units required to meet water resource management objectives and quality targets. It is determined through the consideration of the PES, EIS and realistic opportunities to improve the PES that is driven by the context / setting.

The modus operandi followed by DWAF's Directorate: Resource Directed Measures (RDM) is that if the EIS is high or very high, the ecological management objective should be to improve the condition of the river (Kleynhans & Louw, 2007). However, the causes related to a particular PES should also be considered to determine if improvement is realistic and attainable (Kleynhans & Louw, 2007). This relates to whether the problems in the catchment can be addressed and mitigated (Kleynhans & Louw, 2007). If the EIS is evaluated as moderate or low, the ecological aim should be to maintain the river in its PES (Kleynhans & Louw, 2007). Within the Ecological Reserve context, Ecological Categories A to D can be recommended as future states depending on the EIS and PES (Kleynhans & Louw, 2007). Ecological Categories E and F PES are regarded as ecologically unacceptable, and remediation is needed if possible (Kleynhans & Louw, 2007). A generic matrix for the determination of RECs and RMOs for water resources is shown in Table 29 below.

Table 29. Generic matrix for the determination of REC and RMO for water resources.

			EIS			
			Very high	**High**	**Moderate**	**Low**
PES	**A**	**Pristine/Natural**	A Maintain	A Maintain	A Maintain	A Maintain
	B	**Largely Natural**	A Improve	A/B Improve	B Maintain	B Maintain
	C	**Good - Fair**	B Improve	B/C Improve	C Maintain	C Maintain
	D	**Poor**	C Improve	C/D Improve	D Maintain	D Maintain
	E/F	**Very Poor**	D Improve	E/F Improve	E/F Maintain	E/F Maintain

Based on this matrix (Table 29) and the catchment context, the REC for all watercourse HGM units assessed ranges from a 'B' to a 'D' PES with the RMO being to 'maintain' the current PES and functioning of most watercourses assessed, which can be achieved through careful management of catchment sediment, erosion, flow, and water quality impacts/risks and by avoiding direct impacts to the watercourses. Some onsite wetlands will likely require rehabilitation interventions to 'improve' their current PES and functioning by one class through a combination of careful management of their catchments in terms of sediment, erosion, flow, and water quality impacts/risks and through targeted rehabilitation interventions within their catchment and the watercourse units themselves.

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Table 30. REC and RMO for the delineated watercourse units based on their PES and EIS ratings.

Process Unit	HGM Type	PES Class	EIS Rating	REC	RMO	Proposed Action
R3	Mountain Stream / Mountain Headwater Stream	D	**Low**	D	Maintain	Appropriate catchment management
R4	Mountain Stream / Mountain Headwater Stream	**B**	**Mod**	**B**	Maintain	Appropriate catchment management
S4	Seep	D	**Low**	D	Maintain	Appropriate catchment management
S9	Seep	**C**	**Low**	**C**	Maintain	Appropriate catchment management
S10	Seep	**C**	**High**	**B/C**	Improve	Appropriate catchment management and rehabilitation interventions
S11	Seep	D	**Mod**	D	Maintain	Appropriate catchment management
UCVB2	UCVB	**C**	**High**	**B/C**	Improve	Appropriate catchment management and rehabilitation interventions
UCVB3	UCVB	D	**Low**	D	Maintain	Appropriate catchment management
UCVB4	UCVB	**C**	**High**	**B/C**	Improve	Appropriate catchment management and rehabilitation interventions
	UCVB	D	**High**	**C/D**	Improve	Appropriate catchment management and rehabilitation interventions

5. RISK & IMPACT ASSESSMENT

This section deals with the prediction, description and assessment of the potential construction and operational risks and impacts likely to be associated with the proposed Cato Ridge Land Development and Release Project.

5.1 Description of Development Activities

To anticipate potential risks and impacts to wetland and streams associated with the project, an understanding of the construction and operational processes and development activities is first required.

5.1.1 *Construction Phase Activities and Infrastructure*

- **Clearing of vegetation and grading of site**: Vegetation clearing, soil stripping and earthworks for the establishment of earthen platforms and foundations for buildings and associated access road and service infrastructure will take place on the property.
- **Construction of buildings and service infrastructure**: Once the site has been cleared and graded, construction of infrastructure will take place.

5.1.2 *Operation Phase Activities and Infrastructure*

- **Management of stormwater runoff from built infrastructure (roofs, roads, and parking areas)**: Storm water runoff will be collected, attenuated, and released back into the environment in an environmentally sensitive manner.
- **Operation of sewer pipeline and pump station**: This activity includes the operation of the section of sewer pipeline established.

5.2 Risk, Stressor & Impact Identification

Freshwater ecosystems such as wetlands are inherently vulnerable to human activities and these activities can often lead to irreversible damage or longer term, gradual/cumulative changes to ecosystems. Threats to freshwater biodiversity include processes and activities which reduce system persistence, and alter community diversity and patterns, including reduced genetic diversity (Rivers-Moore et al., 2007).

The general framework for the risk and impact assessment is shown in Table 31 below, which presents the expected risks, stressors and impacts for the construction and operational phase of the project.

Potential risks/stressors associated with the development include (a) vegetation clearing and exposure of bare soils to erosive elements, (b) increased runoff from bare soils and open trenches, (c) concrete/cement mixing, (d) management of waste water and potential pollutants, (e) discharge of stormwater runoff to the environment, leading to increased volumes and velocities of runoff water, (f)

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litter/waste entrained in stormwater and (g) potential for spills due to malfunction of accidental failure of the sewer pipeline infrastructure, accidental fuel spills if logistics operations are planned on site (Table 31). These are likely to translate into the following freshwater ecosystem (wetland) impacts in general:

1. Construction Impacts:
    a. Direct physical loss or modification of wetland habitat
    b. Sedimentation of downstream wetlands
    c. Modification of hydrological regime
    d. Pollution of soils and runoff into stream/wetland habitat, leading to reduced water quality

2. Operation Impacts:
    a. Modification to hydrological regime within the stream/wetland catchment areas
    b. Potential for enhanced soil erosion and sedimentation linked to modified storm water discharge
    c. Pollution of soils and run off into riparian/wetland habitat, leading to reduced water quality
    d. Potential for enhanced soil erosion and sedimentation linked to sewer leaks

Table 31. Freshwater Impact Assessment Framework for the housing development project.

FRESHWATER IMPACT ASSESSMENT FRAMEWORK			
DEVELOPMENT TYPE & ACTIVITIES: *Housing development and supporting wastewater infrastructure*			
Construction Phase Activities: • Vegetation clearing, soil stripping and earthworks for the establishment of platforms, buildings, and associated service infrastructure. • Temporary stormwater and sediment management • Hazardous substances handling, storage, and disposal, • Direct infilling and/or physical modification of watercourses in the vicinity of planned infrastructure.		Operational Phase Activities: • Management of stormwater runoff. • Operation of the Waste water treatment package plant. • Operation of internal sewage reticulation system. • Operation of internal water supply reticulation infrastructure.	
ENVIRONMENTAL STRESSORS/RISKS			
Construction Phase Stressors/Risks:		**Operational Phase Stressors/Risks:**	
a	Vegetation clearing and exposure of bare soils to erosive elements	a	Discharge of storm water runoff to the environment, leading to increased volumes and velocities of runoff water
b	Increased runoff from bare soils and open trenches	b	Litter/waste entrained in storm water
c	Concrete/cement mixing in the vicinity of watercourses	c	Potential for spills due to malfunction or accidental failure of sewer pipeline / pump station
d	Management of waste and potential pollutants	d	Solid waste dumping

FRESHWATER ECOSYSTEM IMPACTS	
1	Direct physical loss or modification of wetland habitat
2	Alteration of hydrological and geomorphological processes (*flow, erosion & sediment regime changes*)
3	Impacts to water quality (*pollution*)
4	Impacts to ecological connectivity and/or ecological disturbance impacts

The significance of the above impacts on relevant Valued Ecosystem Components is assessed in the sections that follow. A total of four VECs are assessed in relation to potential anticipated impacts and are defined briefly below:

1. **Water Resource Management:**

The inter-connected nature of water resources is emphasised here by recognising that an impact at a particular site will ultimately affect downstream users and the ability to meet user requirements. An understanding of the catchment context, with particular emphasis on the existing use of and reliance on water resources by downstream communities is therefore required. Key concerns therefore relate to any direct impacts on water quantity and quality together with habitat-related impacts that could exacerbate downstream impacts by undermining the ability of wetlands and riparian areas to attenuate floods, trap sediments and assimilate pollutants (regulating & supporting services).

2. **Ecosystem Conservation:**

The significance of impacts in relation to the ability to meet habitat conservation targets. This is informed by an understanding of conservation significance that is influenced by factors such as the ecosystem threat status, regional conservation context, condition of habitat, and connectivity to other intact habitats.

3. **Species Conservation:**

Species of special or notable conservation importance or concern, including Red Data Book or Red List taxa in threatened or conservation concern categories, Threatened or Protected Species listed under the National Environmental Management: Biodiversity Act, endemic taxa, locally threatened taxa and/or any taxa of special management concern. Includes both fauna and flora.

4. **Direct Use Values:**

Assessing the social impacts of the development based on an understanding of the impacts on provisioning (water supply, harvestable natural resources, cultivated foods or food for livestock) and cultural services available to local communities. This assessment is therefore based on an understanding of the current importance of water resources for local users and supporting local livelihoods, including religious ceremonies, tourism & recreation or educational activities.

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5.3 Impact Significance Assessment

Impact significance assessments have been completed individually for each proposed phase of the project (Sections 5.3.1, 5.3.2 and 5.3.3). An assessment of cumulative impacts has also been completed. This considers stressors and impacts on watercourses in the study area over the next 20-25 years considering all planned development within the larger Cato Ridge area (Section 5.3.5).

5.3.1 Phase 1

This section deals with the assessment of the potential construction and operation phase impacts and risks associated with Phase 1 of the development. Each of the potential impact consequences are discussed and assessed separately for the construction and operational phases under a 'realistic poor' and 'realistic good' or 'best practice' mitigation scenarios as defined in the 'methods' section of the report (*see section 2*).

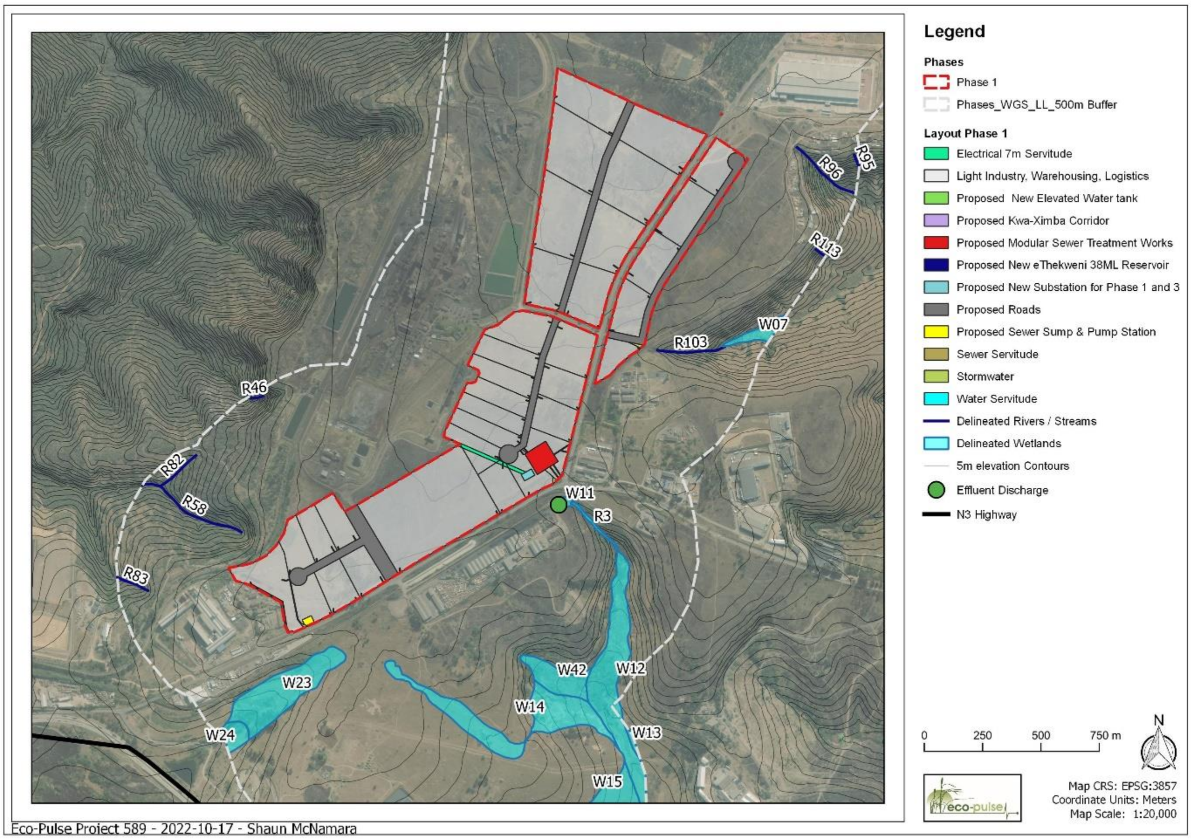

Figure 7. Phase 1 development area.

Construction Phase

Potential Environmental Impact
Direct physical loss or modification of wetland and/ or aquatic habitat associated with the onsite watercourses
Applicable Area
No planned incursions into onsite watercourses
Valued Ecosystem Components:

Water resource management	Ecosystem Conservation	Species Conservation	Direct Use Values
Direct impact	Direct impact	Secondary or indirect impact	Secondary or indirect impact

Significance Pre-Mitigation

Intensity	Duration	Extent	Probability	Consequence	Status (+/-)	Impact Significance
Minor Damage	Medium-Term	Limited	Likely	Slightly Detrimental	Negative	Minor - Negative
2	3	2	5	-7		-35

Summary of Key Impacts

There is no infrastructure planned within any onsite watercourses as part of this phase of the development. The planned development areas also do not encroach into the preliminary recommended watercourse buffer zones (Section 6.2.1). There are therefore no planned direct impacts to freshwater habitat areas during the construction phase of this development. There is however the potential for accidental direct physical modification to stream or wetland habitat during construction, although such impacts are unlikely under a realistic 'good' mitigation scenario.

Summary of Key Mitigation Measures

Key mitigation recommendations:

- No areas outside the construction footprint may be cleared and stripped of vegetation. To this end the outer edges of the construction site must be demarcated using a high visibility barrier / fencing. The demarcation must be signed off by the project ECO.
- Construction staff should be made aware of the location and extent of all watercourses in the vicinity of the proposed development. These should be considered strict no-go zones for the duration of onsite works.
- Drivers and machine operators must take specific care to avoid watercourses when manoeuvring vehicles and heavy equipment.

Significance Post-Mitigation

Intensity	Duration	Extent	Probability	Consequence	Status (+/-)	Impact Significance
Negligible Damage	Immediate	Very Limited	Improbable	Negligible	Negative	Negligible - negative
1	1	1	2	-3		-6

Post-Mitigation Impact Assessment Assumptions

The post-mitigation scenario is based on a scenario whereby complete avoidance of on-site watercourses achieved and no accidental incursions take place.

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Potential Environmental Impact			
Alteration of hydrological and geomorphological processes (erosion and sediment)			
Applicable Area			
The study area			
Valued Ecosystem Components:			
Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**
Direct impact	Direct impact	Secondary or indirect impact	Irrelevant

Significance Pre-Mitigation

Intensity	Duration	Extent	Probability	Consequence	Status (+/-)	Impact Significance
High	**Medium-term**	**Local**	**Definite**	**Moderately Detrimental**	**Negative**	**Minor -Negative**
4	**3**	**3**	**7**	**-10**		**-70**

Summary of Key Impacts

Construction activities in the catchment areas of onsite watercourses will result in a temporary reduction in catchment vegetation cover which could be associated with increased runoff and increased sediment supply to watercourses, especially where bare soils are exposed during peak rainfall periods. These impacts could potentially alter the geomorphic and hydrological regime of onsite watercourses. This could affect freshwater ecosystem condition and indirectly affect fauna and flora through a deterioration in the quality of available habitat . Should these impacts occur they are however likely to be temporary and are unlikely to significantly affect long-term ecological processes associated with onsite watercourses. If poorly managed hydrological and geomorphological impacts on Water Resource Management could be of a 'minor' ecological significance. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), the consequence rating can be reduced from 'moderately detrimental' to 'slightly detrimental'.

Summary of Key Mitigation Measures

Key mitigation recommendations:

- Limit the duration of construction to reduce the risk of prolonged sedimentation and erosion impacts occurring.
- Implement and adhere to buffer zones for wetlands and riparian areas, with planned development infrastructure to remain outside of the buffer zones.
- Demarcate buffers on the ground to avoid incursions into these areas.
- Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
- Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible and in accordance with a Rehabilitation & Management Plan.
- Implement bi-monthly aquatic biomonitoring and water quality monitoring during construction and use findings to inform site management.

Significance Post-Mitigation

Intensity	Duration	Extent	Probability	Consequence	Status (+/-)	Impact Significance
High	**Short-term**	**Limited**	**Likely**	**Slightly detrimental**	**Negative**	**Minor -negative**
4	**2**	**2**	**5**	**-8**		**-40**

Post-Mitigation Impact Assessment Assumptions

The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are, and all erosion and sedimentation risks are addressed.

Potential Environmental Impact
Impacts to water quality
Applicable Area
The study area
Valued Ecosystem Components:

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Water resource management	Ecosystem Conservation	Species Conservation	Direct Use Values
Direct impact	Secondary or indirect impact	Secondary or indirect impact	Irrelevant

Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Moderate	**Medium-term**	**Local**	**Highly Probable**	**Slightly detrimental**	**Negative**	**Minor - Negative**
3	**3**	**3**	**6**	**-9**		**-54**

Summary of Key Impacts

Water quality impacts during construction will be limited to potential increased surface water turbidity due to sediment inputs and / or erosion and physio-chemical pollution related to potential spillages of cement and fuels during construction. Turbidity impacts are likely to be limited given the temporary nature of onsite earthworks, and the maintenance of a well-vegetated buffer around watercourses. Spillages of fuel and other harmful substances could alter the physio-chemical and biological characteristic of surface water and contaminate watercourse substrate (having a direct impact on water resource management), with potential knock-on consequences for both fauna and flora communities (affecting ecosystem and species conservation indirectly). No impact on direct use value is anticipated as watercourses were not rated as important in terms of water supply as a provisioning ecosystem service. If poorly managed, impacts to water quality could be of 'Minor' significance where turbidity and sediment and / or pollution risks are not effectively mitigated. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), this can be potentially reduced to a 'Negligible' and an environmentally acceptable level.

Summary of Key Mitigation Measures

Key mitigation recommendations:

- Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
- Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.
- Rehabilitate any spill related impacts as soon as practically possible in accordance with an 'Aquatic Contingency Plan'.
- Implement bi-monthly aquatic biomonitoring and water quality monitoring during construction and use findings to inform site management.

		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Moderate	**Short-term**	**Limited**	**Unlikely**	**Slightly detrimental**	**Negative**	**Negligible -negative**
3	**2**	**2**	**3**	**-7**		**-21**

Post-Mitigation Impact Assessment Assumptions

The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are adhered to, and all water pollution risks are addressed.

Potential Environmental Impact			
Impacts to ecological connectivity and/or ecological disturbance impacts			
Applicable Area			
The study area			
Valued Ecosystem Components:			
Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**
Irrelevant	Irrelevant	Secondary or indirect impact	Irrelevant
Ultimate Ecological Consequences: Impact Intensity Ratings			
Significance Pre-Mitigation			

Intensity	Duration	Extent	Probability	Consequence	Status	Impact Significance

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					(+/-)	
Minor	**Medium-term**	**Local**	**Likely**	**Slightly detrimental**	**Negative**	**Minor - Negative**
2	**3**	**3**	**5**	**-8**		**-40**
Summary of Key Impacts						
The presence of workers and machinery may create noise and vibration disturbances that may temporarily disturb amphibians, reptiles, birds, and small mammals. These disturbances will be minor, and fauna will likely revisit the site once construction has ceased, and the disturbance has halted. If poorly managed, disturbance impacts could be of 'Negligible' significance. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), the consequence rating can be reduced from slightly detrimental to negligible.						
Summary of Key Mitigation Measures						
Key mitigation recommendations: • Implement and adhere to buffer zones for wetlands and riparian areas, with planned development infrastructure to remain outside of the buffer zones, • Demarcate buffers on the ground to avoid incursions into these areas. • Implement road/pipeline Method Statement to specification. • Restrict worker and machinery access to the construction site and site camp only. • Prohibit poaching or collection of plants and biota from natural areas, including riparian areas and wetlands. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible and in accordance with the 'Rehabilitation & Management Plan'.						
		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Minor	**Short-term**	**Local**	**Probable**	**Slightly detrimental**	**Negative**	**Negligible -negative**
2	**2**	**3**	**4**	**-7**		**-28**
Post-Mitigation Impact Assessment Assumptions						
The above impact assessment rating provided under a post-mitigation scenario assumes that all mitigation measures are adhered to.						

Operation Phase

Potential Environmental Impact			
Alteration of hydrological and geomorphological processes (erosion and sediment)			
Applicable Area			
The study area			
Valued Ecosystem Components:			
Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**
Direct impact	Direct impact	Secondary or indirect impact	Irrelevant

Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Complete loss	**Permanent**	**Local**	**Highly Probable**	**Highly detrimental**	**Negative**	**Moderate - Negative**
7	**7**	**3**	**6**	**-17**		**-102**
Summary of Key Impacts						
The development will result in an increase in hardened catchment surfaces, and an associated increase in surface runoff which will largely be released into the environment as part of the operation of the formal stormwater management system. This could potentially result in erosion and sedimentation along onsite watercourses and thereby inhibit their ability to provide regulating services such as flood attenuation or toxicant assimilation through the creation of concentrated flow paths, thus influencing water resource management objectives. Similarly, erosion						

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and sedimentation can lead to a deterioration in habitat condition or loss of important habitat thereby having implications for ecosystem conservation targets and indirectly on species of conservation concern.

While the attenuation and controlled release of high stormwater runoff volumes (during storms etc.) will aid in preventing erosion and sedimentation associated with increased flow volumes, the presence of stormwater attenuation structures will also serve to alter natural flow and sediment regimes. It is vital that a stormwater attenuation system be designed to have a limited impact on base / low flows to mitigate operation phase hydrological and geomorphological impacts associated with the development.

The development will most likely increase peak flows due to urbanisation in the catchment, which increases the rainfall-runoff coefficient of the land surface area. Watercourses may be subjected to flooding damage. Areas where culverts will be installed at watercourse crossings may be prone to becoming blocked and are higher risk due to the momentum of flow from the prevailing flow direction and this poses a risk of undercutting and rapid erosion/bank failing during peak events. It is assumed that domestic water will be obtained from the local municipality, and there will be no reduction in water within the onsite and downstream watercourses (no direct abstraction of water).

The proposed onsite sewerage package plant will release treated effluent into R03 which transitions into W12. This will increase flow along this system above natural volumes which will could sediment and hydrological dynamics. This is a notable risk along W12 as this wetland is currently characterised by a central drain and associated high concentrated flows. The planned discharge volume of the plant is currently unknown so the intensity of the impact of the associated freshwater ecosystems cannot be fully understood at this time.

A Hydrological Risk Assessment should be undertaken to better understand post-development hydrological risks and impacts. It will be important for the hydrological modelling and risk assessment for each development phase, and for the cumulative development, to consider the effluent discharge volume from the proposed sewage plant.

If not mitigated through appropriate stormwater outfall and attenuation structure design, this impact could be of 'Moderate' significance. Where best practical ecological design is incorporated to allows flows and sediment fluxes to remain largely unimpeded, this impact can be potentially reduced to a 'Moderately Low' and acceptable level.

Summary of Key Mitigation Measures

Key mitigation recommendations:

- Implement best practice stormwater management design, including erosion protection at outfalls and allow for unimpeded base flows along watercourses.
- Stormwater and energy dampening systems to be designed and implemented to decreases the risk of stream bank erosion.
- Maintain storm water infrastructure as necessary.
- Implement and adhere to 33m and 31m buffer zones for wetlands and riparian areas, respectively.
- Wetland rehabilitation along Wetland W12 focused on re-establishing low energy diffuse flow along the system, rather than concentrated flow along the central drain, as it currently the situation.
- Implement aquatic biomonitoring and water quality monitoring during operation and use findings to inform site management.

Significance Post-Mitigation

Intensity	Duration	Extent	Probability	Consequence	Status (+/-)	Impact Significance
Complete loss	Permanent	Limited	Probable	Highly detrimental	Negative	Minor - Negative
7	7	2	4	-16		-64

Post-Mitigation Impact Assessment Assumptions

The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are adhered to and all watercourses on the property are avoided, and all erosion and sedimentation risks are addressed.

Potential Environmental Impact
Impacts to water quality
Applicable Area

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The study area			
Valued Ecosystem Components:			
Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**
Direct impact	Secondary or indirect impact	Secondary or indirect impact	Secondary or indirect impact

Significance Pre-Mitigation

Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Very High	**Beyond Project**	**Local**	**Definite**	**Highly detrimental**	**Negative**	**Moderate - Negative**
6	**6**	**3**	**7**	**-15**		**-105**

Summary of Key Impacts

Any impacts to water quality will have a direct impact on water resource management as higher levels of pollution feeding into downstream watercourses could compromise the assimilative capacity of affected wetlands. Any harmful substance spill events or pollutants feeding into watercourses can result in the die-off of plants and fauna in the vicinity and immediately downstream of a spill affecting wetland and aquatic habitat and species of conservation concern. Die-back of vegetation due to spills could reduce the amount of grazing available for livestock within the watercourses affected but is unlikely to have a significant impact on this direct use value given that alternative sources of grazing available in the area.

The onsite sewage treatment is being designed to treat 2 Mℓ / day of influent. Water pollution impacts during operation are likely to relate to the discharge of treated effluent into the environment and possible leakage of raw sewage from sewer pipeline infrastructure. The wetland into which the treated effluent is to be discharged (W12) is characterised by concentrated flows along a central drain. This increases the possibility of poor-quality water advancing along the watercourse system relative to if this wetland was characterised by low energy diffuse flow, which will have a "polishing" secondary treatment effect on the discharged effluent.

Where pipelines and raw sewage pump stations are properly designed and installed with adequate risk mitigation, the probability of spillage of raw sewage into onsite watercourses is likely to be low. The system should be designed, at a minimum, to meet General Limit Values (GLVs) as stipulated in the National Water Act. However, even if these limits values are consistently met, effluent discharge will still raise background bacterial, salinity, and nutrient levels within the receiving watercourses (R03 and W12). This may result in reduced water quality and a biotic ecological response. Notably, this could result in a change in plant species composition and structure (e.g., increased growth of nutrient-tolerant and opportunistic wetland plant species such as Typha capensis.

Increased water turbidity due to sediment inputs and / or erosion could occur. Potential spillages of cement and fuels during maintenance and repair of road infrastructure in the vicinity of watercourses could also alter water physio-chemical quality. There is also potential for contaminated surface runoff / stormwater flows from roads to enter wetlands and rivers.

If turbidity and / or pollution risks are not effectively mitigated, impacts to water quality associated with the operation of onsite infrastructure could be of 'Moderate - negative' significance. Where best practical mitigation is implemented (*as listed below and explained in detail in Chapter 6 of this report)*, this can be potentially reduced to a 'Negligible - negative' and acceptable level.

Summary of Key Mitigation Measures

<u>Key mitigation recommendations:</u>

- Sewage Treatment Plant:
  - implement best practice design and operation according to an approved management plan that accounts for expected biological and hydraulic loads, makes provision for system failures.
  - Develop a maintenance programme that includes regular inspections for wear and tear of mechanical and electrical plant components.
  - Develop a discharge water quality monitoring programme.
- Wetland rehabilitation along Wetland W12 focused on re-establishing low energy diffuse flow along the system, rather than concentrated flow along the central drain, as it currently the situation.
- Implement best practice stormwater management design, including erosion protection at outfalls and allow for unimpeded base flows along watercourses.

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- Maintain storm water infrastructure as necessary,
- Implement and adhere to buffer zones for wetlands and riparian areas.
- Implement bi-monthly aquatic biomonitoring and water quality monitoring in accordance with the 'Aquatic Monitoring Plan' during construction and use findings to inform site management.
- Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
- Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.
- Rehabilitate wetlands, riparian areas, and buffer zones and in accordance with a 'Wetland Rehabilitation & Management Plan'

		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
High	**Long-term**	**Limited**	**Unlikely**	**Moderately detrimental**	**Negative**	**Negligible - Negative**
4	**4**	**2**	**3**	**-10**		**-30**

Post-Mitigation Impact Assessment Assumptions

The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are adhered to, and all water pollution risks are addressed.

Potential Environmental Impact			
Impacts to ecological connectivity and/or ecological disturbance impacts			
Applicable Area			
The study area			
Valued Ecosystem Components:			
Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**
Irrelevant	Irrelevant	Secondary or indirect impact	Irrelevant

Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Minor	**Project Life**	**Local**	**Likely**	**Moderately detrimental**	**Negative**	**Minor - Negative**
2	**5**	**3**	**5**	**-10**		**-50**

The presence of workers and machinery operating at the individual sites may create ecological noise and vibration disturbances that can disturb amphibians, reptiles, birds, and small mammals which use watercourses for movement and refugia. Where impacts and risks are poorly managed, this impact could be of 'Minor-negative' significance and where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), this can be potentially reduced to 'Negligible - negative' significance and an environmentally acceptable level.

Summary of Key Mitigation Measures

<u>Key mitigation recommendations:</u>

- Implement and adhere to buffer zones for wetlands and riparian areas.
- Limit instream habitat disturbance.
- Restrict worker and machinery access to the repair/maintenance area.
- Prohibit poaching or collection of plants and biota during repair and maintenance.

		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Minor	**Project Life**	**Limited**	**Unlikely**	**Slightly detrimental**	**Negative**	**Negligible -negative**
2	**5**	**2**	**3**	**-9**		**-27**

Post-Mitigation Impact Assessment Assumptions
The above impact assessment rating provided under a post-mitigation scenario assumes that all mitigation measures are adhered to and all watercourses on the property are rehabilitated.

5.3.2 Phase 2

This section deals with the assessment of the potential construction and operation phase impacts and risks associated with Phase 1 of the development. Each of the potential impact consequences are discussed and assessed separately for the construction and operational phases under a 'realistic poor' and 'realistic good' or 'best practice' mitigation scenarios as defined in the 'methods' section of the report (see section 2).

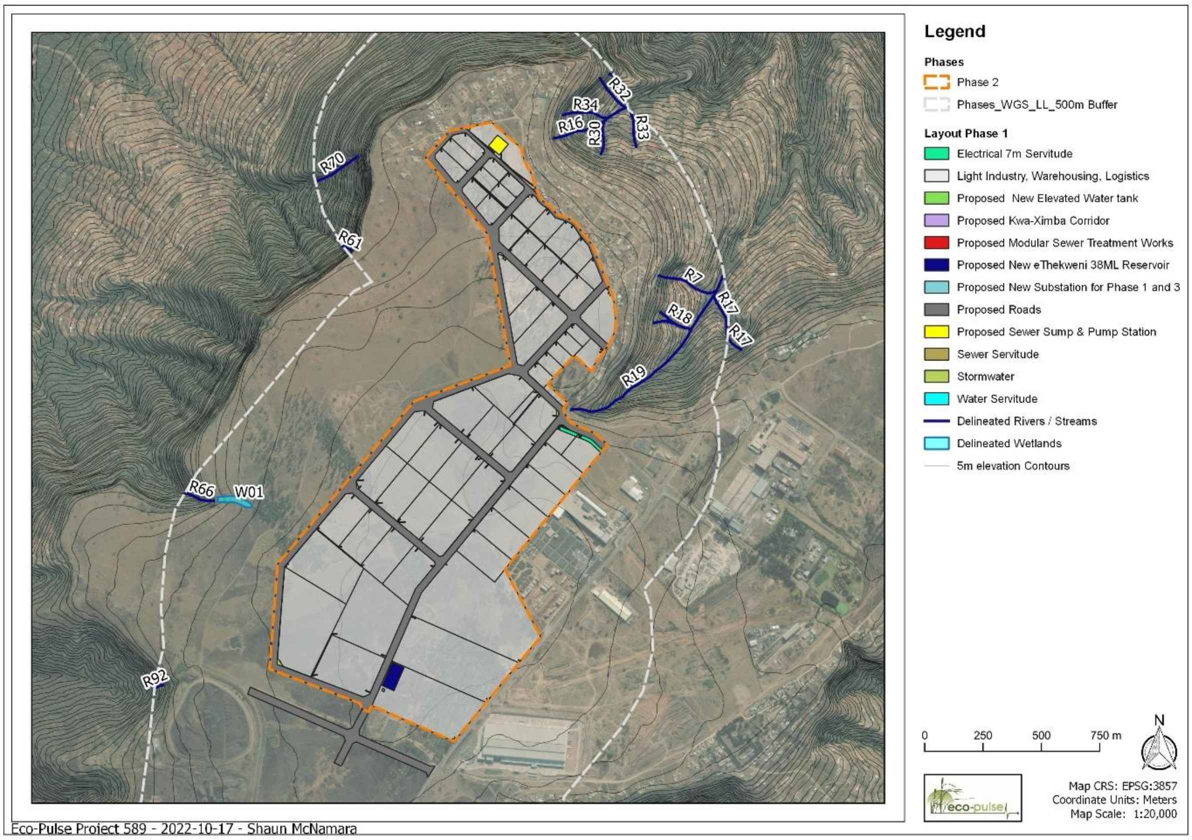

Figure 8. Phase 2 development area.

Construction Phase

Potential Environmental Impact			
Direct physical loss or modification of wetland and/ or aquatic habitat associated with the onsite watercourses			
Applicable Area			
No planned incursions into onsite watercourses			
Valued Ecosystem Components:			
Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**
Direct impact	Direct impact	Secondary or indirect impact	Secondary or indirect impact
Significance Pre-Mitigation			

Intensity	Duration	Extent	Probability	Consequence	Status (+/-)	Impact Significance
Minor Damage	Medium-Term	Limited	Likely	Slightly Detrimental	Negative	Minor - Negative
2	3	2	5	-7		-35

Summary of Key Impacts

There is no infrastructure planned within any onsite watercourses as part of this phase of the development. The planned development areas also do not encroach into the preliminary recommended watercourse buffer zones (Section 6.2.1). There are therefore no planned direct impacts to freshwater habitat areas during the construction phase of this development. There is however the potential for accidental direct physical modification to stream or wetland habitat during construction, although such impacts are unlikely under a realistic 'good' mitigation scenario.

Summary of Key Mitigation Measures

Key mitigation recommendations:

- No areas outside the construction footprint may be cleared and stripped of vegetation. To this end the outer edges of the construction site must be demarcated using a high visibility barrier / fencing. The demarcation must be signed off by the project ECO.
- Construction staff should be made aware of the location and extent of all watercourses in the vicinity of the proposed development. These should be considered strict no-go zones for the duration of onsite works.
- Drivers and machine operators must take specific care to avoid watercourses when manoeuvring vehicles and heavy equipment.

Significance Post-Mitigation

Intensity	Duration	Extent	Probability	Consequence	Status (+/-)	Impact Significance
Negligible Damage	Immediate	Very Limited	Improbable	Negligible	Negative	Negligible - negative
1	1	1	2	-3		-6

Post-Mitigation Impact Assessment Assumptions

The post-mitigation scenario is based on a scenario whereby complete avoidance of on-site watercourses achieved and no accidental incursions take place.

Potential Environmental Impact

Alteration of hydrological and geomorphological processes (erosion and sediment)

Applicable Area

The study area

Valued Ecosystem Components:

Water resource management	Ecosystem Conservation	Species Conservation	Direct Use Values
Direct impact	Direct impact	Secondary or indirect impact	Irrelevant

Significance Pre-Mitigation

Intensity	Duration	Extent	Probability	Consequence	Status (+/-)	Impact Significance
High	Medium-term	Local	Definite	Moderately Detrimental	Negative	Minor -Negative
4	3	3	7	-10		-70

Summary of Key Impacts

Construction activities in the catchment areas of onsite watercourses will result in a temporary reduction in catchment vegetation cover which could be associated with increased runoff and increased sediment supply to watercourses, especially where bare soils are exposed during peak rainfall periods. These impacts could potentially alter the geomorphic and hydrological regime of onsite watercourses. This could affect freshwater ecosystem condition and indirectly affect fauna and flora through a deterioration in the quality of available habitat . Should these impacts occur they are however likely to be temporary and are unlikely to significantly affect long-term ecological processes associated with onsite watercourses. If poorly managed hydrological and geomorphological impacts on Water Resource Management could be of a 'minor' ecological significance. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), the consequence rating can be reduced from 'moderately detrimental' to 'slightly detrimental'.

Summary of Key Mitigation Measures

Key mitigation recommendations:

- Limit the duration of construction to reduce the risk of prolonged sedimentation and erosion impacts occurring.
- Implement and adhere to buffer zones for wetlands and riparian areas, with planned development infrastructure to remain outside of the buffer zones.
- Demarcate buffers on the ground to avoid incursions into these areas.
- Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
- Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible and in accordance with a Rehabilitation & Management Plan.
- Implement bi-monthly aquatic biomonitoring and water quality monitoring during construction and use findings to inform site management.

Significance Post-Mitigation

Intensity	Duration	Extent	Probability	Consequence	Status (+/-)	Impact Significance
High	Short-term	Limited	Likely	Slightly detrimental	Negative	Minor -negative
4	2	2	5	-8		-40

Post-Mitigation Impact Assessment Assumptions

The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are, and all erosion and sedimentation risks are addressed.

Potential Environmental Impact

Impacts to water quality

Applicable Area

The study area

Valued Ecosystem Components:

Water resource management	Ecosystem Conservation	Species Conservation	Direct Use Values
Direct impact	Secondary or indirect impact	Secondary or indirect impact	Irrelevant

Significance Pre-Mitigation

Intensity	Duration	Extent	Probability	Consequence	Status (+/-)	Impact Significance
Moderate	Medium-term	Local	Highly Probable	Slightly detrimental	Negative	Minor - Negative
3	3	3	6	-9		-54

Summary of Key Impacts

Water quality impacts during construction will be limited to potential increased surface water turbidity due to sediment inputs and / or erosion and physio-chemical pollution related to potential spillages of cement and fuels during construction. Turbidity impacts are likely to be limited given the temporary nature of onsite earthworks, and the maintenance of a well-vegetated buffer around watercourses. Spillages of fuel and other harmful substances could alter the physio-chemical and biological characteristic of surface water and contaminate watercourse substrate (having a direct impact on water resource management), with potential knock-on consequences for both fauna and flora communities (affecting ecosystem and species conservation indirectly). No impact on direct use value is anticipated as watercourses were not rated as important in terms of water supply as a provisioning ecosystem service. If poorly managed, impacts to water quality could be of 'Minor' significance where turbidity and sediment and / or pollution risks are not effectively mitigated. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), this can be potentially reduced to a 'Negligible' and an environmentally acceptable level.

Summary of Key Mitigation Measures

Key mitigation recommendations:

- Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
- Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.
- Rehabilitate any spill related impacts as soon as practically possible in accordance with an 'Aquatic Contingency Plan'.
- Implement bi-monthly aquatic biomonitoring and water quality monitoring during construction and use findings to inform site management.

		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Moderate	**Short-term**	**Limited**	**Unlikely**	**Slightly detrimental**	**Negative**	**Negligible -negative**
3	**2**	**2**	**3**	**-7**		**-21**

Post-Mitigation Impact Assessment Assumptions

The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are adhered to, and all water pollution risks are addressed.

Potential Environmental Impact			
Impacts to ecological connectivity and/or ecological disturbance impacts			
Applicable Area			
The study area			
Valued Ecosystem Components:			
Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**
Irrelevant	Irrelevant	Secondary or indirect impact	Irrelevant
Ultimate Ecological Consequences: Impact Intensity Ratings			

Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Minor	**Medium-term**	**Local**	**Likely**	**Slightly detrimental**	**Negative**	**Minor - Negative**
2	**3**	**3**	**5**	**-8**		**-40**

Summary of Key Impacts

The presence of workers and machinery may create noise and vibration disturbances that may temporarily disturb amphibians, reptiles, birds, and small mammals. These disturbances will be minor, and fauna will likely revisit the site once construction has ceased, and the disturbance has halted. If poorly managed, disturbance impacts could be of 'Negligible' significance. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), the consequence rating can be reduced from slightly detrimental to negligible.

Summary of Key Mitigation Measures

<u>Key mitigation recommendations:</u>

- Implement and adhere to buffer zones for wetlands and riparian areas, with planned development infrastructure to remain outside of the buffer zones,
- Demarcate buffers on the ground to avoid incursions into these areas.
- Implement road/pipeline Method Statement to specification.
- Restrict worker and machinery access to the construction site and site camp only.
- Prohibit poaching or collection of plants and biota from natural areas, including riparian areas and wetlands.
- Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible and in accordance with the 'Rehabilitation & Management Plan'.

		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Minor	**Short-term**	**Local**	**Probable**	**Slightly detrimental**	**Negative**	**Negligible -negative**

2	2	3	4	-7		-28
Post-Mitigation Impact Assessment Assumptions						
The above impact assessment rating provided under a post-mitigation scenario assumes that all mitigation measures are adhered to.						

Operation Phase

Potential Environmental Impact						
Alteration of hydrological and geomorphological processes (erosion and sediment)						
Applicable Area						
The study area						
Valued Ecosystem Components:						
Water resource management		**Ecosystem Conservation**		**Species Conservation**	**Direct Use Values**	
Direct impact		Direct impact		Secondary or indirect impact	Irrelevant	
Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Complete loss	**Permanent**	**Local**	**Highly Probable**	**Highly detrimental**	**Negative**	**Moderate - Negative**
7	7	3	6	-17		-102
Summary of Key Impacts						
The development will result in an increase in hardened catchment surfaces, and an associated increase in surface runoff which will largely be released into the environment as part of the operation of the formal stormwater management system. This could potentially result in erosion and sedimentation along onsite watercourses and thereby inhibit their ability to provide regulating services such as flood attenuation or toxicant assimilation through the creation of concentrated flow paths, thus influencing water resource management objectives. Similarly, erosion and sedimentation can lead to a deterioration in habitat condition or loss of important habitat thereby having implications for ecosystem conservation targets and indirectly on species of conservation concern. While the attenuation and controlled release of high stormwater runoff volumes (during storms etc.) will aid in preventing erosion and sedimentation associated with increased flow volumes, the presence of stormwater attenuation structures will also serve to alter natural flow and sediment regimes. It is vital that a stormwater attenuation system be designed to have a limited impact on base / low flows to mitigate operation phase hydrological and geomorphological impacts associated with the development. The development will most likely increase peak flows due to urbanisation in the catchment, which increases the rainfall-runoff coefficient of the land surface area. Watercourses may be subjected to flooding damage. Areas where culverts will be installed at watercourse crossings may be prone to becoming blocked and are higher risk due to the momentum of flow from the prevailing flow direction and this poses a risk of undercutting and rapid erosion/bank failing during peak events. It is assumed that domestic water will be obtained from the local municipality, and there will be no reduction in water within the onsite and downstream watercourses (no direct abstraction of water). The proposed onsite sewerage package plant will release treated effluent into R03 which transitions into W12. This will increase flow along this system above natural volumes which will could sediment and hydrological dynamics. This is a notable risk along W12 as this wetland is currently characterised by a central drain and associated high concentrated flows. The planned discharge volume of the plant is currently unknown so the intensity of the impact of the associated freshwater ecosystems cannot be fully understood at this time. A Hydrological Risk Assessment should be undertaken to better understand post-development hydrological risks and impacts. It will be important for the hydrological modelling and risk assessment for each development phase, and for the cumulative development, to consider the effluent discharge volume from the proposed sewage plant. If not mitigated through appropriate stormwater outfall and attenuation structure design, this impact could be of 'Moderate' significance. Where best practical ecological design is incorporated to allows flows and sediment						

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fluxes to remain largely unimpeded, this impact can be potentially reduced to a 'Moderately Low' and acceptable level.						
Summary of Key Mitigation Measures						
<u>Key mitigation recommendations:</u> • Implement best practice stormwater management design, including erosion protection at outfalls and allow for unimpeded base flows along watercourses. • Stormwater and energy dampening systems to be designed and implemented to decreases the risk of stream bank erosion. • Maintain storm water infrastructure as necessary. • Implement and adhere to 33m and 31m buffer zones for wetlands and riparian areas, respectively. • Wetland rehabilitation along Wetland W12 focused on re-establishing low energy diffuse flow along the system, rather than concentrated flow along the central drain, as it currently the situation. • Implement aquatic biomonitoring and water quality monitoring during operation and use findings to inform site management.						
Significance Post-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Complete loss	**Permanent**	**Limited**	**Probable**	**Highly detrimental**	**Negative**	**Minor - Negative**
7	**7**	**2**	**4**	**-16**		**-64**
Post-Mitigation Impact Assessment Assumptions						
The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are adhered to and all watercourses on the property are avoided, and all erosion and sedimentation risks are addressed.						

Potential Environmental Impact						
Impacts to water quality						
Applicable Area						
The study area						
Valued Ecosystem Components:						
Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**			
Direct impact	Secondary or indirect impact	Secondary or indirect impact	Secondary or indirect impact			
Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Very High	**Beyond Project**	**Local**	**Definite**	**Highly detrimental**	**Negative**	**Moderate - Negative**
6	**6**	**3**	**7**	**-15**		**-105**
Summary of Key Impacts						
Any impacts to water quality will have a direct impact on water resource management as higher levels of pollution feeding into downstream watercourses could compromise the assimilative capacity of affected wetlands. Any harmful substance spill events or pollutants feeding into watercourses can result in the die-off of plants and fauna in the vicinity and immediately downstream of a spill affecting wetland and aquatic habitat and species of conservation concern. Die-back of vegetation due to spills could reduce the amount of grazing available for livestock within the watercourses affected but is unlikely to have a significant impact on this direct use value given that alternative sources of grazing available in the area. The onsite sewage treatment is being designed to treat 2 Mℓ / day of influent. Water pollution impacts during operation are likely to relate to the discharge of treated effluent into the environment and possible leakage of raw sewage from sewer pipeline infrastructure. The wetland into which the treated effluent is to be discharged (W12) is characterised by concentrated flows along a central drain. This increases the possibility of poor-quality water advancing along the watercourse system relative to if this wetland was characterised by low energy diffuse flow, which will have a "polishing" secondary treatment effect on the discharged effluent.						

Where pipelines and raw sewage pump stations are properly designed and installed with adequate risk mitigation, the probability of spillage of raw sewage into onsite watercourses is likely to be low. The system should be designed, at a minimum, to meet General Limit Values (GLVs) as stipulated in the National Water Act. However, even if these limits values are consistently met, effluent discharge will still raise background bacterial, salinity, and nutrient levels within the receiving watercourses (R03 and W12). This may result in reduced water quality and a biotic ecological response. Notably, this could result in a change in plant species composition and structure (e.g., increased growth of nutrient-tolerant and opportunistic wetland plant species such as Typha capensis.

Increased water turbidity due to sediment inputs and / or erosion could occur. Potential spillages of cement and fuels during maintenance and repair of road infrastructure in the vicinity of watercourses could also alter water physio-chemical quality. There is also potential for contaminated surface runoff / stormwater flows from roads to enter wetlands and rivers.

If turbidity and / or pollution risks are not effectively mitigated, impacts to water quality associated with the operation of onsite infrastructure could be of 'Moderate - negative' significance. Where best practical mitigation is implemented (*as listed below and explained in detail in Chapter 6 of this report)*, this can be potentially reduced to a 'Negligible - negative' and acceptable level.

Summary of Key Mitigation Measures

<u>Key mitigation recommendations:</u>

- Sewage Treatment Plant:
  - implement best practice design and operation according to an approved management plan that accounts for expected biological and hydraulic loads, makes provision for system failures.
  - Develop a maintenance programme that includes regular inspections for wear and tear of mechanical and electrical plant components.
  - Develop a discharge water quality monitoring programme.
- Wetland rehabilitation along Wetland W12 focused on re-establishing low energy diffuse flow along the system, rather than concentrated flow along the central drain, as it currently the situation.
- Implement best practice stormwater management design, including erosion protection at outfalls and allow for unimpeded base flows along watercourses.
- Maintain storm water infrastructure as necessary,
- Implement and adhere to buffer zones for wetlands and riparian areas.
- Implement bi-monthly aquatic biomonitoring and water quality monitoring in accordance with the 'Aquatic Monitoring Plan' during construction and use findings to inform site management.
- Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
- Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.
- Rehabilitate wetlands, riparian areas, and buffer zones and in accordance with a 'Wetland Rehabilitation & Management Plan'

		Significance Post-Mitigation					
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
High	**Long-term**	**Limited**	**Unlikely**	**Moderately detrimental**	**Negative**	**Negligible - Negative**
4	**4**	**2**	**3**	**-10**		**-30**

Post-Mitigation Impact Assessment Assumptions

The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are adhered to, and all water pollution risks are addressed.

Potential Environmental Impact			
Impacts to ecological connectivity and/or ecological disturbance impacts			
Applicable Area			
The study area			
Valued Ecosystem Components:			
Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**

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Irrelevant		Irrelevant		Secondary or indirect impact	Irrelevant	
Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Minor	**Project Life**	**Local**	**Likely**	**Moderately detrimental**	**Negative**	**Minor - Negative**
2	**5**	**3**	**5**	**-10**		**-50**
The presence of workers and machinery operating at the individual sites may create ecological noise and vibration disturbances that can disturb amphibians, reptiles, birds, and small mammals which use watercourses for movement and refugia. Where impacts and risks are poorly managed, this impact could be of 'Minor-negative' significance and where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), this can be potentially reduced to 'Negligible - negative' significance and an environmentally acceptable level.						
Summary of Key Mitigation Measures						
Key mitigation recommendations: • Implement and adhere to buffer zones for wetlands and riparian areas. • Limit instream habitat disturbance. • Restrict worker and machinery access to the repair/maintenance area. • Prohibit poaching or collection of plants and biota during repair and maintenance.						
		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Minor	**Project Life**	**Limited**	**Unlikely**	**Slightly detrimental**	**Negative**	**Negligible -negative**
2	**5**	**2**	**3**	**-9**		**-27**
Post-Mitigation Impact Assessment Assumptions						
The above impact assessment rating provided under a post-mitigation scenario assumes that all mitigation measures are adhered to and all watercourses on the property are rehabilitated.						

5.3.3 Phase 3

This section deals with the assessment of the potential construction and operation phase impacts and risks associated with proposed development area 3. Each of the potential impact consequences are discussed and assessed separately for the construction and operational phases under a 'realistic poor' and 'realistic good' or 'best practice' mitigation scenarios as defined in the 'methods' section of the report (*see section 2*).

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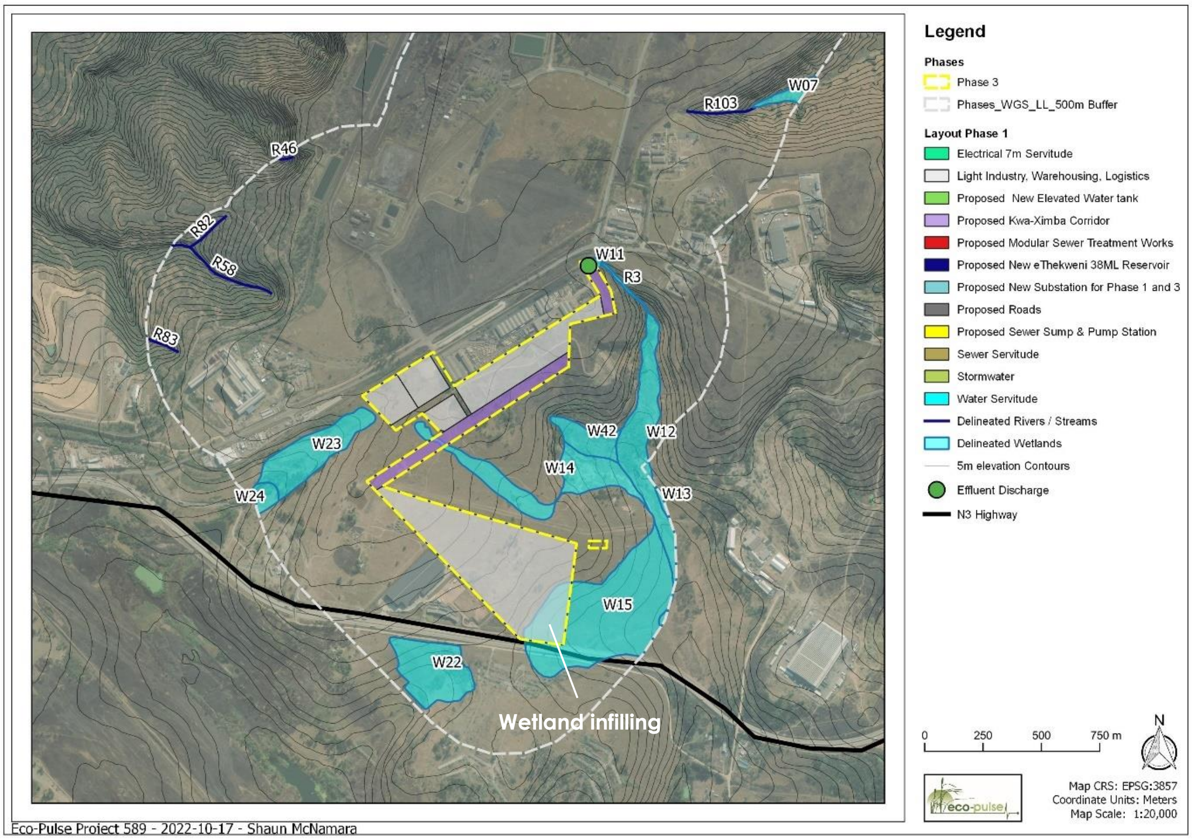

Figure 9. Phase 3 development area.

Construction Phase

<table>
<tr><th colspan="7">Potential Environmental Impact</th></tr>
<tr><td colspan="7">Direct physical loss or modification of wetland and/ or aquatic habitat associated with the onsite watercourses</td></tr>
<tr><th colspan="7">Applicable Area</th></tr>
<tr><td colspan="7">The study area</td></tr>
<tr><th colspan="7">Valued Ecosystem Components:</th></tr>
<tr><th colspan="3">Water resource management</th><th colspan="2">Ecosystem Conservation</th><th>Species Conservation</th><th>Direct Use Values</th></tr>
<tr><td colspan="3">Direct impact</td><td colspan="2">Direct impact</td><td>Secondary or indirect impact</td><td>Secondary or indirect impact</td></tr>
<tr><th colspan="7">Significance Pre-Mitigation</th></tr>
<tr><th>Intensity</th><th>Duration</th><th>Extent</th><th>Probability</th><th>Consequence</th><th>Status (+/-)</th><th>Impact Significance</th></tr>
<tr><td>Serious Damage</td><td>Permanent</td><td>Limited</td><td>Definite</td><td>Highly Detrimental</td><td rowspan="2">Negative</td><td>Major - Negative</td></tr>
<tr><td>7</td><td>7</td><td>2</td><td>7</td><td>-16</td><td>-116</td></tr>
<tr><th colspan="7">Summary of Key Impacts</th></tr>
<tr><td colspan="7">Development phase 3 encroaches into a large seep wetland (W15 – Figure 9). W15 was assessed as being in the C PES category but is of High ecological importance and sensitivity. This is because the unit is an example of a critically endangered wetland ecosystem type (seep in the sub-escarpment grassland bioregion) (National Biodiversity Assessment, 2018). The total area of wetland impacted by the encroachment is approximately 3.12ha. There are no other planned direct impacts to freshwater habitat areas during the construction phase of this development. There is however the potential for accidental direct physical modification to stream or wetland habitat during construction, although such impacts are unlikely under a realistic ‘good’ mitigation scenario.</td></tr>
<tr><th colspan="7">Summary of Key Mitigation Measures</th></tr>
</table>

Key mitigation recommendations: • Avoid encroachment and infilling of Wetland W15. • No areas outside the construction footprint may be cleared and stripped of vegetation. To this end the outer edges of the construction site must be demarcated using a high visibility barrier / fencing. The demarcation must be signed off by the project ECO. • Construction staff should be made aware of the location and extent of all watercourses in the vicinity of the proposed development. These should be considered strict no-go zones for the duration of onsite works. • Drivers and machine operators must take specific care to avoid watercourses when manoeuvring vehicles and heavy equipment.						
Significance Post-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Negligible Damage	**Immediate**	**Very Limited**	**Improbable**	**Negligible**	**Negative**	**Negligible - negative**
1	**1**	**1**	**2**	**-3**		**-6**
Post-Mitigation Impact Assessment Assumptions						
The post-mitigation scenario is based on a scenario whereby complete avoidance of on-site watercourses achieved and no accidental incursions take place.						

Potential Environmental Impact						
Alteration of hydrological and geomorphological processes (erosion and sediment)						
Applicable Area						
The study area						
Valued Ecosystem Components:						
Water resource management		**Ecosystem Conservation**		**Species Conservation**		**Direct Use Values**
Direct impact		Direct impact		Secondary or indirect impact		Irrelevant
Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
High	**Medium-term**	**Local**	**Definite**	**Moderately Detrimental**	**Negative**	**Minor -Negative**
4	**3**	**3**	**7**	**-10**		**-70**
Summary of Key Impacts						
Construction activities in the catchment areas of onsite watercourses will result in a temporary reduction in catchment vegetation cover which could be associated with increased runoff and increased sediment supply to watercourses, especially where bare soils are exposed during peak rainfall periods. These impacts could potentially alter the geomorphic and hydrological regime of onsite watercourses. This could affect freshwater ecosystem condition and indirectly affect fauna and flora through a deterioration in the quality of available habitat . Should these impacts occur they are however likely to be temporary and are unlikely to significantly affect long-term ecological processes associated with onsite watercourses. If poorly managed hydrological and geomorphological impacts on Water Resource Management could be of a 'minor' ecological significance. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), the consequence rating can be reduced from 'moderately detrimental' to 'slightly detrimental'.						
Summary of Key Mitigation Measures						
Key mitigation recommendations: • Limit the duration of construction to reduce the risk of prolonged sedimentation and erosion impacts occurring. • Implement and adhere to buffer zones for wetlands and riparian areas, with planned development infrastructure to remain outside of the buffer zones. • Demarcate buffers on the ground to avoid incursions into these areas. • Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible and in accordance with a Rehabilitation & Management Plan.						

• Implement bi-monthly aquatic biomonitoring and water quality monitoring during construction and use findings to inform site management.						
Significance Post-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
High	**Short-term**	**Limited**	**Likely**	**Slightly detrimental**	**Negative**	**Minor -negative**
4	**2**	**2**	**5**	**-8**		**-40**
Post-Mitigation Impact Assessment Assumptions						
The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are, and all erosion and sedimentation risks are addressed.						

Potential Environmental Impact						
Impacts to water quality						
Applicable Area						
The study area						
Valued Ecosystem Components:						
Water resource management		**Ecosystem Conservation**		**Species Conservation**		**Direct Use Values**
Direct impact		Secondary or indirect impact		Secondary or indirect impact		Irrelevant
Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Moderate	**Medium-term**	**Local**	**Highly Probable**	**Slightly detrimental**	**Negative**	**Minor - Negative**
3	**3**	**3**	**6**	**-9**		**-54**
Summary of Key Impacts						
Water quality impacts during construction will be limited to potential increased surface water turbidity due to sediment inputs and / or erosion and physio-chemical pollution related to potential spillages of cement and fuels during construction. Turbidity impacts are likely to be limited given the temporary nature of onsite earthworks, and the maintenance of a well-vegetated buffer around watercourses. Spillages of fuel and other harmful substances could alter the physio-chemical and biological characteristic of surface water and contaminate watercourse substrate (having a direct impact on water resource management), with potential knock-on consequences for both fauna and flora communities (affecting ecosystem and species conservation indirectly). No impact on direct use value is anticipated as watercourses were not rated as important in terms of water supply as a provisioning ecosystem service. If poorly managed, impacts to water quality could be of 'Minor' significance where turbidity and sediment and / or pollution risks are not effectively mitigated. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), this can be potentially reduced to a 'Negligible' and an environmentally acceptable level.						
Summary of Key Mitigation Measures						
Key mitigation recommendations: • Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control. • Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management. • Rehabilitate any spill related impacts as soon as practically possible in accordance with an 'Aquatic Contingency Plan'. • Implement bi-monthly aquatic biomonitoring and water quality monitoring during construction and use findings to inform site management.						
		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Moderate	**Short-term**	**Limited**	**Unlikely**	**Slightly detrimental**	**Negative**	**Negligible -negative**

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3	2	2	3	-7		-21
Post-Mitigation Impact Assessment Assumptions						
The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are adhered to, and all water pollution risks are addressed.						

Potential Environmental Impact						
Impacts to ecological connectivity and/or ecological disturbance impacts						
Applicable Area						
The study area						
Valued Ecosystem Components:						
Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**			
Irrelevant	Irrelevant	Secondary or indirect impact	Irrelevant			
Ultimate Ecological Consequences: Impact Intensity Ratings						
Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Minor	**Medium-term**	**Local**	**Likely**	**Slightly detrimental**	**Negative**	**Minor - Negative**
2	**3**	**3**	**5**	**-8**		**-40**
Summary of Key Impacts						
The presence of workers and machinery may create noise and vibration disturbances that may temporarily disturb amphibians, reptiles, birds, and small mammals. These disturbances will be minor, and fauna will likely revisit the site once construction has ceased, and the disturbance has halted. If poorly managed, disturbance impacts could be of 'Negligible' significance. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), the consequence rating can be reduced from slightly detrimental to negligible.						
Summary of Key Mitigation Measures						
<u>Key mitigation recommendations:</u> • Implement and adhere to buffer zones for wetlands and riparian areas, with planned development infrastructure to remain outside of the buffer zones, • Demarcate buffers on the ground to avoid incursions into these areas. • Implement road/pipeline Method Statement to specification. • Restrict worker and machinery access to the construction site and site camp only. • Prohibit poaching or collection of plants and biota from natural areas, including riparian areas and wetlands. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible and in accordance with the 'Rehabilitation & Management Plan'.						
		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Minor	**Short-term**	**Local**	**Probable**	**Slightly detrimental**	**Negative**	**Negligible -negative**
2	**2**	**3**	**4**	**-7**		**-28**
Post-Mitigation Impact Assessment Assumptions						
The above impact assessment rating provided under a post-mitigation scenario assumes that all mitigation measures are adhered to.						

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Operation Phase

Potential Environmental Impact						
Alteration of hydrological and geomorphological processes (erosion and sediment)						
Applicable Area						
The study area						
Valued Ecosystem Components:						
Water resource management		**Ecosystem Conservation**		**Species Conservation**	**Direct Use Values**	
Direct impact		Direct impact		Secondary or indirect impact	Irrelevant	
Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Complete loss	**Permanent**	**Local**	**Highly Probable**	**Highly detrimental**	**Negative**	**Moderate - Negative**
7	**7**	**3**	**6**	**-17**		**-102**

Summary of Key Impacts

The development will result in an increase in hardened catchment surfaces, and an associated increase in surface runoff which will largely be released into the environment as part of the operation of the formal stormwater management system. This could potentially result in erosion and sedimentation along onsite watercourses and thereby inhibit their ability to provide regulating services such as flood attenuation or toxicant assimilation through the creation of concentrated flow paths, thus influencing water resource management objectives. Similarly, erosion and sedimentation can lead to a deterioration in habitat condition or loss of important habitat thereby having implications for ecosystem conservation targets and indirectly on species of conservation concern.

While the attenuation and controlled release of high stormwater runoff volumes (during storms etc.) will aid in preventing erosion and sedimentation associated with increased flow volumes, the presence of stormwater attenuation structures will also serve to alter natural flow and sediment regimes. It is vital that a stormwater attenuation system be designed to have a limited impact on base / low flows to mitigate operation phase hydrological and geomorphological impacts associated with the development.

The development will most likely increase peak flows due to urbanisation in the catchment, which increases the rainfall-runoff coefficient of the land surface area. Watercourses may be subjected to flooding damage. Areas where culverts will be installed at watercourse crossings may be prone to becoming blocked and are higher risk due to the momentum of flow from the prevailing flow direction and this poses a risk of undercutting and rapid erosion/bank failing during peak events. It is assumed that domestic water will be obtained from the local municipality, and there will be no reduction in water within the onsite and downstream watercourses (no direct abstraction of water).

The proposed onsite sewerage package plant will release treated effluent into R03 which transitions into W12. This will increase flow along this system above natural volumes which will could sediment and hydrological dynamics. This is a notable risk along W12 as this wetland is currently characterised by a central drain and associated high concentrated flows. The planned discharge volume of the plant is currently unknown so the intensity of the impact of the associated freshwater ecosystems cannot be fully understood at this time.

A Hydrological Risk Assessment should be undertaken to better understand post-development hydrological risks and impacts. It will be important for the hydrological modelling and risk assessment for each development phase, and for the cumulative development, to consider the effluent discharge volume from the proposed sewage plant.

If not mitigated through appropriate stormwater outfall and attenuation structure design, this impact could be of 'Moderate' significance. Where best practical ecological design is incorporated to allows flows and sediment fluxes to remain largely unimpeded, this impact can be potentially reduced to a 'Moderately Low' and acceptable level.

Summary of Key Mitigation Measures

Key mitigation recommendations:

- Implement best practice stormwater management design, including erosion protection at outfalls and allow for unimpeded base flows along watercourses.

- Stormwater and energy dampening systems to be designed and implemented to decreases the risk of stream bank erosion.
- Maintain storm water infrastructure as necessary.
- Implement and adhere to 33m and 31m buffer zones for wetlands and riparian areas, respectively.
- Wetland rehabilitation along Wetland W12 focused on re-establishing low energy diffuse flow along the system, rather than concentrated flow along the central drain, as it currently the situation.
- Implement aquatic biomonitoring and water quality monitoring during operation and use findings to inform site management.

Significance Post-Mitigation

Intensity	Duration	Extent	Probability	Consequence	Status (+/-)	Impact Significance
Complete loss	Permanent	Limited	Probable	Highly detrimental	Negative	Minor - Negative
7	7	2	4	-16		-64

Post-Mitigation Impact Assessment Assumptions

The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are adhered to and all watercourses on the property are avoided, and all erosion and sedimentation risks are addressed.

Potential Environmental Impact			
Impacts to water quality			
Applicable Area			
The study area			
Valued Ecosystem Components:			
Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**
Direct impact	Secondary or indirect impact	Secondary or indirect impact	Secondary or indirect impact

Significance Pre-Mitigation

Intensity	Duration	Extent	Probability	Consequence	Status (+/-)	Impact Significance
Very High	Beyond Project	Local	Definite	Highly detrimental	Negative	Moderate - Negative
6	6	3	7	-15		-105

Summary of Key Impacts

Any impacts to water quality will have a direct impact on water resource management as higher levels of pollution feeding into downstream watercourses could compromise the assimilative capacity of affected wetlands. Any harmful substance spill events or pollutants feeding into watercourses can result in the die-off of plants and fauna in the vicinity and immediately downstream of a spill affecting wetland and aquatic habitat and species of conservation concern. Die-back of vegetation due to spills could reduce the amount of grazing available for livestock within the watercourses affected but is unlikely to have a significant impact on this direct use value given that alternative sources of grazing available in the area.

The onsite sewage treatment is being designed to treat 2 Mℓ / day of influent. Water pollution impacts during operation are likely to relate to the discharge of treated effluent into the environment and possible leakage of raw sewage from sewer pipeline infrastructure. The wetland into which the treated effluent is to be discharged (W12) is characterised by concentrated flows along a central drain. This increases the possibility of poor-quality water advancing along the watercourse system relative to if this wetland was characterised by low energy diffuse flow, which will have a "polishing" secondary treatment effect on the discharged effluent.

Where pipelines and raw sewage pump stations are properly designed and installed with adequate risk mitigation, the probability of spillage of raw sewage into onsite watercourses is likely to be low. The system should be designed, at a minimum, to meet General Limit Values (GLVs) as stipulated in the National Water Act. However, even if these limits values are consistently met, effluent discharge will still raise background bacterial, salinity, and nutrient levels within the receiving watercourses (R03 and W12). This may result in reduced water quality and a biotic ecological response. Notably, this could result in a change in plant species composition and structure (e.g., increased growth of nutrient-tolerant and opportunistic wetland plant species such as Typha capensis.

Increased water turbidity due to sediment inputs and / or erosion could occur. Potential spillages of cement and fuels during maintenance and repair of road infrastructure in the vicinity of watercourses could also alter water physio-chemical quality. There is also potential for contaminated surface runoff / stormwater flows from roads to enter wetlands and rivers.

If turbidity and / or pollution risks are not effectively mitigated, impacts to water quality associated with the operation of onsite infrastructure could be of 'Moderate - negative' significance. Where best practical mitigation is implemented *(as listed below and explained in detail in Chapter 6 of this report)*, this can be potentially reduced to a 'Negligible - negative' and acceptable level.

Summary of Key Mitigation Measures

Key mitigation recommendations:

- Sewage Treatment Plant:
    - implement best practice design and operation according to an approved management plan that accounts for expected biological and hydraulic loads, makes provision for system failures.
    - Develop a maintenance programme that includes regular inspections for wear and tear of mechanical and electrical plant components.
    - Develop a discharge water quality monitoring programme.
- Wetland rehabilitation along Wetland W12 focused on re-establishing low energy diffuse flow along the system, rather than concentrated flow along the central drain, as it currently the situation.
- Implement best practice stormwater management design, including erosion protection at outfalls and allow for unimpeded base flows along watercourses.
- Maintain storm water infrastructure as necessary,
- Implement and adhere to buffer zones for wetlands and riparian areas.
- Implement bi-monthly aquatic biomonitoring and water quality monitoring in accordance with the 'Aquatic Monitoring Plan' during construction and use findings to inform site management.
- Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
- Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.
- Rehabilitate wetlands, riparian areas, and buffer zones and in accordance with a 'Wetland Rehabilitation & Management Plan'

		Significance Post-Mitigation					
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
High	**Long-term**	**Limited**	**Unlikely**	**Moderately detrimental**	**Negative**	**Negligible - Negative**
4	**4**	**2**	**3**	**-10**		**-30**

Post-Mitigation Impact Assessment Assumptions

The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are adhered to, and all water pollution risks are addressed.

Potential Environmental Impact			
Impacts to ecological connectivity and/or ecological disturbance impacts			
Applicable Area			
The study area			
Valued Ecosystem Components:			
Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**
Irrelevant	Irrelevant	Secondary or indirect impact	Irrelevant

Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status**	**Impact Significance**

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					(+/-)	
Minor	**Project Life**	**Local**	**Likely**	**Moderately detrimental**	**Negative**	**Minor - Negative**
2	**5**	**3**	**5**	**-10**		**-50**
The presence of workers and machinery operating at the individual sites may create ecological noise and vibration disturbances that can disturb amphibians, reptiles, birds, and small mammals which use watercourses for movement and refugia. Where impacts and risks are poorly managed, this impact could be of 'Minor-negative' significance and where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), this can be potentially reduced to 'Negligible - negative' significance and an environmentally acceptable level.						
Summary of Key Mitigation Measures						
Key mitigation recommendations: • Implement and adhere to buffer zones for wetlands and riparian areas. • Limit instream habitat disturbance. • Restrict worker and machinery access to the repair/maintenance area. • Prohibit poaching or collection of plants and biota during repair and maintenance.						
		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Minor	**Project Life**	**Limited**	**Unlikely**	**Slightly detrimental**	**Negative**	**Negligible -negative**
2	**5**	**2**	**3**	**-9**		**-27**
Post-Mitigation Impact Assessment Assumptions						
The above impact assessment rating provided under a post-mitigation scenario assumes that all mitigation measures are adhered to and all watercourses on the property are rehabilitated.						

5.3.4 All Development Phases

This section deals with the assessment of the potential construction and operation phase impacts and risks associated with proposed development Phases 1, 2, and 3 collectively. Each of the potential impact consequences are discussed and assessed separately for the construction and operational phases under a 'realistic poor' and 'realistic good' or 'best practice' mitigation scenarios as defined in the 'methods' section of the report (*see section* 2).

Construction Phase

Potential Environmental Impact						
Direct physical loss or modification of wetland and/ or aquatic habitat associated with the onsite watercourses						
Applicable Area						
The study area						
Valued Ecosystem Components:						
Water resource management			**Ecosystem Conservation**		**Species Conservation**	**Direct Use Values**
Direct impact			Direct impact		Secondary or indirect impact	Secondary or indirect impact
Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Serious Damage	**Permanent**	**Limited**	**Definite**	**Highly Detrimental**	**Negative**	**Major - Negative**
7	**7**	**2**	**7**	**-16**		**-116**

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<table>
<tr><th colspan="7">Summary of Key Impacts</th></tr>
<tr><td colspan="7">Development phase 3 encroaches into a large seep wetland (W15 – Figure 9). W15 was assessed as being in the C PES category but is of High ecological importance and sensitivity. This is because the unit is an example of a critically endangered wetland ecosystem type (seep in the sub-escarpment grassland bioregion) (National Biodiversity Assessment, 2018). The total area of wetland impacted by the encroachment is approximately 3.12ha. There are no other planned direct impacts to freshwater habitat areas during the construction phase of this development. There is however the potential for accidental direct physical modification to stream or wetland habitat during construction, although such impacts are unlikely under a realistic 'good' mitigation scenario.</td></tr>
<tr><th colspan="7">Summary of Key Mitigation Measures</th></tr>
<tr><td colspan="7"><u>Key mitigation recommendations:</u>
• Avoid encroachment and infilling of Wetland W15.
• No areas outside the construction footprint may be cleared and stripped of vegetation. To this end the outer edges of the construction site must be demarcated using a high visibility barrier / fencing. The demarcation must be signed off by the project ECO.
• Construction staff should be made aware of the location and extent of all watercourses in the vicinity of the proposed development. These should be considered strict no-go zones for the duration of onsite works.
• Drivers and machine operators must take specific care to avoid watercourses when manoeuvring vehicles and heavy equipment.</td></tr>
<tr><th colspan="7">Significance Post-Mitigation</th></tr>
<tr><th>Intensity</th><th>Duration</th><th>Extent</th><th>Probability</th><th>Consequence</th><th>Status (+/-)</th><th>Impact Significance</th></tr>
<tr><td>Negligible Damage</td><td>Immediate</td><td>Very Limited</td><td>Improbable</td><td>Negligible</td><td rowspan="2">Negative</td><td>Negligible - negative</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>2</td><td>-3</td><td>-6</td></tr>
<tr><th colspan="7">Post-Mitigation Impact Assessment Assumptions</th></tr>
<tr><td colspan="7">The post-mitigation scenario is based on a scenario whereby complete avoidance of on-site watercourses achieved and no accidental incursions take place.</td></tr>
</table>

<table>
<tr><th colspan="7">Potential Environmental Impact</th></tr>
<tr><td colspan="7">Alteration of hydrological and geomorphological processes (erosion and sediment)</td></tr>
<tr><th colspan="7">Applicable Area</th></tr>
<tr><td colspan="7">The study area</td></tr>
<tr><th colspan="7">Valued Ecosystem Components:</th></tr>
<tr><th colspan="2">Water resource management</th><th colspan="2">Ecosystem Conservation</th><th>Species Conservation</th><th colspan="2">Direct Use Values</th></tr>
<tr><td colspan="2">Direct impact</td><td colspan="2">Direct impact</td><td>Secondary or indirect impact</td><td colspan="2">Irrelevant</td></tr>
<tr><th colspan="7">Significance Pre-Mitigation</th></tr>
<tr><th>Intensity</th><th>Duration</th><th>Extent</th><th>Probability</th><th>Consequence</th><th>Status (+/-)</th><th>Impact Significance</th></tr>
<tr><td>High</td><td>Medium-term</td><td>Local</td><td>Definite</td><td>Moderately Detrimental</td><td rowspan="2">Negative</td><td>Minor -Negative</td></tr>
<tr><td>4</td><td>3</td><td>3</td><td>7</td><td>-10</td><td>-70</td></tr>
<tr><th colspan="7">Summary of Key Impacts</th></tr>
<tr><td colspan="7">Construction activities in the catchment areas of onsite watercourses will result in a temporary reduction in catchment vegetation cover which could be associated with increased runoff and increased sediment supply to watercourses, especially where bare soils are exposed during peak rainfall periods. These impacts could potentially alter the geomorphic and hydrological regime of onsite watercourses. This could affect freshwater ecosystem condition and indirectly affect fauna and flora through a deterioration in the quality of available habitat . Should these impacts occur they are however likely to be temporary and are unlikely to significantly affect long-term ecological processes associated with onsite watercourses. If poorly managed hydrological and geomorphological impacts on Water Resource Management could be of a 'minor' ecological significance. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), the consequence rating can be reduced from 'moderately detrimental' to 'slightly detrimental'.</td></tr>
<tr><th colspan="7">Summary of Key Mitigation Measures</th></tr>
</table>

<table>
<tr><td colspan="7">Key mitigation recommendations:
• Limit the duration of construction to reduce the risk of prolonged sedimentation and erosion impacts occurring.
• Implement and adhere to buffer zones for wetlands and riparian areas, with planned development infrastructure to remain outside of the buffer zones.
• Demarcate buffers on the ground to avoid incursions into these areas.
• Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
• Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible and in accordance with a Rehabilitation & Management Plan.
• Implement bi-monthly aquatic biomonitoring and water quality monitoring during construction and use findings to inform site management.</td></tr>
<tr><th colspan="7">Significance Post-Mitigation</th></tr>
<tr><th>Intensity</th><th>Duration</th><th>Extent</th><th>Probability</th><th>Consequence</th><th>Status (+/-)</th><th>Impact Significance</th></tr>
<tr><td>High</td><td>Short-term</td><td>Limited</td><td>Likely</td><td>Slightly detrimental</td><td rowspan="2">Negative</td><td>Minor -negative</td></tr>
<tr><td>4</td><td>2</td><td>2</td><td>5</td><td>-8</td><td>-40</td></tr>
<tr><th colspan="7">Post-Mitigation Impact Assessment Assumptions</th></tr>
<tr><td colspan="7">The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are, and all erosion and sedimentation risks are addressed.</td></tr>
</table>

<table>
<tr><th colspan="7">Potential Environmental Impact</th></tr>
<tr><td colspan="7">Impacts to water quality</td></tr>
<tr><th colspan="7">Applicable Area</th></tr>
<tr><td colspan="7">The study area</td></tr>
<tr><th colspan="7">Valued Ecosystem Components:</th></tr>
<tr><th colspan="2">Water resource management</th><th colspan="2">Ecosystem Conservation</th><th>Species Conservation</th><th colspan="2">Direct Use Values</th></tr>
<tr><td colspan="2">Direct impact</td><td colspan="2">Secondary or indirect impact</td><td>Secondary or indirect impact</td><td colspan="2">Irrelevant</td></tr>
<tr><th colspan="7">Significance Pre-Mitigation</th></tr>
<tr><th>Intensity</th><th>Duration</th><th>Extent</th><th>Probability</th><th>Consequence</th><th>Status (+/-)</th><th>Impact Significance</th></tr>
<tr><td>Moderate</td><td>Medium-term</td><td>Local</td><td>Highly Probable</td><td>Slightly detrimental</td><td rowspan="2">Negative</td><td>Minor - Negative</td></tr>
<tr><td>3</td><td>3</td><td>3</td><td>6</td><td>-9</td><td>-54</td></tr>
<tr><th colspan="7">Summary of Key Impacts</th></tr>
<tr><td colspan="7">Water quality impacts during construction will be limited to potential increased surface water turbidity due to sediment inputs and / or erosion and physio-chemical pollution related to potential spillages of cement and fuels during construction. Turbidity impacts are likely to be limited given the temporary nature of onsite earthworks, and the maintenance of a well-vegetated buffer around watercourses. Spillages of fuel and other harmful substances could alter the physio-chemical and biological characteristic of surface water and contaminate watercourse substrate (having a direct impact on water resource management), with potential knock-on consequences for both fauna and flora communities (affecting ecosystem and species conservation indirectly). No impact on direct use value is anticipated as watercourses were not rated as important in terms of water supply as a provisioning ecosystem service. If poorly managed, impacts to water quality could be of ‘Minor’ significance where turbidity and sediment and / or pollution risks are not effectively mitigated. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), this can be potentially reduced to a ‘Negligible’ and an environmentally acceptable level.</td></tr>
<tr><th colspan="7">Summary of Key Mitigation Measures</th></tr>
<tr><td colspan="7">Key mitigation recommendations:
• Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
• Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.</td></tr>
</table>

- Rehabilitate any spill related impacts as soon as practically possible in accordance with an 'Aquatic Contingency Plan'.
- Implement bi-monthly aquatic biomonitoring and water quality monitoring during construction and use findings to inform site management.

		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Moderate	**Short-term**	**Limited**	**Unlikely**	**Slightly detrimental**	**Negative**	**Negligible -negative**
3	**2**	**2**	**3**	**-7**		**-21**

Post-Mitigation Impact Assessment Assumptions

The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are adhered to, and all water pollution risks are addressed.

Potential Environmental Impact			
Impacts to ecological connectivity and/or ecological disturbance impacts			
Applicable Area			
The study area			
Valued Ecosystem Components:			
Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**
Irrelevant	Irrelevant	Secondary or indirect impact	Irrelevant
Ultimate Ecological Consequences: Impact Intensity Ratings			

Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Minor	**Medium-term**	**Local**	**Likely**	**Slightly detrimental**	**Negative**	**Minor - Negative**
2	**3**	**3**	**5**	**-8**		**-40**

Summary of Key Impacts

The presence of workers and machinery may create noise and vibration disturbances that may temporarily disturb amphibians, reptiles, birds, and small mammals. These disturbances will be minor, and fauna will likely revisit the site once construction has ceased, and the disturbance has halted. If poorly managed, disturbance impacts could be of 'Negligible' significance. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), the consequence rating can be reduced from slightly detrimental to negligible.

Summary of Key Mitigation Measures

Key mitigation recommendations:

- Implement and adhere to buffer zones for wetlands and riparian areas, with planned development infrastructure to remain outside of the buffer zones,
- Demarcate buffers on the ground to avoid incursions into these areas.
- Implement road/pipeline Method Statement to specification.
- Restrict worker and machinery access to the construction site and site camp only.
- Prohibit poaching or collection of plants and biota from natural areas, including riparian areas and wetlands.
- Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible and in accordance with the 'Rehabilitation & Management Plan'.

		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Minor	**Short-term**	**Local**	**Probable**	**Slightly detrimental**	**Negative**	**Negligible -negative**
2	**2**	**3**	**4**	**-7**		**-28**

Post-Mitigation Impact Assessment Assumptions

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The above impact assessment rating provided under a post-mitigation scenario assumes that all mitigation measures are adhered to.

Operation Phase

Potential Environmental Impact						
Alteration of hydrological and geomorphological processes (erosion and sediment)						
Applicable Area						
The study area						
Valued Ecosystem Components:						
Water resource management		**Ecosystem Conservation**		**Species Conservation**		**Direct Use Values**
Direct impact		Direct impact		Secondary or indirect impact		Irrelevant
Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Complete loss	**Permanent**	**Local**	**Highly Probable**	**Highly detrimental**	**Negative**	**Moderate - Negative**
7	**7**	**3**	**6**	**-17**		**-102**
Summary of Key Impacts						

The development will result in an increase in hardened catchment surfaces, and an associated increase in surface runoff which will largely be released into the environment as part of the operation of the formal stormwater management system. This could potentially result in erosion and sedimentation along onsite watercourses and thereby inhibit their ability to provide regulating services such as flood attenuation or toxicant assimilation through the creation of concentrated flow paths, thus influencing water resource management objectives. Similarly, erosion and sedimentation can lead to a deterioration in habitat condition or loss of important habitat thereby having implications for ecosystem conservation targets and indirectly on species of conservation concern. While the attenuation and controlled release of high stormwater runoff volumes (during storms etc.) will aid in preventing erosion and sedimentation associated with increased flow volumes, the presence of stormwater attenuation structures will also serve to alter natural flow and sediment regimes. It is vital that a stormwater attenuation system be designed to have a limited impact on base / low flows to mitigate operation phase hydrological and geomorphological impacts associated with the development. The development will most likely increase peak flows due to urbanisation in the catchment, which increases the rainfall-runoff coefficient of the land surface area. Watercourses may be subjected to flooding damage. Areas where culverts will be installed at watercourse crossings may be prone to becoming blocked and are higher risk due to the momentum of flow from the prevailing flow direction and this poses a risk of undercutting and rapid erosion/bank failing during peak events. It is assumed that domestic water will be obtained from the local municipality, and there will be no reduction in water within the onsite and downstream watercourses (no direct abstraction of water). The proposed onsite sewerage package plant will release treated effluent into R03 which transitions into W12. This will increase flow along this system above natural volumes which will could sediment and hydrological dynamics. This is a notable risk along W12 as this wetland is currently characterised by a central drain and associated high concentrated flows. The planned discharge volume of the plant is currently unknown so the intensity of the impact of the associated freshwater ecosystems cannot be fully understood at this time. A Hydrological Risk Assessment should be undertaken to better understand post-development hydrological risks and impacts. It will be important for the hydrological modelling and risk assessment for each development phase, and for the cumulative development, to consider the effluent discharge volume from the proposed sewage plant. If not mitigated through appropriate stormwater outfall and attenuation structure design, this impact could be of 'Moderate' significance. Where best practical ecological design is incorporated to allows flows and sediment fluxes to remain largely unimpeded, this impact can be potentially reduced to a 'Moderately Low' and acceptable level.

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Summary of Key Mitigation Measures

Key mitigation recommendations:

- Implement best practice stormwater management design, including erosion protection at outfalls and allow for unimpeded base flows along watercourses.
- Stormwater and energy dampening systems to be designed and implemented to decreases the risk of stream bank erosion.
- Maintain storm water infrastructure as necessary.
- Implement and adhere to 33m and 31m buffer zones for wetlands and riparian areas, respectively.
- Wetland rehabilitation along Wetland W12 focused on re-establishing low energy diffuse flow along the system, rather than concentrated flow along the central drain, as it currently the situation.
- Implement aquatic biomonitoring and water quality monitoring during operation and use findings to inform site management.

Significance Post-Mitigation

Intensity	Duration	Extent	Probability	Consequence	Status (+/-)	Impact Significance
Complete loss	Permanent	Limited	Probable	Highly detrimental	Negative	Minor - Negative
7	7	2	4	-16		-64

Post-Mitigation Impact Assessment Assumptions

The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are adhered to and all watercourses on the property are avoided, and all erosion and sedimentation risks are addressed.

Potential Environmental Impact

Impacts to water quality

Applicable Area

The study area

Valued Ecosystem Components:

Water resource management	Ecosystem Conservation	Species Conservation	Direct Use Values
Direct impact	Secondary or indirect impact	Secondary or indirect impact	Secondary or indirect impact

Significance Pre-Mitigation

Intensity	Duration	Extent	Probability	Consequence	Status (+/-)	Impact Significance
Very High	Beyond Project	Local	Definite	Highly detrimental	Negative	Moderate - Negative
6	6	3	7	-15		-105

Summary of Key Impacts

Any impacts to water quality will have a direct impact on water resource management as higher levels of pollution feeding into downstream watercourses could compromise the assimilative capacity of affected wetlands. Any harmful substance spill events or pollutants feeding into watercourses can result in the die-off of plants and fauna in the vicinity and immediately downstream of a spill affecting wetland and aquatic habitat and species of conservation concern. Die-back of vegetation due to spills could reduce the amount of grazing available for livestock within the watercourses affected but is unlikely to have a significant impact on this direct use value given that alternative sources of grazing available in the area.

The onsite sewage treatment is being designed to treat 2 Mℓ / day of influent. Water pollution impacts during operation are likely to relate to the discharge of treated effluent into the environment and possible leakage of raw sewage from sewer pipeline infrastructure. The wetland into which the treated effluent is to be discharged (W12) is characterised by concentrated flows along a central drain. This increases the possibility of poor-quality water advancing along the watercourse system relative to if this wetland was characterised by low energy diffuse flow, which will have a "polishing" secondary treatment effect on the discharged effluent.

Where pipelines and raw sewage pump stations are properly designed and installed with adequate risk mitigation, the probability of spillage of raw sewage into onsite watercourses is likely to be low. The system should be designed, at a minimum, to meet General Limit Values (GLVs) as stipulated in the National Water Act. However, even if these limits values are consistently met, effluent discharge will still raise background bacterial, salinity, and nutrient levels within the receiving watercourses (R03 and W12). This may result in reduced water quality and a biotic ecological response. Notably, this could result in a change in plant species composition and structure (e.g., increased growth of nutrient-tolerant and opportunistic wetland plant species such as Typha capensis.

Increased water turbidity due to sediment inputs and / or erosion could occur. Potential spillages of cement and fuels during maintenance and repair of road infrastructure in the vicinity of watercourses could also alter water physio-chemical quality. There is also potential for contaminated surface runoff / stormwater flows from roads to enter wetlands and rivers.

If turbidity and / or pollution risks are not effectively mitigated, impacts to water quality associated with the operation of onsite infrastructure could be of 'Moderate - negative' significance. Where best practical mitigation is implemented (*as listed below and explained in detail in Chapter 6 of this report)*, this can be potentially reduced to a 'Negligible - negative' and acceptable level.

Summary of Key Mitigation Measures

Key mitigation recommendations:

- Sewage Treatment Plant:
  - implement best practice design and operation according to an approved management plan that accounts for expected biological and hydraulic loads, makes provision for system failures.
  - Develop a maintenance programme that includes regular inspections for wear and tear of mechanical and electrical plant components.
  - Develop a discharge water quality monitoring programme.
- Wetland rehabilitation along Wetland W12 focused on re-establishing low energy diffuse flow along the system, rather than concentrated flow along the central drain, as it currently the situation.
- Implement best practice stormwater management design, including erosion protection at outfalls and allow for unimpeded base flows along watercourses.
- Maintain storm water infrastructure as necessary,
- Implement and adhere to buffer zones for wetlands and riparian areas.
- Implement bi-monthly aquatic biomonitoring and water quality monitoring in accordance with the 'Aquatic Monitoring Plan' during construction and use findings to inform site management.
- Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
- Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.
- Rehabilitate wetlands, riparian areas, and buffer zones and in accordance with a 'Wetland Rehabilitation & Management Plan'

		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
High	**Long-term**	**Limited**	**Unlikely**	**Moderately detrimental**	**Negative**	**Negligible - Negative**
4	**4**	**2**	**3**	**-10**		**-30**

Post-Mitigation Impact Assessment Assumptions

The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are adhered to, and all water pollution risks are addressed.

Potential Environmental Impact			
Impacts to ecological connectivity and/or ecological disturbance impacts			
Applicable Area			
The study area			
Valued Ecosystem Components:			
Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**
Irrelevant	Irrelevant	Secondary or indirect impact	Irrelevant

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Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Minor	**Project Life**	**Local**	**Likely**	**Moderately detrimental**	**Negative**	**Minor - Negative**
2	**5**	**3**	**5**	**-10**		**-50**
The presence of workers and machinery operating at the individual sites may create ecological noise and vibration disturbances that can disturb amphibians, reptiles, birds, and small mammals which use watercourses for movement and refugia. Where impacts and risks are poorly managed, this impact could be of 'Minor-negative' significance and where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), this can be potentially reduced to 'Negligible - negative' significance and an environmentally acceptable level.						
Summary of Key Mitigation Measures						
<u>Key mitigation recommendations:</u> • Implement and adhere to buffer zones for wetlands and riparian areas. • Limit instream habitat disturbance. • Restrict worker and machinery access to the repair/maintenance area. • Prohibit poaching or collection of plants and biota during repair and maintenance.						
		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Minor	**Project Life**	**Limited**	**Unlikely**	**Slightly detrimental**	**Negative**	**Negligible -negative**
2	**5**	**2**	**3**	**-9**		**-27**
Post-Mitigation Impact Assessment Assumptions						
The above impact assessment rating provided under a post-mitigation scenario assumes that all mitigation measures are adhered to and all watercourses on the property are rehabilitated.						

5.3.5 Cumulative (Across Cato Ridge Local Area Plan)

A "cumulative impact" is defined in the EIA regulations, 2014 as '*past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to the existing and reasonably foreseeable impacts eventuating from similar or diverse activities*'.

The International Finance Corporation (2013) defines cumulative impacts as '*those that result from the successive, incremental, and/or combined effects of an action, project, or activity (collectively referred to … as "developments") when added to other existing, planned, and/or reasonably anticipated future ones*' and further states that '*For practical reasons, the identification and management of cumulative impacts are limited to those effects generally recognised as important on the basis of scientific concerns and/or concerns of affected communities*.'

Valued Ecosystem Components (VECs) are considered key to understanding cumulative impacts because the sources of these impacts are diffuse and distributed over long periods of time. VECs may be:

- physical features, habitats, wildlife populations, e.g., biodiversity.
- ecosystem services.
- natural processes, e.g., water and nutrient cycles, microclimate.

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- social conditions, e.g., health, economics.
- cultural aspects, e.g., traditional spiritual ceremonies.

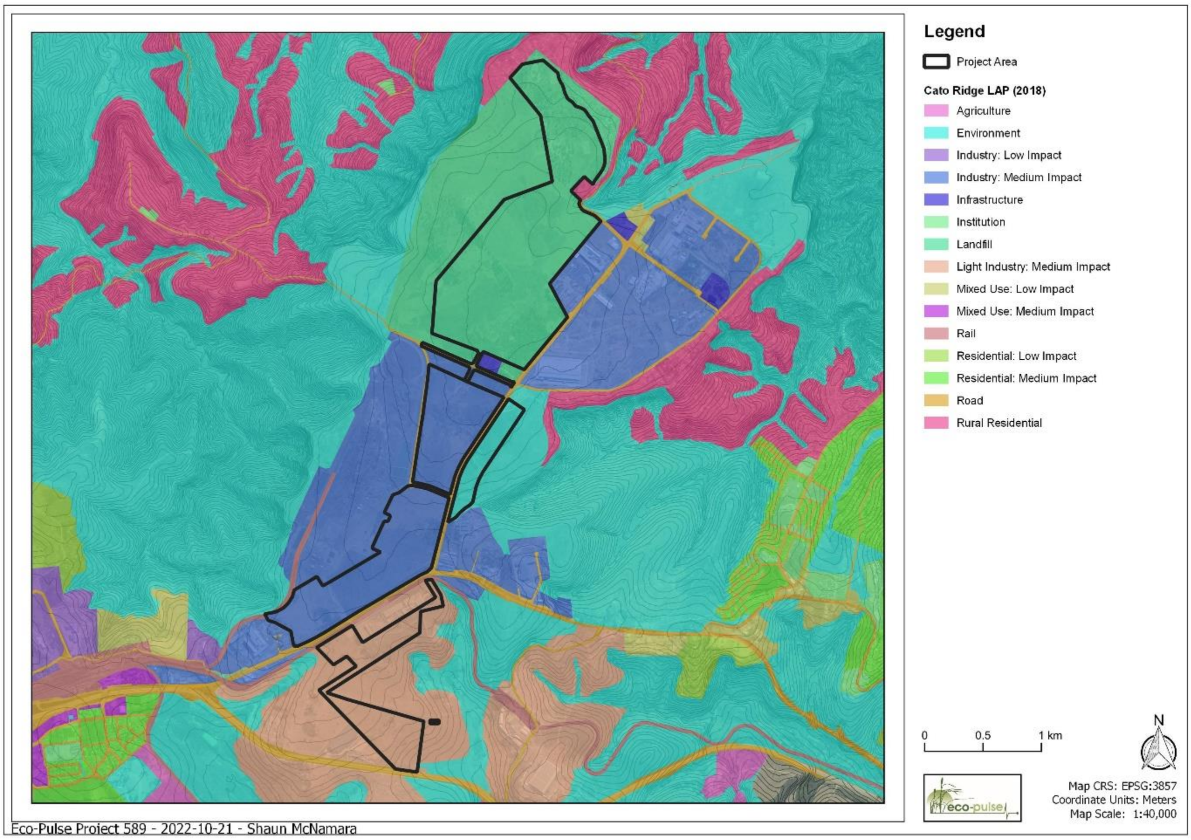

Figure 10. The development footprint overlaying the Cato Ridge Local area Plan

Construction Phase

Potential Environmental Impact
Direct physical loss or modification of wetland and/ or aquatic habitat associated with the onsite watercourses
Applicable Area
The study area
Valued Ecosystem Components:

Water resource management	Ecosystem Conservation	Species Conservation	Direct Use Values
Direct impact	Direct impact	Secondary or indirect impact	Secondary or indirect impact

Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Permanent	**Permanent**	**Local**	**Definite**	**Highly Detrimental**	**Negative**	**Major - Negative**
7	**7**	**3**	**7**	**-17**		**-119**

Summary of Key Impacts

Development phase 3 encroaches into a large seep wetland (W15 – Figure 9). W15 was assessed as being in the C PES category but is of High ecological importance and sensitivity. This is because the unit is an example of a critically endangered wetland ecosystem type (seep in the sub-escarpment grassland bioregion) (National Biodiversity Assessment, 2018). The total area of wetland impacted by the encroachment is approximately 3.12ha. There are no other planned direct impacts to freshwater habitat areas during the construction phase of this development. There is however the potential for accidental direct physical modification to stream or wetland habitat during construction, although such impacts are unlikely under a realistic 'good' mitigation scenario.

Summary of Key Mitigation Measures

<u>Key mitigation recommendations:</u>

- Avoid encroachment and infilling of Wetland W15.
- No areas outside the construction footprint may be cleared and stripped of vegetation. To this end the outer edges of the construction site must be demarcated using a high visibility barrier / fencing. The demarcation must be signed off by the project ECO.
- Construction staff should be made aware of the location and extent of all watercourses in the vicinity of the proposed development. These should be considered strict no-go zones for the duration of onsite works.
- Drivers and machine operators must take specific care to avoid watercourses when manoeuvring vehicles and heavy equipment.

Significance Post-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Negligible Damage	**Immediate**	**Very Limited**	**Improbable**	**Negligible**	**Negative**	**Negligible - negative**
1	**1**	**1**	**2**	**-3**		**-6**

Post-Mitigation Impact Assessment Assumptions

The post-mitigation scenario is based on a scenario whereby complete avoidance of on-site watercourses achieved and no accidental incursions take place.

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Potential Environmental Impact
Alteration of hydrological and geomorphological processes (erosion and sediment)
Applicable Area
The study area
Valued Ecosystem Components:

Water resource management	Ecosystem Conservation	Species Conservation	Direct Use Values
Direct impact	Direct impact	Secondary or indirect impact	Irrelevant

Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**

High	Medium-term	Local	Definite	Moderately Detrimental	Negative	Minor -Negative
4	3	3	7	-10		-70
Summary of Key Impacts						
Construction activities in the catchment areas of onsite watercourses will result in a temporary reduction in catchment vegetation cover which could be associated with increased runoff and increased sediment supply to watercourses, especially where bare soils are exposed during peak rainfall periods. These impacts could potentially alter the geomorphic and hydrological regime of onsite watercourses. This could affect freshwater ecosystem condition and indirectly affect fauna and flora through a deterioration in the quality of available habitat . Should these impacts occur they are however likely to be temporary and are unlikely to significantly affect long-term ecological processes associated with onsite watercourses. If poorly managed hydrological and geomorphological impacts on Water Resource Management could be of a 'minor' ecological significance. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), the consequence rating can be reduced from 'moderately detrimental' to 'slightly detrimental'.						
Summary of Key Mitigation Measures						
Key mitigation recommendations: • Limit the duration of construction to reduce the risk of prolonged sedimentation and erosion impacts occurring. • Implement and adhere to buffer zones for wetlands and riparian areas, with planned development infrastructure to remain outside of the buffer zones. • Demarcate buffers on the ground to avoid incursions into these areas. • Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible and in accordance with a Rehabilitation & Management Plan. • Implement bi-monthly aquatic biomonitoring and water quality monitoring during construction and use findings to inform site management.						
Significance Post-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
High	Short-term	Limited	Likely	Slightly detrimental	Negative	Minor -negative
4	2	2	5	-8		-40
Post-Mitigation Impact Assessment Assumptions						
The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are, and all erosion and sedimentation risks are addressed.						

Potential Environmental Impact						
Impacts to water quality						
Applicable Area						
The study area						
Valued Ecosystem Components:						
Water resource management		**Ecosystem Conservation**		**Species Conservation**		**Direct Use Values**
Direct impact		Secondary or indirect impact		Secondary or indirect impact		Irrelevant
Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Moderate	Medium-term	Local	Highly Probable	Slightly detrimental	Negative	Minor - Negative
3	3	3	6	-9		-54
Summary of Key Impacts						
Water quality impacts during construction will be limited to potential increased surface water turbidity due to sediment inputs and / or erosion and physio-chemical pollution related to potential spillages of cement and fuels during construction. Turbidity impacts are likely to be limited given the temporary nature of onsite earthworks, and						

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the maintenance of a well-vegetated buffer around watercourses. Spillages of fuel and other harmful substances could alter the physio-chemical and biological characteristic of surface water and contaminate watercourse substrate (having a direct impact on water resource management), with potential knock-on consequences for both fauna and flora communities (affecting ecosystem and species conservation indirectly). No impact on direct use value is anticipated as watercourses were not rated as important in terms of water supply as a provisioning ecosystem service. If poorly managed, impacts to water quality could be of 'Minor' significance where turbidity and sediment and / or pollution risks are not effectively mitigated. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), this can be potentially reduced to a 'Negligible' and an environmentally acceptable level.						
Summary of Key Mitigation Measures						
Key mitigation recommendations: • Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control. • Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management. • Rehabilitate any spill related impacts as soon as practically possible in accordance with an 'Aquatic Contingency Plan'. • Implement bi-monthly aquatic biomonitoring and water quality monitoring during construction and use findings to inform site management.						
		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Moderate	**Short-term**	**Limited**	**Unlikely**	**Slightly detrimental**	**Negative**	**Negligible -negative**
3	**2**	**2**	**3**	**-7**		**-21**
Post-Mitigation Impact Assessment Assumptions						
The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are adhered to, and all water pollution risks are addressed.						

Potential Environmental Impact						
Impacts to ecological connectivity and/or ecological disturbance impacts						
Applicable Area						
The study area						
Valued Ecosystem Components:						
Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**			
Irrelevant	Irrelevant	Secondary or indirect impact	Irrelevant			
Ultimate Ecological Consequences: Impact Intensity Ratings						
Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Minor	**Medium-term**	**Local**	**Likely**	**Slightly detrimental**	**Negative**	**Minor - Negative**
2	**3**	**3**	**5**	**-8**		**-40**
Summary of Key Impacts						
The presence of workers and machinery may create noise and vibration disturbances that may temporarily disturb amphibians, reptiles, birds, and small mammals. These disturbances will be minor, and fauna will likely revisit the site once construction has ceased, and the disturbance has halted. If poorly managed, disturbance impacts could be of 'Negligible' significance. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), the consequence rating can be reduced from slightly detrimental to negligible.						
Summary of Key Mitigation Measures						
Key mitigation recommendations:						

• Implement and adhere to buffer zones for wetlands and riparian areas, with planned development infrastructure to remain outside of the buffer zones, • Demarcate buffers on the ground to avoid incursions into these areas. • Implement road/pipeline Method Statement to specification. • Restrict worker and machinery access to the construction site and site camp only. • Prohibit poaching or collection of plants and biota from natural areas, including riparian areas and wetlands. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible and in accordance with the 'Rehabilitation & Management Plan'.						
		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Minor	**Short-term**	**Local**	**Probable**	**Slightly detrimental**	**Negative**	**Negligible - Negative**
2	**2**	**3**	**4**	**-7**		**-28**
Post-Mitigation Impact Assessment Assumptions						
The above impact assessment rating provided under a post-mitigation scenario assumes that all mitigation measures are adhered to.						

Operation Phase

Potential Environmental Impact			
Alteration of hydrological and geomorphological processes (erosion and sediment)			
Applicable Area			
The study area			
Valued Ecosystem Components:			
Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**
Direct impact	Direct impact	Secondary or indirect impact	Irrelevant
Ultimate Ecological Consequences: Impact Intensity Ratings			

Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Complete loss	**Permanent**	**Municipal**	**Highly Probable**	**Highly detrimental**	**Negative**	**Moderate - Negative**
7	**7**	**4**	**6**	**-18**		**-108**
Summary of Key Impacts						
Multiple developments are planned along the catchment divide between quaternary catchments U20J, U20L and U60C. These developments will result in an increase in hardened surfaces at the head of these respective catchments, and an associated increase in surface runoff which will largely be released into the environment as part of the operation of the formal stormwater management system. This could potentially result in erosion and sedimentation along watercourses downstream of these developments and their respective stormwater management systems and thereby inhibit their ability to provide regulating services such as flood attenuation or toxicant assimilation through the creation of concentrated flow paths, thus having an effect on water resource management objectives. Similarly, erosion and sedimentation can lead to a deterioration in habitat condition or loss of important habitat thereby having implications for ecosystem conservation targets and indirectly on species of conservation concern. While the attenuation and controlled release of high stormwater runoff volumes (during storms etc.)- under a post-mitigation scenario will aid in preventing erosion and sedimentation associated with increased flow volumes, the presence of stormwater attenuation structures will nevertheless alter natural flow and sediment regimes. Therefore, it is vital that all stormwater attenuation systems associated with these planned developments be designed to have a limited impact on base / low flows to mitigate operation phase hydrological and geomorphological impacts associated with development.						

Hydrological Risk Assessments should be standard practice to assist in understanding post-development hydrological risks and impacts. Cumulatively these developments will increase peak flows due to urbanisation in the catchment, which will increase the rainfall-runoff coefficient of the land surface area. Watercourses may be subjected to flooding damage. Areas where culverts will be installed at watercourse crossings may be prone to becoming blocked and are higher risk due to the momentum of flow from the prevailing flow direction and this poses a risk of undercutting and rapid erosion/bank failing during peak events. It is assumed that domestic water for all planned future developments will be obtained from the local municipality, and there will be no reduction in water within downstream watercourses (no direct abstraction of water). If not mitigated through appropriate stormwater outfall and attenuation structure design, this impact could be of 'Moderate' significance. Even with best practical ecological design that allows flows and sediment fluxes to remain largely unimpeded, this impact remains of 'Moderate' significance given the large collective area that will be converted to hardened surfaces.						
Summary of Key Mitigation Measures						
Key mitigation recommendations: • Implement best practice stormwater management design, including erosion protection at outfalls and allow for unimpeded base flows along watercourses. • Stormwater and energy dampening systems to be designed and implemented to decreases the risk of stream bank erosion. • Maintain storm water infrastructure as necessary. • Implement and adhere to 30m buffer zones for wetlands and riparian areas. • Implement aquatic biomonitoring and water quality monitoring in accordance with the 'Aquatic Monitoring Plan' during operation and use findings to inform site management.						
Significance Post-Mitigation						
Intensity	**Duration**	**Extent**	**Status (+/-)**	**Consequence**	**Probability**	**Impact Significance**
Complete loss	**Permanent**	**Limited**	**Negative**	**Highly detrimental**	**Likely**	**Moderate - Negative**
7	**7**	**2**		**-16**	**5**	**-80**
Post-Mitigation Impact Assessment Assumptions						
The above impact assessment rating provided under a post-mitigation scenario assumes that even if all the above mitigation measures are adhered to, erosion risks would still be a significant concern given the steep topography.						

Potential Environmental Impact						
Impacts to water quality						
Applicable Area						
The study area						
Valued Ecosystem Components:						
Water resource management		**Ecosystem Conservation**		**Species Conservation**	**Direct Use Values**	
Direct impact		Secondary or indirect impact		Secondary or indirect impact	Secondary or indirect impact	
Ultimate Ecological Consequences: Impact Intensity Ratings						
Significance Pre-Mitigation						
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
Very High	**Beyond Project**	**Local**	**Definite**	**Highly detrimental**	**Negative**	**Moderate - Negative**
6	**6**	**3**	**7**	**-15**		**-105**
Summary of Key Impacts						
Any impacts to water quality will have a direct impact on water resource management as higher levels of pollution feeding into downstream watercourses could compromise the assimilative capacity of affected wetlands. Any harmful substance spill events or pollutants feeding into watercourses can result in the die-off of plants and fauna in the vicinity and immediately downstream of a spill affecting wetland and aquatic habitat and species of						

conservation concern. Die-back of vegetation due to spills could reduce the amount of grazing available for livestock within the watercourses affected but is unlikely to have a significant impact on this direct use value given that alternative sources of grazing available in the area.

The onsite sewage treatment planned as part of the Cato Ridge Land Development & Release Project is being designed to treat 2 Mℓ / day of influent. It is assumed that an additional treatment plant will ultimately be required to meet the population demands for the Cato Ridge LAP. Water pollution impacts during operation are likely to relate to the discharge of treated effluent into the wetland and possible leakage of raw sewage from sewer pipeline infrastructure. Where pipelines and raw sewage pump stations are properly designed and installed with adequate risk mitigation, the probability of spillage of raw sewage into onsite watercourses is likely to be low. The treatment systems should be designed, at a minimum, to meet General Limit Values (GLVs) as stipulated in the National Water Act. However, even if these limits values are consistently met, effluent discharge will still raise background bacterial, salinity, and nutrient levels within the receiving watercourses. This may result in reduced water quality and a biotic ecological response.

Increased water turbidity due to sediment inputs and / or erosion could occur. Potential spillages of cement and fuels during maintenance and repair of road infrastructure in the vicinity of watercourses could also alter water physio-chemical quality. There is also potential for contaminated surface runoff / stormwater flows from roads to enter wetlands and rivers.

If turbidity and / or pollution risks are not effectively mitigated, impacts to water quality associated with the operation of onsite infrastructure could be of 'Moderate - negative' significance. Where best practical mitigation is implemented (*as listed below and explained in detail in Chapter 6 of this report)*, this can be potentially reduced to a 'Negligible - negative' and acceptable level.

Summary of Key Mitigation Measures

Key mitigation recommendations:

- Sewage Treatment Plant:
    - implement best practice design and operation according to an approved management plan that accounts for expected biological and hydraulic loads, makes provision for system failures.
    - Develop a maintenance programme that includes regular inspections for wear and tear of mechanical and electrical plant components.
    - Develop a discharge water quality monitoring programme.
- Implement best practice stormwater management design, including erosion protection at outfalls and allow for unimpeded base flows along watercourses.
- Maintain storm water infrastructure as necessary,
- Implement and adhere to buffer zones for wetlands and riparian areas.
- Implement bi-monthly aquatic biomonitoring and water quality monitoring in accordance with the 'Aquatic Monitoring Plan' during construction and use findings to inform site management.
- Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
- Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.
- Rehabilitate wetlands, riparian areas and buffer zones and in accordance with a 'Wetland Rehabilitation & Management Plan'

		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
High	**Long-term**	**Limited**	**Unlikely**	**Moderately detrimental**	**Negative**	**Negligible - Negative**
4	**4**	**2**	**3**	**-10**		**-30**

Post-Mitigation Impact Assessment Assumptions

The above impact assessment rating provided under a post-mitigation scenario assumes that all the above mitigation measures are adhered to, and all water pollution risks are addressed.

Potential Environmental Impact

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Impacts to ecological connectivity and/or ecological disturbance impacts
Applicable Area
The study area
Valued Ecosystem Components:

Water resource management	**Ecosystem Conservation**	**Species Conservation**	**Direct Use Values**
Irrelevant	Irrelevant	Secondary or indirect impact	Irrelevant

Ultimate Ecological Consequences: Impact Intensity Ratings
Significance Pre-Mitigation

Intensity	**Duration**	**Extent**	**Probability**	**Consequence**	**Status (+/-)**	**Impact Significance**
High	**Permanent**	**Municipal**	**Likely**	**Highly detrimental**	**Negative**	**Moderate - Negative**
4	**7**	**4**	**5**	**-15**		**-75**

The presence of workers during the operational phase of offices, retail and warehouse development planned within the area is likely to create ecological noise and vibration disturbances that will disturb amphibians, reptiles, birds, and small mammals. These disturbances although minor is likely to act as a deterrent for fauna who are unlikely to frequent the area once these developments reach their operational phase. Where impacts and risks are poorly managed, this impact could be of 'Moderate-negative' significance and where best practical mitigation is implemented including the incorporation of ecological corridors for faunal species movement (and as listed below and explained in detail in Chapter 6 of this report), this can be potentially reduced to 'Minor - negative' significance and an environmentally acceptable level.

Summary of Key Mitigation Measures

<u>Key mitigation recommendations:</u>

- Implement and adhere to buffer zones for wetlands and riparian areas.
- Limit instream habitat disturbance.
- Restrict worker and machinery access to the repair/maintenance area.
- Prohibit poaching or collection of plants and biota during repair and maintenance.

		Significance Post-Mitigation				
Intensity	**Duration**	**Extent**	**Status (+/-)**	**Consequence**	**Probability**	**Impact Significance**
High	**Permanent**	**Municipal**	**Negative**	**Highly detrimental**	**Unlikely**	**Minor - Negative**
4	**7**	**4**		**-15**	**3**	**-45**

Post-Mitigation Impact Assessment Assumptions
The above impact assessment rating provided under a post-mitigation scenario assumes that all mitigation measures are adhered to and all watercourses on the property are rehabilitated.

5.4 Impact Significance Assessment Summary & Comparison with Previous Layout

A summary of the construction and operation phase impact significance rating for the proposed development are displayed in the tables 32 and 33, respectively. This includes significance ratings for the current proposed development layout and the previously proposed layout (which has been abandoned) for comparison purposes. The previous version of the development layout in presented in Annexure B.

Under a realistic poor mitigation scenario construction phase impacts for Phase 3 of the project were assessed as being 'Major – Negative'. This is because development Phase 3 encroaches into a large seep wetland (W15 – Figure 9). W15 was assessed as being in the C PES category but is of High ecological importance and sensitivity. The total area of wetland impacted by the encroachment is approximately 3.12ha. Under a realistic poor mitigation scenario construction phase impacts for Phases 1 and 2 were assessed as being 'Minor – Negative'. Overall, under a realistic good mitigation scenario the construction significance of each phase of the proposed project is 'Minor – Negative'. This is however contingent on direct physical impacts to W15 being avoided during Phase 3 of the development.

The key operation phase concern is stormwater management and the potential alteration of watercourse hydrological and geomorphological processes. Under a realistic poor mitigation scenario these impacts are considered 'Moderate – Negative' for each project phase. Potential impacts to surface water quality as a result of the discharge of effluent into the environment from the proposed package treatment plant are also an operational phase concern. The significance of these impacts can however be reduced to 'Minor – Negative' under a realistic good mitigation scenario. Mitigation to reduced operational phase impact significance should focus on adhering to recommended watercourse buffer zones, wetland rehabilitation and operation phase management, stormwater management design, and the design of the proposed onsite sewage package treatment plant.

The most notable difference in the significance ratings of impacts between the current and previous proposed layout is a reduction in the significance of physical losses or modifications of wetland and / or aquatic habitat. This is due to the iterative layout planning process which considered freshwater ecological constraints to minimize proposed areas of watercourse infilling. Operation phase impact significance is largely similar between the two layout scenarios.

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5.4.1 Construction Phase

Table 32. Summary of the construction phase impact significance ratings, including the ratings from the previous development layout scenario.

		Current Layout		Previous Layout	
		Mitigation Scenario			
		Poor	Good	Poor	Good
Phase 1	Direct physical loss or modification of wetland and/ or aquatic habitat	-35 (Minor)	-6 (Negligible)	-119 (Major)	-119 (Major)
	Alteration of hydrological and geomorphological processes	-70 (Minor)	-40 (Minor)	-70 (Minor)	-48 (Minor)
	Impacts to water quality	-54 (Minor)	-21 (Negligible)	-54 (Minor)	-21 (Negligible)
	Impacts to ecological connectivity and/or ecological disturbance impacts	-40 (Minor)	-28 (Negligible)	-40 (Minor)	-28 (Negligible)
Phase 2	Direct physical loss or modification of wetland and/ or aquatic habitat	-35 (Minor)	-6 (Negligible)	-119 (Major)	-119 (Major)
	Alteration of hydrological and geomorphological processes	-70 (Minor)	-40 (Minor)	-70 (Minor)	-48 (Minor)
	Impacts to water quality	-54 (Minor)	-21 (Negligible)	-54 (Minor)	-21 (Negligible)
	Impacts to ecological connectivity and/or ecological disturbance impacts	-40 (Minor)	-28 (Negligible)	-40 (Minor)	-28 (Negligible)
Phase 3	Direct physical loss or modification of wetland and/ or aquatic habitat	-116 (Major)	-6 (Negligible)	-119 (Major)	-119 (Major)
	Alteration of hydrological and geomorphological processes)	-70 (Minor)	-40 (Minor)	-70 (Minor)	-48 (Minor)
	Impacts to water quality	-54 (Minor)	-21 (Negligible)	-54 (Minor)	-21 (Negligible)
	Impacts to ecological connectivity and/or ecological disturbance impacts	-40 (Minor)	-28 (Negligible)	-40 (Minor)	-28 (Negligible)
All Phases	Direct physical loss or modification of wetland and/ or aquatic habitat	-116 (Major)	-6 (Negligible)	-119 (Major)	-119 (Major)
	Alteration of hydrological and geomorphological processes	-70 (Minor)	-40 (Minor)	-70 (Minor)	-48 (Minor)
	Impacts to water quality	-54 (Minor)	-21 (Negligible)	-54 (Minor)	-21 (Negligible)
	Impacts to ecological connectivity and/or ecological disturbance impacts	-40 (Minor)	-28 (Negligible)	-40 (Minor)	-28 (Negligible)
Cumulative	Direct physical loss or modification of wetland and/ or aquatic habitat	-119 (Major)	-6 (Negligible	-126 (Major)	-126 (Major)
	Alteration of hydrological and geomorphological processes	-70 (Minor)	-40 (Minor)	-77 (Moderate)	-54 (Minor)

	Impacts to water quality	-54 (Minor)	-21 (Negligible)	-60 (Minor)	-40 (Minor)
	Impacts to ecological connectivity and/or ecological disturbance impacts	-40 (Minor)	-28 (Negligible)	-45 (Minor)	-36 (Minor)

5.4.2 Operation Phase

Table 33. Summary of the construction phase impact significance ratings, including the ratings from the previous development layout scenario.

		Current Layout		Previous Layout	
		Mitigation Scenario			
		Poor	Good	Poor	Good
Phase 1	Alteration of hydrological and geomorphological processes	-102 (Moderate)	-64 (Minor)	-102 (Moderate)	-64 (Minor)
	Impacts to water quality	-105 (Moderate)	-30 (Negligible)	-78 (Moderate)	-30 (Negligible)
	Impacts to ecological connectivity and/or ecological disturbance impacts	-50 (Minor)	-27 (Negligible)	-50 (Minor)	-27 (Negligible)
Phase 2	Alteration of hydrological and geomorphological processes	-102 (Moderate)	-64 (Minor)	-102 (Moderate)	-80 (Moderate)
	Impacts to water quality	-105 (Moderate)	-30 (Negligible)	-78 (Moderate)	-30 (Negligible)
	Impacts to ecological connectivity and/or ecological disturbance impacts	-50 (Minor)	-27 (Negligible)	-50 (Minor)	-27 (Negligible)
Phase 3	Alteration of hydrological and geomorphological processes)	-102 (Moderate)	-64 (Minor)	-102 (Moderate)	-64 (Minor)
	Impacts to water quality	-105 (Moderate)	-30 (Negligible)	-78 (Moderate)	-30 (Negligible)
	Impacts to ecological connectivity and/or ecological disturbance impacts	-50 (Minor)	-27 (Negligible)	-50 (Minor)	-27 (Negligible)
All Phases	Alteration of hydrological and geomorphological processes	-102 (Moderate)	-64 (Minor)	-102 (Moderate)	-80 (Moderate)
	Impacts to water quality	-105 (Moderate)	-30 (Negligible)	-78 (Moderate)	-30 (Negligible)
	Impacts to ecological connectivity and/or ecological disturbance impacts	-50 (Minor)	-27 (Negligible)	-50 (Minor)	-27 (Negligible)
Cumulative	Alteration of hydrological and geomorphological processes	-108 (Moderate)	-80 (Moderate)	-108 (Moderate)	-80 (Moderate)
	Impacts to water quality	-105 (Moderate)	-30 (Negligible)	-78 (Moderate)	-30 (Negligible)
	Impacts to ecological connectivity and/or ecological disturbance impacts	-75 (Moderate)	-45 (Minor)	-75 (Moderate)	-45 (Minor)

5.5 Risk Assessment to inform Water Use Licensing

It is our understanding that the purpose of the risk matrix tool developed by the DWS is to give a preliminary indication of the likely impact / degree of change (consequence) of activities (water uses) to local and regional water resource quality. For the purposes of this study, the degree of change is reflected in PES change and/or the change in the supply of regulating ecosystem services.

A summary of the potential risk and impacts ratings for the proposed development activities is provided in Table 34 to 37 below.

Whilst some risks associated with proposed project can be managed to 'low' overall levels through mitigation, **the overall project risk is still likely to remain at least a 'moderate'**. This suggests that the project cannot be generally authorised under the GA for Section 21 c and i water uses. Therefore, a full WULA is likely to be required. Additionally, General Notice (GN) 509. GN 509, published in Government Gazette (GG) no. 40229 under Section 39 of the National Water Act (Act no. 36 of 1998) in August 2016, allows for Section 21 (c) and (i) water uses to be generally authorised if risks and be reduced to acceptable level, there is however no GA notice for the remaining Section 21 water uses. This project will trigger several waters uses beyond (c) and (i), and will require a full WULA on that basis, also.

It should be noted that wetland rehabilitation has been recommended as an impact mitigation measure in Section 6.2, below. Wetland rehabilitation will require licensing under Section 21 of the of the National Water Act (Act no. 36 of 1998).

It is important to also note that the Risk Assessment in this section overlaps strongly with the impact significance assessment findings which is to be expected since the risk ratings should in essence align to a large degree with the impact ratings.

5.5.1 Phase 1

Table 34. Summary of the risk matrix assessment scores and ratings for each activity and risk group for proposed development Phase 1

Activity	Aspects	Impact	Risk Rating	Revised Risk Rating for Borderline LOW / MODERATE Rating Classes
CONSTRUCTION PHASE	Accidental direct physical modification to freshwater habitat during construction.	Direct physical loss or modification of freshwater habitat	60 Moderate	35 Low
	increase in sediment supply to watercourses associated with bulk earthworks. Temporarily alteration natural water distribution patterns.	Alteration of hydrological and geomorphological processes	104 Moderate	73 Moderate

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Activity	Aspects	Impact	Risk Rating	Revised Risk Rating for Borderline LOW / MODERATE Rating Classes
	Potential elevated sediment delivery (and associated turbidity) to watercourses and potential pollution related to accidental spillages / leakages of fuels and chemicals during construction.	Impacts to water quality	60 Moderate	35 Low
	Presence of workers and heavy machinery in the general vicinity of onsite watercourses creating noise, vibrations, and dust.	Impacts to ecological connectivity and/or ecological disturbance impacts	51 Low	NA
OPERATIONAL PHASE	Operation phase storm water management. High runoff volumes incite erosion along watercourses, and large volumes of sediment are regularly deposited into nearby watercourses.	Alteration of hydrological and geomorphological processes	165.75 Moderate	140.75 Moderate
	Risk of potential hydrocarbon (fuel/oil) spills, polluted storm water runoff, sedimentation, and, treated effluent discharge from onsite sewer treatment plant.	Impacts to water quality	108 Moderate	83 Moderate
	The presence of workers and machinery during infrastructure repairs and maintenance, and the use of the developed area by cars and people creating ecological noise and vibration disturbances.	Impacts to ecological connectivity and/or ecological disturbance impacts	46.75 Low	NA

5.5.2 Phase 1

Table 35. Summary of the risk matrix assessment scores and ratings for each activity and risk group for proposed development Phase 1

Activity	Aspects	Impact	Risk Rating	Revised Risk Rating for Borderline LOW / MODERATE Rating Classes
CONSTRUCTION PHASE	Accidental direct physical modification to freshwater habitat during construction.	Direct physical loss or modification of freshwater habitat	60 Moderate	35 Low
	increase in sediment supply to watercourses associated with bulk earthworks. Temporarily alteration natural water distribution patterns.	Alteration of hydrological and geomorphological processes	104 Moderate	73 Moderate

Activity	Aspects	Impact	Risk Rating	Revised Risk Rating for Borderline LOW / MODERATE Rating Classes
	Potential elevated sediment delivery (and associated turbidity) to watercourses and potential pollution related to accidental spillages / leakages of fuels and chemicals during construction.	Impacts to water quality	60 Moderate	35 Low
	Presence of workers and heavy machinery in the general vicinity of onsite watercourses creating noise, vibrations, and dust.	Impacts to ecological connectivity and/or ecological disturbance impacts	51 Low	NA
OPERATIONAL PHASE	Operation phase storm water management. High runoff volumes incite erosion along watercourses, and large volumes of sediment are regularly deposited into nearby watercourses.	Alteration of hydrological and geomorphological processes	165.75 Moderate	140.75 Moderate
	Risk of potential hydrocarbon (fuel/oil) spills, polluted storm water runoff, sedimentation, and, treated effluent discharge from onsite sewer treatment plant.	Impacts to water quality	108 Moderate	83 Moderate
	The presence of workers and machinery during infrastructure repairs and maintenance, and the use of the developed area by cars and people creating ecological noise and vibration disturbances.	Impacts to ecological connectivity and/or ecological disturbance impacts	46.75 Low	NA

5.5.3 Phase 3

Table 36. Summary of the risk matrix assessment scores and ratings for each activity and risk group for proposed development Phase 3

Activity	Aspects	Impact	Risk Rating	Revised Risk Rating for Borderline LOW / MODERATE Rating Classes
CONSTRUCTION PHASE	In filling of a portion of W15. Accidental direct physical modification to freshwater habitat during construction.	Direct physical loss or modification of freshwater habitat	90 Moderate	NA
	increase in sediment supply to watercourses associated with bulk earthworks. Temporarily alteration natural water distribution patterns.	Alteration of hydrological and geomorphological processes	104 Moderate	73 Moderate

Activity	Aspects	Impact	Risk Rating	Revised Risk Rating for Borderline LOW / MODERATE Rating Classes
	Potential elevated sediment delivery (and associated turbidity) to watercourses and potential pollution related to accidental spillages / leakages of fuels and chemicals during construction.	Impacts to water quality	60 Moderate	35 Low
	Presence of workers and heavy machinery in the general vicinity of onsite watercourses creating noise, vibrations, and dust.	Impacts to ecological connectivity and/or ecological disturbance impacts	51 Low	NA
OPERATIONAL PHASE	Operation phase storm water management. High runoff volumes incite erosion along watercourses, and large volumes of sediment are regularly deposited into nearby watercourses.	Alteration of hydrological and geomorphological processes	165.75 Moderate	140.75 Moderate
	Risk of potential hydrocarbon (fuel/oil) spills, polluted storm water runoff, sedimentation, and, treated effluent discharge from onsite sewer treatment plant.	Impacts to water quality	108 Moderate	83 Moderate
	The presence of workers and machinery during infrastructure repairs and maintenance, and the use of the developed area by cars and people creating ecological noise and vibration disturbances.	Impacts to ecological connectivity and/or ecological disturbance impacts	46.75 Low	NA

5.5.4 All Development Phases

Table 37. Summary of the risk matrix assessment scores and ratings for each activity and risk group for all development phases.

Activity	Aspects	Impact	Risk Rating	Revised Risk Rating for Borderline LOW / MODERATE Rating Classes
CONSTRUCTION PHASE	In filling of a portion of W15. Accidental direct physical modification to freshwater habitat during construction.	Direct physical loss or modification of freshwater habitat	90 Moderate	NA
	increase in sediment supply to watercourses associated with bulk earthworks. Temporarily alteration natural water distribution patterns.	Alteration of hydrological and geomorphological processes	104 Moderate	73 Moderate

Activity	Aspects	Impact	Risk Rating	Revised Risk Rating for Borderline LOW / MODERATE Rating Classes
	Potential elevated sediment delivery (and associated turbidity) to watercourses and potential pollution related to accidental spillages / leakages of fuels and chemicals during construction.	Impacts to water quality	**60 Moderate**	**35 Low**
	Presence of workers and heavy machinery in the general vicinity of onsite watercourses creating noise, vibrations, and dust.	Impacts to ecological connectivity and/or ecological disturbance impacts	**51 Low**	**NA**
OPERATIONAL PHASE	Operation phase storm water management. High runoff volumes incite erosion along watercourses, and large volumes of sediment are regularly deposited into nearby watercourses.	Alteration of hydrological and geomorphological processes	**165.75 Moderate**	**140.75 Moderate**
	Risk of potential hydrocarbon (fuel/oil) spills, polluted storm water runoff, sedimentation, and, treated effluent discharge from onsite sewer treatment plant.	Impacts to water quality	**108 Moderate**	**83 Moderate**
	The presence of workers and machinery during infrastructure repairs and maintenance, and the use of the developed area by cars and people creating ecological noise and vibration disturbances.	Impacts to ecological connectivity and/or ecological disturbance impacts	**46.75 Low**	**NA**

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6. IMPACT MITIGATION & MANAGEMENT

According to the National Environmental Management Act No. 107 of 1998 (NEMA), sensitive, vulnerable, highly dynamic, or stressed ecosystems, such as wetlands, rivers and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure. NEMA also requires "a risk-averse and cautious approach which takes into account the limits of current knowledge about the consequences of decisions and actions". The 'precautionary principle' therefore applies, and cost-effective measures must be implemented to pro-actively prevent degradation of the region's water resources and the social systems that depend on it. Ultimately, the risk of water resource degradation and biodiversity reduction/loss must drive sustainability in development design.

Of particular importance is the requirement of 'duty of care' with regards to environmental remediation stipulated in Section 28 of NEMA (National Environmental Management Act No.107 of 1998):

Duty of care and remediation of environmental damage: "(1) *Every person who causes has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot be reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.*"

6.1 The 'Mitigation Hierarchy' Best Practice Environmental Planning Framework

'Impact Mitigation' is a broad term that covers all components involved in selecting and implementing measures to conserve biodiversity and prevent significant adverse impacts to natural ecosystems. The mitigation of negative impacts on freshwater resources is a legal requirement for authorisation purposes and must take on different forms depending on the significance of impacts and the particulars of the target area being affected. This generally follows some form of 'mitigation hierarchy' (see Figure 12, below) which aims firstly at avoiding disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided, to minimise, rehabilitate, and then finally offset any remaining significant residual impacts.

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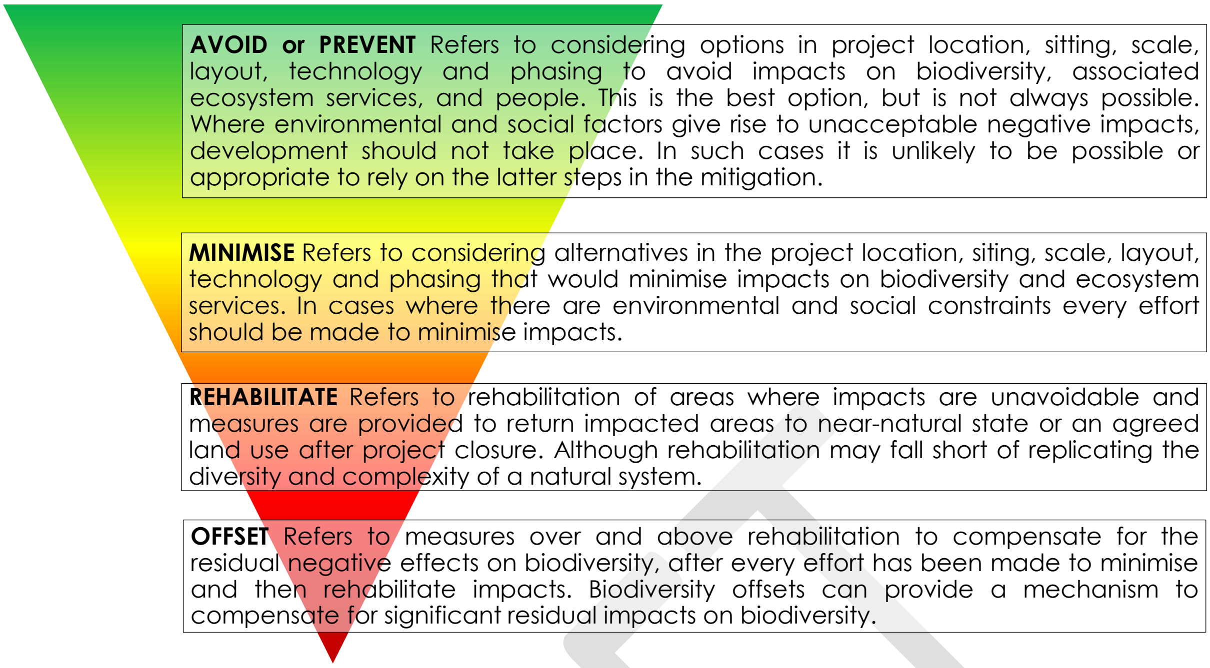

Figure 11. Diagram illustrating the 'mitigation hierarchy' (after DEA *et al.,* 2013).

The mitigation hierarchy is inherently proactive, requiring the on-going and iterative consideration of alternatives in terms of project location, siting, scale, layout, technology, and phasing until the proposed development can best be accommodated without incurring significant negative impacts to the receiving environment. In cases where the receiving environment cannot support the development or where the project will destroy the natural resources on which local communities are wholly dependent for their livelihoods or eradicate unique biodiversity; the development may not be feasible and the more the developer is made aware of these risks, and can plan to avoid them, the better. In the case of particularly sensitive ecosystems, where ecological impacts can be severe, the guiding principle should generally be "*anticipate and prevent*" rather than "*assess and repair*". This principle is also in line with the recommended management objective for the project and receiving aquatic environment, that being to '*maintain the current status quo of aquatic ecosystems without any further loss of integrity (PES) or functioning*'.

A stepped approach has therefore been followed in trying to minimize impacts freshwater ecosystems, which included:

i. **Firstly, attempting to avoid/prevent impacts through appropriate project design and location:**
   - Eco-Pulse completed an initial Aquatic Baseline and Sensitivity Verification Assessment (Eco-Pulse, 2021) to inform layout planning.
   - Eco-Pulse completed a draft impact assessment, including layout planning recommendations (including buffers), for a preliminary development layout.
   - This and other ecological specialist reports, and discussion with EDTEA were used to refine the development layout to avoid sensitive areas as far as practically possible.

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ii. **Secondly, employing mitigation measures aimed at minimizing the likelihood and intensity of potential risks/impacts**:

- Provision of construction and operation phase management and mitigation measures to avoid any unnecessary direct or indirect impacts to watercourses.

iii. **Thirdly, addressing residual impacts to areas adjacent to the development site which may be impacted:**

- Wetland rehabilitation strategy recommended.

iv. **Lastly, compensating for any remaining/residual impacts associated with permanent habitat transformation.**

- Not applicable to freshwater ecosystems for this project.

6.2 Planning & Design Measures

6.2.1 Aquatic Buffer Zone Recommendations

'Buffer zones' (also termed "development setbacks") are essentially strips of undeveloped and vegetated land typically designed to act as a protective barrier between human activities and ecosystems/habitats such as wetlands and rivers. Research shows that buffer zones are useful at performing a wide range of functions such as sediment trapping and nutrient retention, and in doing so, play an important role in protecting water resources from adverse water quality and sediment impacts that are typically associated with adjacent human land-uses and development. Although there are no formal requirements regarding the establishment of buffers around water resources in the South African legislation, the application of buffers is aligned with the principles of the National Water Act (1998), which aim to maintain water quality and preserve natural aquatic habitats and ecosystem functions.

A national protocol for buffer determination around rivers, wetlands, and estuaries (Macfarlane and Bredin, 2016) has been developed and represents best-practice in aquatic buffer zone determination. The methodology and accompanying buffer zone determination tool were used to develop preliminary freshwater ecosystem buffer requirements for the project.

It is important to note that the buffer tool does not account for the role buffers play in maintaining watercourse hydrology. It is therefore likely that a formal hydro-pedological study will need to be conducted to inform the recommendation of appropriate buffer zones for the development, as per the Department of Water and Sanitation's latest buffer determination requirements.

Preliminary recommended buffer zone widths

The buffer model by Macfarlane and Bredin (2016) produces an output for two scenarios based on potential risks associated with the proposed project type, in conjunction with the sensitivity of wetlands and rivers. These two scenarios are (i) without specific mitigation, and (ii) with specific impact/risk mitigation. The tool was used to produce preliminary buffer zone recommendations for watercourses delineated and assessed within the study area.

Final siting and final extent of development activities will only be determined when the land is released for sale. Broad-level land-use options have however been proposed, which indicate that the project area will consist of light industry, general industry, warehousing, and logistics land uses. Thus, the buffer tool 'mixed-use medium impact land-use scenario' was used in the buffer zone determination process. This land-use scenario is briefly described in the tool as "*A mixed-use area where the full range of residential, businesses, offices, service and light industries, civic and social, educational and environmental uses are freely permitted but excludes other forms of industry*". This serves to provide broad level preliminary planning information for layout development. ***Specific buffer zones will however need to be revised once site-specific development plans are available from future tenants/developers.***

The results of the buffer tool assessment for this land-use option are presented in Table 38 below and include the two potential scenarios the tool accounts for in its outputs/results i.e. (i) without specific mitigation; and (ii) with specific impact/risk mitigation.

Typical mitigation and best-practice measures likely to be required under a specific impact/risk mitigation scenario include the demarcation of construction servitudes, runoff, erosion and sediment control, soil, hazardous substances, wastewater, solid waste and stormwater management, a freshwater ecosystem rehabilitation strategy, IAP control, noise dust and light pollution minimisation, and a freshwater ecosystem monitoring plan.

Table 38. Summary of the outcomes of the buffer model (Macfarlane and Bredin, 2016) as it applies to the mixed-use medium impact land-use scenario.

Watercourse Type	Project Phase	Recommended Buffer Width	
		Mitigation	
		Without	With
Rivers/ Streams	Construction	33 m	33 m
	Operation	29 m	29 m
	Final	**33 m**	**33 m**
Wetlands	Construction	31 m	31 m
	Operation	26 m	26 m
	Final	**31 m**	**31 m**

Under a 'with mitigation' scenario final buffer model outputs for rivers and wetlands recommend a 33 m and 31 m buffer width respectively for mixed-use medium impact land-use activities. The proposed development layout in relation to the recommended buffers is displayed in Figure 12. Through the iterative layout planning process, the development plan has been refined to avoid encroachments into watercourses and buffers such that, under the current layout, there are only three instances where the layout encroaches into the wetland recommended buffer. Each of these instances is associated with Phase 3 of the development (Figure 12).

The proposed buffers will limit direct disturbance/edge effects to wetland and riparian habitats, will reduce sediment/erosion impacts through sediment trapping by vegetated buffer strips, and will contribute to dealing with water quality impacts (such as nutrient enrichment from of surface runoff). The recommended buffer zones will also contribute to maintaining areas of terrestrial habitat.

However, it is important to note that buffers have their limitations in terms of protecting wetlands/rivers from adjacent/upstream land-use impacts and that other mitigation measures may be necessary in most cases, which is emphasised in Macfarlane & Bredin (2016) and discussed in more detail below:

- Buffers may be most effective at reducing pollutants in diffuse surface flow but are far less effective at addressing point-source pollution or concentrated flows and their role in mitigating pollution impacts associated with ground-water (subsurface flow) is not well documented.
- According to the Preliminary Guideline for the Determination of Buffer Zones (Macfarlane & Bredin, 2016), buffer zone requirements are only advocated where scientific studies have shown that they can be an effective mitigation measure.
- Furthermore, the proposed aquatic buffer zone widths do not specifically consider biodiversity concerns related to fauna/flora, etc.

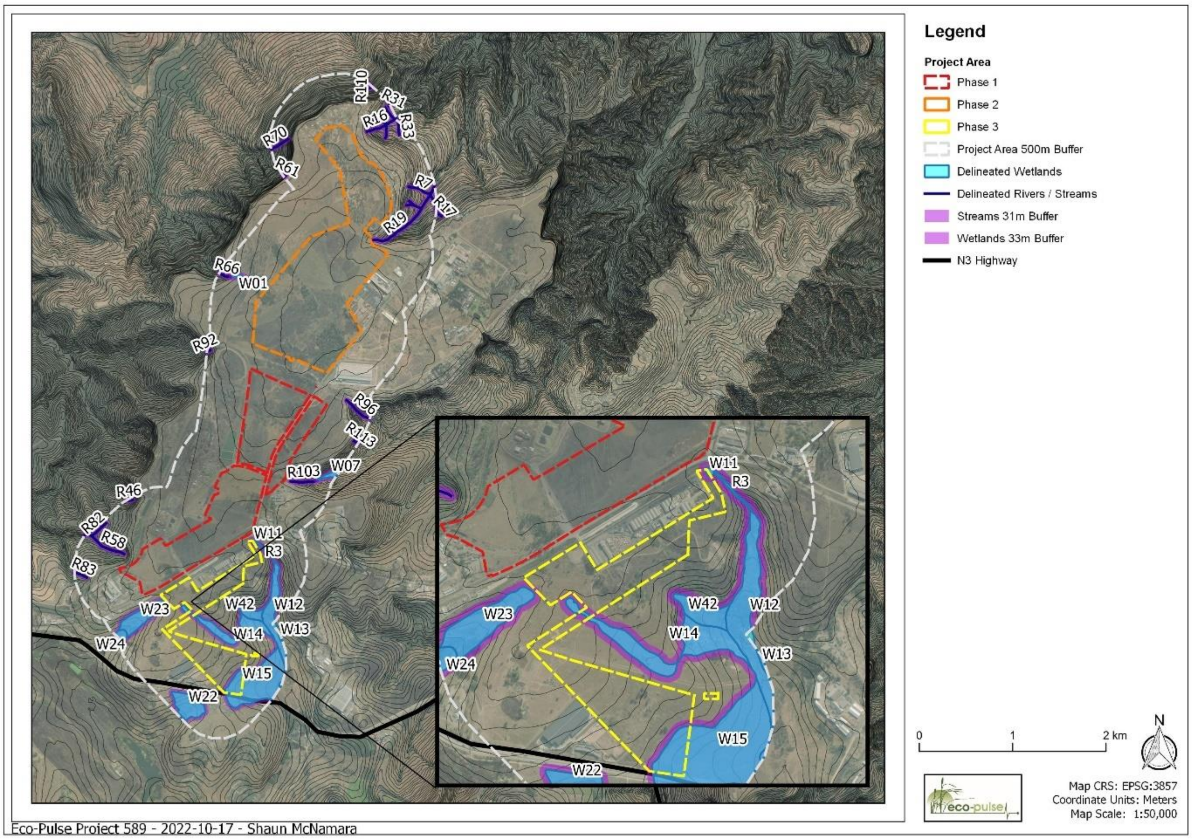

Figure 12. Delineated and classified watercourses in relation to recommended buffer zones.

6.2.2 Wetland Rehabilitation & Management

South African environmental legislation creates the framework for the protection and management of freshwater resources in the country. The law ultimately places responsibility, directly and indirectly, on landowners and other responsible parties, to manage and restore wetlands where relevant. This requirement is strongly enforced by the eThekwini Environmental Planning and Climate Protection Department (EPCPD) who see basic onsite wetland rehabilitation and appropriate management as a minimum requirement for developments within the municipality. Of particular importance is the requirement of 'duty of care' with regards to environmental remediation stipulated in Section 28 of NEMA (National Environmental Management Act No.107 of 1998):

> **Duty of care and remediation of environmental damage**: "(1) *Every person who causes has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot be reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.*"

Wetlands have been highly degraded, particularly in response to sand mining and artificial drainage activities which have compromised their conservation and functional values. Opportunities for rehabilitating and managing wetlands should be investigated as part of the development planning process. This is especially pertinent in instances where aspects of the proposed development could exacerbate existing wetland impacts and result in further degradation of onsite wetlands. For example, the release of effluent and stormwater into wetlands associated with erosion channels or drains could aggravate existing erosion issues. It is also noted that wetlands occur within proposed on-site offset areas, and as such, there is a strong motivation to ensure that conservation values are enhanced.

To help guide wetland rehabilitation and management efforts Eco-Pulse have highlighted key impacts to wetlands associated with the study area and have given an indication of the nature of rehabilitation and management efforts required to prevent further degradation of these watercourses during the development operational phase (Table 39). This table should be used to guide further investigations into wetland rehabilitation and management opportunities. Ultimately a wetland rehabilitation and management plan should be compiled for the prosed development.

Table 39. Recommended rehabilitation and management efforts for wetlands within the study area

Wetland unit	Priority for rehab efforts	Reason for priority rating	Recommended rehabilitation and management efforts
W01	Low	Limited notable impacts that are likely to worsen during the operational phase of the proposed development.	• Ongoing IAP clearing.
W07	Low	Limited notable impacts that are likely to worsen during the operational phase of the proposed development.	• Ongoing IAP clearing.

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W11	Medium	Notable IAP pressure that is likely to worsen rapidly/	• Ongoing IAP clearing.
W12	High	Wetland set to receive stormwater and package treatment plant inputs. This could worsen erosion along the existing incised central drain. Without rehabilitation the effluent discharged into this unit will enter the existing drain and quickly flow downstream without receiving any secondary treatment known to be associated with well vegetated wetlands characterised by diffuse flow. The likelihood of the package sewerage treatment plant affecting the water quality of the wetland and watercourses downstream of the wetland is therefore significantly higher if no onsite rehabilitation takes place.	• Structural interventions at strategic locations along the existing drainage channel to promote diffuse flow along the wetland. • Ongoing IAP clearing.
W14	High	The lower reaches of this wetland have experienced notable disturbance due to sand mining activity. The poorly vegetated and unnaturally steepened nature of the wetland in its current state leaves the unit susceptible to notable erosion impacts due to additional stormwater flows into the watercourse during the development operational phase.	• Shaping and revegetation of highly disturbed wetland areas. • Ongoing IAP clearing.
W15	Medium	Notable IAP pressure that is likely to worsen rapidly/	• Ongoing IAP clearing.
W23	Medium	Notable IAP pressure that is likely to worsen rapidly/	• Ongoing IAP clearing.
W24	Medium	Notable IAP pressure that is likely to worsen rapidly/	• Ongoing IAP clearing.
W42	Medium	Notable IAP pressure that is likely to worsen rapidly/	• Ongoing IAP clearing.

6.2.3 Stormwater Management Guidelines

It is understood by Eco-Pulse that stormwater management planning will be completed per individual site once these are released for purchase or rent. There is therefore no overarching stormwater management plan for the Cato Ridge Land Development and Release Project. It should however be noted than an appropriate best practice stormwater management plan must be designed for each site with consideration given to the cumulative impact on onsite and surrounding watercourses. The management of storm water prior to its discharge, and the way water is released into the environment will be critical in managing and protecting downstream freshwater resources.

A range of recommendations and guidelines for managing storm water runoff to protect wetlands and rivers have been compiled by the specialists from Eco-Pulse Consulting (Table 40). It is recommended that these guidelines/recommendations for managing storm water be considered when individual site stormwater planning commences.

Table 40. Summary of stormwater management recommendations

Item	Recommendations
Grading of the site	• To avoid the formation of preferential stormwater flow paths and associated point source erosion/ scouring the entire site must be graded/ sloped to encourage shallow diffuse sheet flow towards stormwater collection and conveyance systems. • All stormwater management infrastructure/ systems including collection, detention, attenuation, conveyance and outlet structures must be located outside of delineated watercourses and their respective buffer zones with some allowance for outlet protection/ armouring within buffers where this is not practically feasible.
Source controls &	• Stormwater should be harvested onsite from roofed surfaces thus reducing the quantity (volume) of water received by downstream water resources as surface flow. This water is to

Item	Recommendations
Rainwater harvesting	be used onsite for non-potable applications or made available to landowners / communities for irrigation or other non-potable uses. • The use of hardened surfaces on the property will be kept to a minimum as far as possible to encourage infiltration and reduce runoff capacity. Car parks for example could be gravel or another semi-permeable material (permeable paving, porous bricks/blocks) rather than impermeable asphalt or concrete.
Local controls and stormwater conveyance	• Use a combination of open, grass-lined channels/swales and stone-filled infiltration ditches rather than simply relying on underground piped systems or concrete V-drains. This will encourage infiltration across the site, provide for the filtration and removal of pollutants and provide for some degree of flow attenuation by reducing the energy and velocity of storm water flows through increased roughness when compared with pipes and concrete V-drains • For parking lots and driveways - garden beds (landscaped areas) and stormwater conveyance channels, the use of concave open-lined swales or bio-retention areas should be used to receive and convey stormwater. For these areas no curbs or spaced curbs are recommended so water can move freely from hardened surfaces into the swales or bio-retention areas. • Equally, if flower/plant beds are to be established adjacent to paved surfaces, then these should be designed to receive stormwater from hardened surfaces and should be planted with robust indigenous species that contribute to stormwater management objectives. • Road runoff will need to be managed through use of grassed swales or grassed drainage trenches running parallel along the road on the downslope side of the access road. Grassed swales/drainage ditches/trenches will intercept runoff and promote stormwater infiltration thus reducing surface runoff volumes and velocities downslope. Alternatively, numerous mitre drains can be constructed to dissipate water in small quantities and low velocities. • Bio-retention methods do not only address flow volume and velocity issues but are an effective means of removing suspended solids, heavy metals, hydrocarbons, organic compounds, and dissolved nutrients from stormwater. Images 1 and 2, below, provide a visual example of the type of bio-retention swales being recommended[7].  Source: https://za.pinterest.com/pin/419186677789410327/  Source: http://www.dec.ny.gov/lands/100871.html
Stormwater outlets	• Stormwater discharge outlets are to be used to ensure that the erosive energy of surface run-off is dissipated, and sediment suspended in the run-off is trapped before entering aquatic ecosystems. With regards to these outlets, the following environmentally responsible storm water discharge/outlet design considerations should be considered: • A series of smaller stormwater outlets is recommended over a few large outlets. The stormwater outlets must be constructed at regular intervals to spread out surface flow and avoid flow concentration. • All outlets must be designed to dissipate the energy of outgoing flows to reduce point source scouring and erosion risks. In this regard, adequately sized concrete stilling basins/sumps must be installed at all outlets and flow from these stilling basins must fall onto suitably designed gabion reno-mattresses with wing walls. The reno-mattresses must extend an appropriate distance downslope to ensure that erosion risks are minimised. • Appropriate armouring (e.g. reno-mattresses or rock packs) downstream/downslope of discharge points is essential to avoid scouring and sedimentation. This applies to discharge points in terrestrial and aquatic ecosystems and is of importance due to the sandy erodible nature of the soils in the study area.

[7] Note that Images 1 to 4 are for visual aid and descriptive purposes only. They should be considered conceptual in nature and do not promote any particular product, company or brand.

Item	Recommendations
	• The outlet reno-mattresses must be established to reflect the natural slope of the surface it is constructed on and are to be located at the natural ground-level. • The outlets and associated outlet protection structures should be aligned parallel to contours wherever possible to reduce the gradient of outflows and remain outside of wetland, river and their buffers.
Stormwater attenuatio n structures	• Stormwater attenuation structures should be designed to allow for the maintenance of base flow. • The outlets of stormwater attenuation structures should be associated with appropriate erosion protection measures. • A series of small outlets from attenuation structures is preferred to a single large outlet.
Inlet protection	• Measures to capture solid waste and debris entrained in stormwater entering the stormwater management system (inlet protection devices) will be incorporated into the design of the system and could include the use of either curb inlet/inlet drain grates and/or debris baskets/bags.
Managem ent of 'dirty water'	• The recycling/reuse of dirty water is promoted; alternatively, this water will need to be directed into the sewer system.

6.2.4 *Internal Road Design Recommendations*

A. Road Stormwater Management Recommendations

Key design considerations for the management of stormwater and erosion linked with road development have been included below:

- Measures must be implemented to distribute storm water as evenly as possible to avoid point sources of discharge directly into watercourses.
- The location and design of road drainage and discharge points shall be done in a manner that minimises peak discharge to downstream aquatic resources by considering the following:
  - Decreasing volume of water reaching wetlands as surface flow by encouraging infiltration; and
  - Decreasing velocity of flows entering aquatic resources (either through structural or vegetative means).
- To reduce the volume and velocity of stormwater runoff received by watercourses, road runoff should be removed from roads via road drainage infrastructure constructed at regular intervals at the approach to watercourse crossings to avoid point source scouring at the outlets.
- Wherever possible, all outlets must be located outside of the delineated watercourses (wetlands/river).
- When designing stormwater outlets, many small outlet discharges must be favoured over a few large outlets to reduce outlet flow volumes and velocities.
- All outlets must have adequately designed erosion protection and energy dissipation measures (e.g., Reno-mattresses, stone-pitching) suitable to reduce anticipated discharge velocities to levels that do not pose an erosion risk.

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- Armouring (e.g., reno-mattresses with vetiver bands) must be installed below all storm water outlets prior to flows entering downstream watercourses.
- Wherever possible, vegetated swales/side drains should be specified rather than concrete lined drainage channels (e.g., concrete V-drains). Vegetated swales/side drains should be well-vegetated with appropriate species and stabilized by means of gabion or concrete cut-off walls to prevent erosion and vertical incision. Similarly, outlets should not be piped outlets but open vegetated channels or vegetated mitre drains.
- Water should be discharged at regular intervals along road segments on the approach to watercourses so that the volume and velocity of flows reaching final discharge point into a watercourse is reduced as far as possible.
- Appropriate outlet structures and energy dissipator blocks are to be specified at all discharge points to break the energy of the storm water.
- Where possible, construct attenuation features (e.g. stilling basins) at the discharge points of the side drains to control the flows entering the water courses.

6.2.5 Wastewater Reticulation Pipeline Design Recommendations

- No pipelines or manholes should be established within 50m of a watercourse.
- To reduce the risk of surcharging sewer manholes onsite and downstream, a form of gully trap should be installed at or before the connection of the various components of the development with the main line. This gully trap will block foreign objects from entering the main internal line of the site and isolate blockage problems at the source.

6.2.6 Underground Fuel Storage Tanks (USTs)

The following environmental design guidelines are recommended for Underground (fuel) Storage Tanks (USTs) and pipework required for a service station (in the event this planned as part of the proposed development):

- The USTs must be installed according to:
  - The selected petrol station Engineering Guidelines and specifications.
  - Relevant National Building Regulations.
  - Relevant SANS and SABS codes.
- USTs must be properly founded and be leak-proof.
- There must be a leak detection and monitoring programme to monitor ground water contamination risk, and this should ideally be informed by a Geohydrological Assessment.
- Once in place, and before backfilling, all USTs must be inspected for damage / cracks. Any damage to be repaired, or the tanks to be replaced before any further action is taken.
- The tank farm must be lined with a HDPE liner or a suitable clay layer to prevent infiltration of product to the ground water should a spill\leak occur.

- The void around the UST must be back filled with a non-cohesive granular material to ensure that any product loss through the UST or ancillary pipe work will flow towards the low point, where a monitoring well should be located.
- The USTs are to be overlain with a reinforced concrete slab, its thickness and strength is to be determined by a qualified Engineer.
- The filler point and tank must be fitted with overfill protection. The critical level should be such that a space remains in the tank to accommodate the delivery hose volume.
- All pipeline connections are to be housed within impermeable containment chambers.
- All pipework to consist of internationally approved non-corrosive material and all pipes to be housed in secondary containment sleeving.
- Tanks should ideally be double walled / Jacketed (i.e., possessing secondary containment and must have an interstitial leak detection monitoring system between the two walls to monitor for product leakage).

6.2.7 Wastewater Package Plant Design Recommendations

The main risk associated with the proposed WWTP is the malfunction and / or failure of the treatment process. The success of the treatment process is largely influenced by its design which needs to make adequately accounts for expected biological and hydraulic loads. The following basic recommendation should be adhered to ensure adequate design and operation of the plant:

- The plant must be designed to the appropriate specifications to treat the type of wastewater being delivered (domestic, industrial, etc.).
- The plant should be designed to include emergency sewage storage and process pump infrastructure in case of system failure.
- The plant must be designed to consistently achieve General Limit Values (GLVs) as defined in Section 3.6 of Government Notice No. 339 (2004).
- The effluent discharge point should include suitable erosion protection measures. This could be gabions or a stilling basin, etc.

6.2.8 Sewer Pump Station Design Recommendations

- All sewer infrastructure, including pump station and sewer pipelines, must be designed according to best-practice environmental principles and requirements.
- No sewer pump stations are to be located within the delineated watercourses (wetlands and rivers) and must be located outside of the recommended aquatic buffer zone.
- Pump stations must be fenced off to prevent unauthorized access by humans/wildlife which could cause damage to infrastructure and cause accidental malfunction and/or spillage of untreated wastewater.
- Reasonable measures must be taken to provide back-up for mechanical, electrical, operational or process failure and malfunction at pump stations. At a minimum there should be an alarm

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system to warn of an electrical failure and sufficient standby equipment to provide for reasonable assurance that the pump station can be functional within 24 hours.

- The pump station must be placed within a lined, impermeable concrete bunded area with the capacity to hold untreated wastewater in an emergency and provide for sufficient time for maintenance staff to address any faults/ problems. This is to limit the risk of untreated wastewater overflowing in the event of any leakage or accidental spillage at the pump station(s).
- Signage should be provided at a visible location at pump stations to inform local residents in the area of the purpose of the pump station. Emergency telephone contact details should also be provided on the signs so that pump station failure, leakage or electrical power outages affecting the system can be easily reported.

6.3 Construction Phase Mitigation Measures

Several practical measures and onsite controls are also recommended to prevent or limit the construction phase impact of the proposed development. These should be included in the Environmental Management Programme (EMPr) for the development.

6.3.1 Demarcation of Construction Area and 'No-Go' Areas

- The edges of the construction servitude within the vicinity of the watercourse buffer must be clearly staked-out by a surveyor and demarcated using highly visible material (e.g. danger tape) prior to construction commencing.
- The demarcation work must be signed off by the Environmental Control Officer (ECO) before any work commences.
- Demarcations are to remain until construction and rehabilitation is complete.
- All areas outside of this demarcated working servitude must be considered no-go areas for the entire construction phase.
- No equipment laydown or storage areas must be located within the recommended buffer of watercourses.
- Access to and from the development area should be either via existing roads or within the construction servitude.

6.3.2 Accidental incursions into No-Go areas

- Any contractors found working inside the 'No-Go' wetland/river areas (areas outside the construction/ working servitude) should be fined as per a fining schedule/system setup for the project.

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- Watercourses outside of the construction corridor that are disturbed during the construction phase must be rehabilitated immediately. All disturbed areas must be prepared and then re-vegetated to the satisfaction of the ECO as per an appropriate rehabilitation and management plan.

6.3.3 Specific Measures for Working Directly Upslope of Rivers & Wetlands

- No clearing of indigenous vegetation outside of the defined working servitudes is permitted for any reason (i.e., for firewood or medicinal use).
- Before any work commences, sediment control/silt capture measures (e.g., bidim/silt curtains) must be installed downstream/downslope of the active working areas. Quantities of silt fences/curtains shall be decided on site with the engineer, contractor, and ECO. The ECO should be present during the location and installation of the silt curtains.
- Silt fences/curtains must be regularly checked and maintained (de-silted to ensure continued capacity to trap silt) and repaired where necessary. When de-silting takes place silt must not be returned to the wetland / watercourse.
- Movement of construction vehicles across wetlands and rivers must be prohibited.
- Excavated rock and sediments from the construction zone, and including any foreign materials, should not be placed within the delineated rivers and riparian areas in order to reduce the possibility of material being washed downstream.
- No physical damage should be done to any aspects of the channel and banks of watercourses. Channel bed and bank materials are not to be removed from the watercourse or used for construction purposes.
- Soil and other material required for construction purposes must not be derived from any river or wetland.
- No persons may remove, damage, deface, paint, or disturb of any flora (plants) outside of the demarcated construction areas, unless specifically authorised by the ECO in consultation with the resident engineer.

6.3.4 *Pollution Control*

- The proper storage and handling of hazardous substances (e.g., fuel, oil, cement, etc.) needs to be administered.
- All cement mixing or other hazardous substances handling, and dispensing activities must be undertaken on an impermeable surface.
- No refuelling, servicing or chemical storage should occur within the buffer of the delineated watercourses.
- No vehicles transporting concrete, or any hazardous product may be washed on site.

- Vehicle maintenance should not take place on site unless a specific bunded area is constructed for such a purpose.
- All necessary equipment for dealing with spills of fuels/chemicals must be available at the site. Spills must be cleaned up immediately and contaminated soil/material disposed of appropriately at a registered site.
- Sanitation - portable toilets (1 toilet per 10 users) to be provided where construction is occurring. Workers need to be encouraged to use these facilities and not the natural environment. Toilets must not be located within the 1:100yr flood line of a watercourse or within the buffer of any natural watercourses. Waste from chemical toilets must be disposed of regularly (at least once a week) and in a responsible manner by a registered waste contractor. Toilet facilities must be serviced weekly and in a responsible manner by a registered waste contractor to prevent pollution and improper hygiene conditions.
- Contaminated water containing fuel, oil or other hazardous substances must never be released into the environment. It must be disposed of at a registered hazardous landfill site.
- Provide adequate rubbish bins and waste disposal facilities on-site and educate/encourage workers not to litter or dispose of solid waste in the natural environment but to use available facilities for waste disposal.
- Clear and completely remove from site all general waste, constructional plant, equipment, surplus rock and other foreign materials once construction has been completed.
- Litter generated by the construction crew must be collected in rubbish bins and disposed of at registered landfill sites.
- Litter bins must be equipped with a closing mechanism to prevent their contents from blowing out or wild animals from accessing the contents.

6.3.5 Runoff & Erosion Management

- Wherever possible, existing vegetation cover should be maintained during the construction phase. The unnecessary removal of groundcover from slopes must be prevented, especially on steep slopes.
- Clearing activities must only be undertaken during agreed working times and permitted weather conditions. If heavy rains are expected, clearing activities should be put on hold. In this regard, the contractor must be aware of weather forecasts.
- All bare slopes and surfaces to be exposed to the elements during clearing and earthworks must be protected against erosion using rows of hay-bales, sandbags and/or silt fences aligned along the contours and spaced at regular intervals (e.g., every 2m) to break the energy of surface flows.

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- Once shaped, all exposed/bare surfaces and embankments must be re-vegetated immediately.
- If re-vegetation of exposed surfaces cannot be established immediately due to phasing issues, temporary erosion and sediment control measures must be maintained until such a time that re-vegetation can commence.
- All temporary erosion and sediment control measures must be monitored for the duration of the construction phase and repaired immediately when damaged. All temporary erosion and sediment control structures must only be removed once vegetation cover has successfully re-colonised the affected areas.
- After every rainfall event, the contractor must check the site for erosion damage and rehabilitate this damage immediately. Erosion rills and gullies must be filled-in with appropriate material and silt fences or fascine work must be established along the gully for additional protection until vegetation has re-colonised the rehabilitated area.

6.3.6 Soil Management

- Soil required for construction purposes must not be derived from the wetlands or rivers/streams.
- Soil stockpiles must be established on flat ground at least 30m away from delineated watercourses.
- Erosion/sediment control measures such as silt fences, low soil berms or wooden shutter boards must be placed around the stockpiles to limit sediment runoff from stockpiles.
- Subsoil and topsoil is to be stockpiled separately. Stockpiled soil must be replaced in the reverse order as to which it was removed (subsoil first followed by topsoil).
- Stockpiles of construction materials must be clearly separated from soil stockpiles in order to limit any contamination of soils.
- The stockpiles may only be placed within demarcated stockpile areas, which must fall within the demarcated construction area. The contractor shall, where possible, avoid stockpiling materials in vegetated areas that will not be cleared.
- Stockpiles shall be located outside of freshwater wetland habitat (including riparian zones).
- Stockpiled soils are to be kept free of weeds and are not to be compacted. The stockpiled soil must be kept moist using some form of spray irrigation on a regular basis as appropriate and according to weather conditions.
- If soil stockpiles are to be kept for more than 3 months, they must be hydro-seeded.
- The slope and height of stockpiles must be limited to 1.5m and are not be sloped more than 1:2 to avoid collapse.

6.3.7 Invasive Alien Plant Control

- All alien invasive vegetation that colonises the construction site must be removed as per the requirements of the NEM:BA, which obligates the landowner/developer to control IAPs on his property.
- IAP control must be undertaken as per the IAP control plan compiled for the development.

6.3.8 Water Abstraction & Use

- No water is to be abstracted from wetlands/streams/rivers for use in construction activities without prior approval by the Department of Water and Sanitation (DWS), subject to acquiring a relevant Water Use License in terms of Section 21 (a) of the National Water Act for taking water from a water resource.
- Employees are not to make use of any natural water sources (e.g. rivers) for the purposes of swimming, bathing, or washing of equipment, machinery or clothes.
- Drinking water is to be provided to all employees and labourers are to be discouraged from drinking directly from rivers on site.

6.3.9 Noise & Dust Pollution Minimisation

- Temporary noise pollution due to construction works should be minimized where possible.
- Water trucks will be required to suppress dust. This will likely be required daily.

6.3.10 Construction Phase Monitoring Measures

- The ECO must undertake regular compliance monitoring audits. Freshwater ecosystem aspects that must be monitored include:
    - The condition of the temporary runoff, erosion and sediment control measures and evidence of any failures or sediment deposits within watercourses.
    - Evidence of elevated river / stream turbidity levels.
    - Evidence of gully or bed/bank erosion.
    - The condition of waste bins and the presence of litter within the working area.
    - Evidence of solid waste within the no-go areas.
    - Evidence of hazardous materials spills and soil contamination.
    - Presence of alien invasive and weedy vegetation within the working area.
    - Rehabilitation and re-vegetation successes and failures.
- Once the construction and rehabilitation has been completed, the ECO should conduct a close out site audit.

6.4 Operational Impact Mitigation Recommendations

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6.4.1 Maintenance of Sewer Pipelines and Sewer Pump Stations

- Sewer pump stations and pipelines will need to be designed with longevity in mind and to require as little maintenance as possible in order to ensure the optimal functioning of such systems.
- Maintenance of pipelines and pump stations must be undertaken as sensitively as possible to prevent adverse impacts to the environment during access and repairs.
- Ensure the area around the pump station is mown on a regular basis to prevent fire damage.
- Blockages and manhole overflows must be fixed immediately.
- Ensure that an incident response and contingency plan is prepared to deal with any potential unforeseen impacts that could arise at the pump station during operation. These may include:
    - Failure of sewer pipeline design/poor construction;
    - Failure of materials leading to rupture of the sewer pipe and leakage;
    - Exposure of sewer pipelines and damage through erosion;
    - Unintentional damage by machinery operating near pipelines; and
    - The pump station also has the potential to malfunction, overflow or leak raw sewerage into the environment due to electrical failure, poor maintenance, environmental damage (e.g. storms) or systems operating above capacity.
- A monitoring and maintenance programme should be prepared for the various pump stations to ensure the on-going performance of infrastructure and prevention of foreseeable faults/problems that could result in leakage/failure. Pump station monitoring to include:
    - Assessing motor/gearbox problems – replace gearbox oil;
    - Checking for wear and tear;
    - Checking electrical components are working correctly (e.g. electrical board in good operating condition);
    - Looking for any surcharging (blockages);
    - Checking that access to the facility is controlled (no gaps in fencing, etc.); and
    - Checking that any emergency alarms are in working-order.

6.4.2 Freshwater Ecosystem Monitoring Programme

Given the threat of a decline in water quality of onsite watercourses associated with the development, especially if a fuel service station is planned for logistics operations, it is important that a detailed freshwater ecosystem monitoring plan developed for the site. This should involve at least bi-annual monitoring of water resource units (rivers/streams) in the vicinity of the development. This can also be achieved through basic visual inspections by the ECO and support staff, documenting issues such as:

- Invasive Alien Plant infestation.
- Scouring and deposition associated with storm water runoff.
- Development of erosion head cuts.
- Channel incision downstream of development.
- Blockage/siltation of culverts/pipes/side drains.
- Scouring at the location of stormwater water outlets.
- Erosion or instability of road embankments.
- Surface water quality monitoring (including monitoring for petrol and diesel range hydrocarbons) at strategic points along onsite watercourses.
    - The results of the surface water quality monitoring must be used to inform further management actions, remedial measures and/or the revision of mitigation strategies aimed at protecting watercourses in the study area and downstream from water quality impacts associated with the development (particularly the fuel service station facility).

6.4.3 Water Quality Monitoring

A surface water quality and aquatic bio-monitoring plan should be developed to inform the monitoring of surface water quality and aquatic habitats/biota associated with the wetland and riparian ecosystems at the site. Surface water quality should be monitored at strategic points in the landscape and the results used to inform further management actions, remedial measures and/or the revision of mitigation strategies aimed at protecting the wetlands, rivers/streams and instream/riparian habitat on the property and downstream from water quality impacts associated with the development. This monitoring plan should be referred to for all aspects of surface water quality monitoring and aquatic biomonitoring at the site.

6.4.4 Contingency Plan for Wetlands & Aquatic Ecosystems

An Environmental Contingency Plan for Aquatic Ecosystems should be developed to assist in the identification of potential abnormal/unforeseen environmental incidents and provide guidance on communication including notification and activation in the event of an environmental emergency. It provides a framework of organisational responsibility and actions to be taken in the event of an incident on, or in the immediate vicinity of the development site. The plan should identify key personnel and their responsibilities in terms of identifying incidents, reporting on emergencies, preparing for abnormal incidents/events, and implementing measures to contain and remediate aquatic environmental hazards. This plan should be referred to for all aspects of the management of operational emergencies relating to the planned development.

6.4.5 Storm Water Management

Importantly, the stormwater management system and related infrastructure is likely to require regular on-going maintenance in the form of silt, debris/litter clearing to ensure the optimal functioning of such systems. Storm water management systems will therefore be designed with longevity in mind.

6.4.6 Landscaping Recommendations

It is recommended that landscaping promote the use of indigenous species common to the region and that as much natural ground cover is established on the site to help with binding soils and encouraging water infiltration, thus reducing overland flows and the pressure on storm water management infrastructure.

6.4.7 Waste Minimisation, Reuse, and Recycling

A culture of "conserve, reduce, reuse & recycle" should be promoted with regards to the use and disposal of products to minimise resource consumption and reduce the amount of potential waste. Project design can also promote the conservation and efficient utilisation of water, implement rainwater harvesting measures, the recycling / re-use through grey water systems and using water efficient fittings.

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7. CONCLUSION

A total of thirty-nine (39) watercourse units were delineated within the study area through a combination of desktop mapping and selective infield sampling. The impact potential screening assessment indicates that a total of nine (9) individual wetland HGM units and ten (10) river/stream units are at risk of being potentially measurably impacted during the construction and operational phases of the proposed development. These watercourse units were taken forward for detailed infield assessment.

The PES of the wetland units assessed ranged from largely modified ('D' category) to moderately modified ('C' category). Streams units IHI categories ranged from 'D' (severely modified) to 'B' (largely natural). EIS ratings for wetland process units ranged from Low to High. High EIS ratings were typically driven by the importance of wetland units in contributing to biodiversity maintenance, as these units are categorised as a critically endangered ecosystem type according to the latest national biodiversity assessment. The most important wetlands were typically in fair condition, with large intact or semi-intact buffer areas that make them important priority areas for meeting regional, provincial, and national ecosystem conservation targets. EIS ratings for stream process units assessed ranged from Low to Moderate. Moderate EIS categories were assigned to those stream units that were moderately modified/largely intact, had moderate to high connectivity to upstream watercourses and retained relatively intact buffer zones. All these factors collectively contribute to the likelihood that these units play an important role in biodiversity maintenance or act as important wildlife corridors.

Eco-Pulse undertook an impact significance assessment for the proposed project using a methodology provided by Zutari. Overall, under a realistic poor mitigation scenario construction phase impacts for Phase 3 of the project were assessed as being 'Major – Negative'. This is because development Phase 3 encroaches into a large seep wetland (W15 – Figure 9). W15 was assessed as being in the C PES category but is of High ecological importance and sensitivity. The total area of wetland impacted by the encroachment is approximately 3.12ha. Under a realistic poor mitigation scenario construction phase impacts for Phases 1 and 2 were assessed as being 'Minor – Negative'. Under a realistic good mitigation scenario, the construction significance of each phase of the proposed project is 'Minor – Negative'. This is however contingent on direct physical impacts to W15 being avoided during Phase 3 of the development. The key operation phase concern is stormwater management and the potential alteration of watercourse hydrological and geomorphological processes. Under a realistic poor mitigation scenario these impacts are considered 'Moderate – Negative' for each project phase. The significance of these impacts can however be reduced to 'Minor – Negative' under a realistic good mitigation scenario. Mitigation to reduced operational phase impact significance should focus on adhering to recommended watercourse buffer zones, wetland rehabilitation and operation phase management, stormwater management design, and the design of the proposed onsite sewage package treatment plant.

Eco-Pulse also undertook a DWS Risk Assessment to inform the water use licencing requirements for the project. Whilst some risks associated with proposed project can be managed to 'low' overall levels through mitigation, the overall project risk is still likely to remain at least a 'moderate'. This suggests that the project cannot be generally authorised under the GA for Section 21 c and i water uses. Therefore, a full WULA is likely to be required. Additionally, General Notice (GN) 509. GN 509, published in Government Gazette (GG) no. 40229 under Section 39 of the National Water Act (Act no. 36 of 1998) in August 2016, allows for Section 21 (c) and (i) water uses to be generally authorised if risks and be reduced to acceptable level, there is however no GA notice for the remaining Section 21 water uses. This project will trigger several waters uses beyond (c) and (i), and will require a full WULA on that basis, also.

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Annexure A: Maps Showing Field Sample Locations

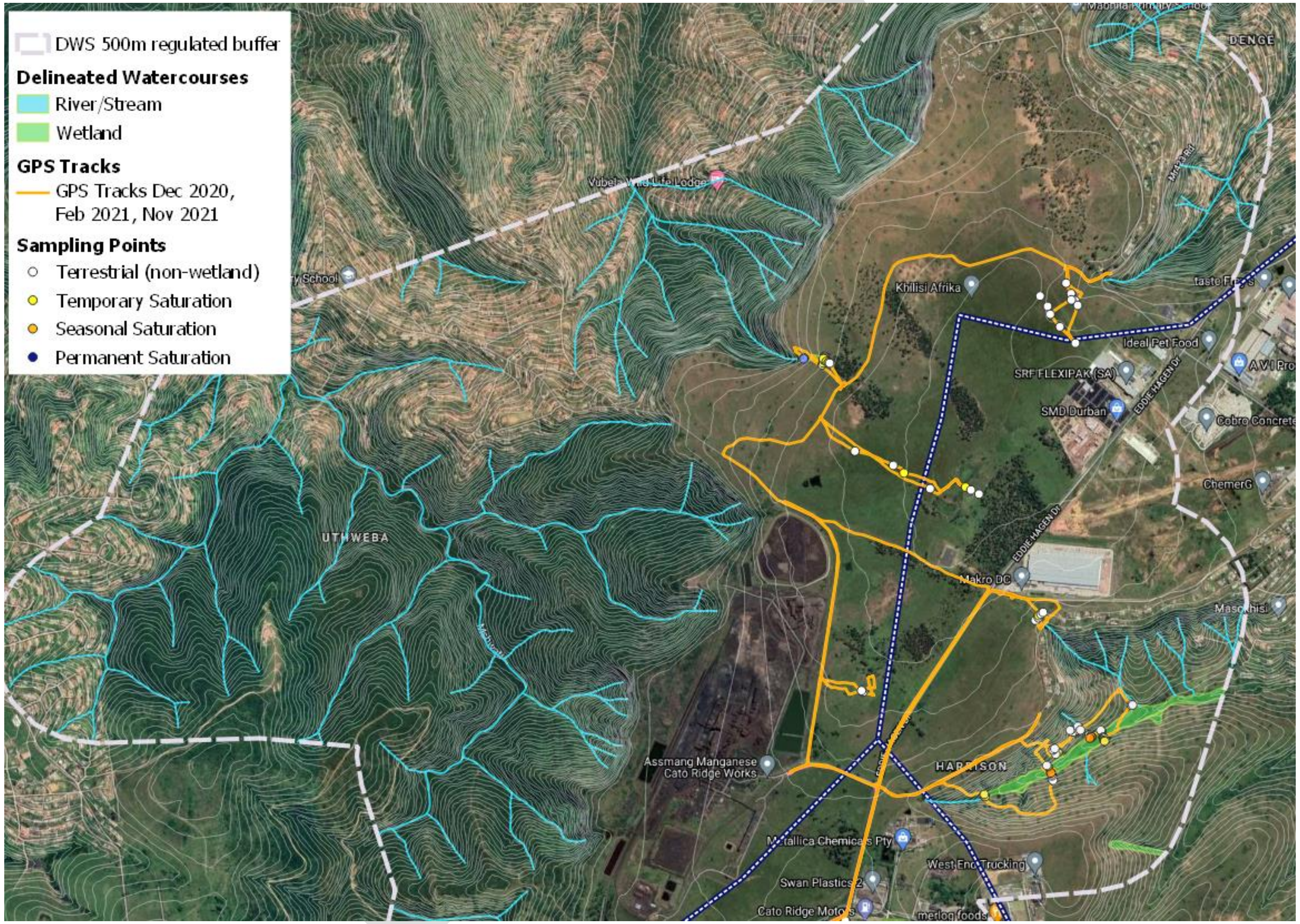


Figure 13. Map showing watercourses in the northern portion of the project area in relation to observation/sampling points taken in the field.

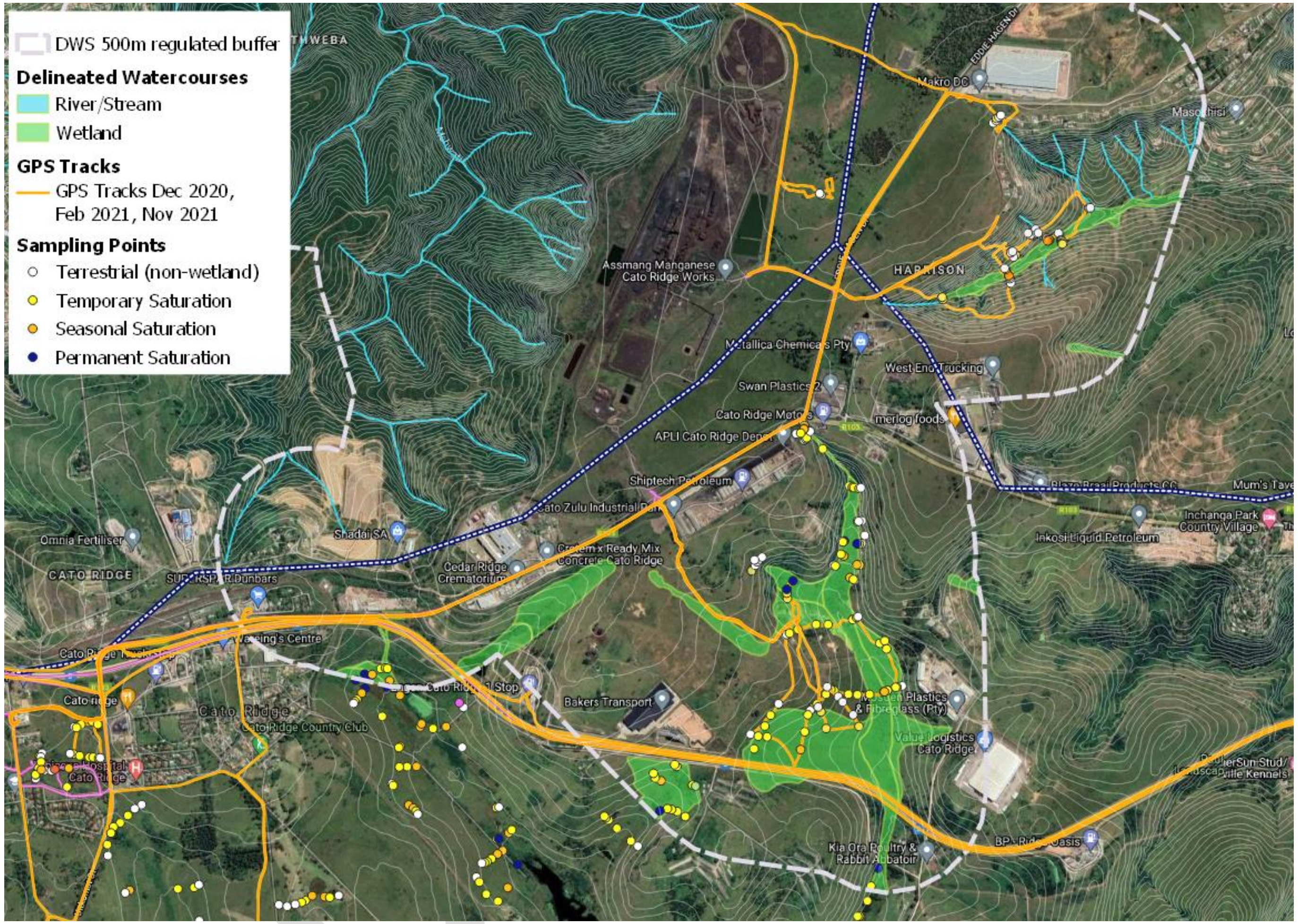
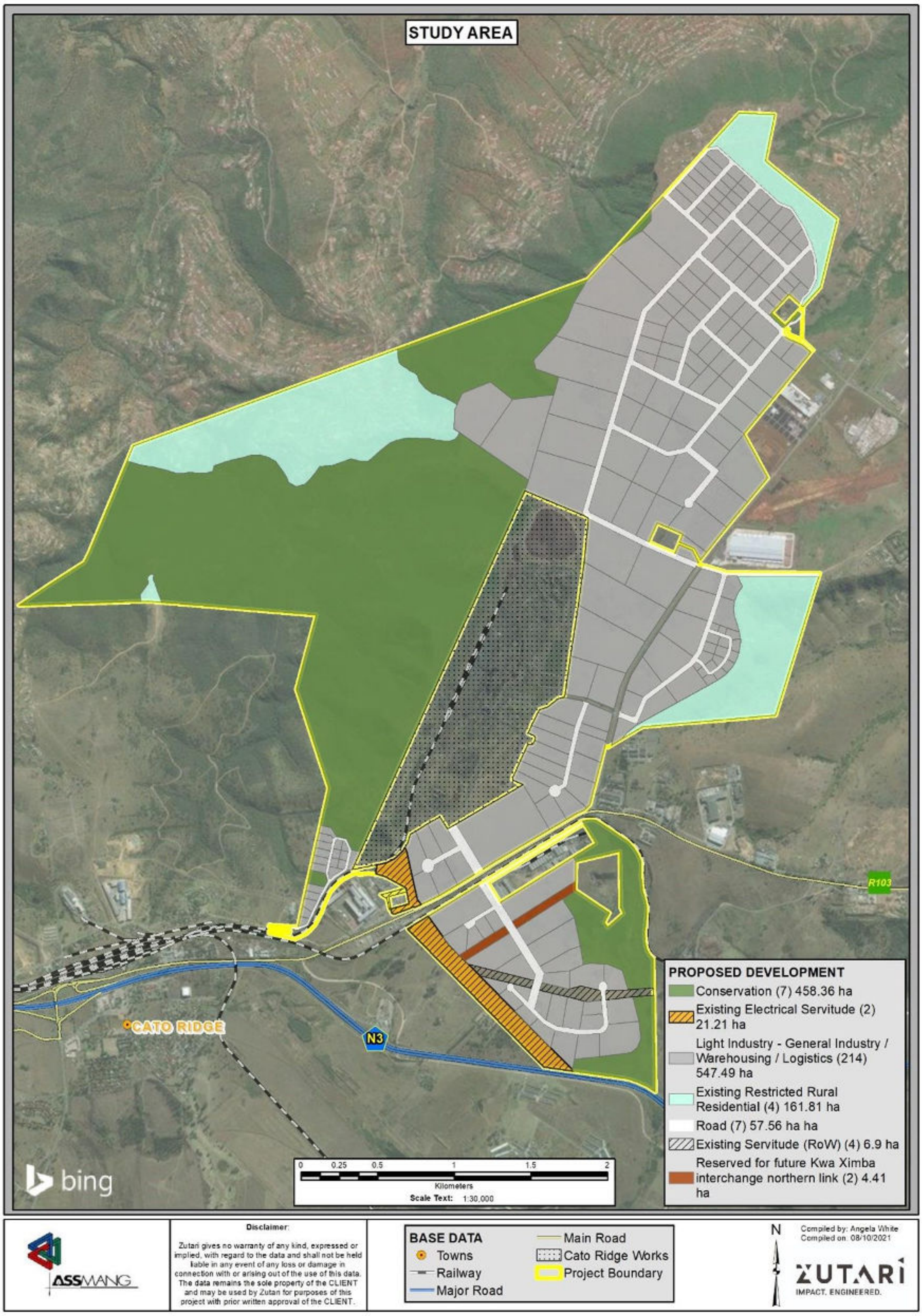


Figure 14. Map showing watercourses in the southern portion of the project area in relation to observation/sampling points taken in the field.

Annexure B: Maps Showing the Previous / Preliminary Layout (since abandoned in Favour of the assessed layout)



Previous / preliminary layout. Map provided by Zutari (2021).