NGQONDO WATER SUPPLY SCHEME

Aquatic Biodiversity Assessment

DRAFT REPORT

GroundTruth

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The project deliverables, including the reported results, comments, recommendations, and conclusions, are based on the author's professional knowledge, as well as available information. The study is based on assessment techniques and investigations that are limited by time and budgetary constraints applicable to the type and level of survey undertaken. GroundTruth therefore reserves the right to modify aspects of the project deliverables if and when new/additional information may become available from research or further work in the applicable field of practice or pertaining to this study.

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VALIDITY PERIOD

It should be noted that the findings of these freshwater ecosystem studies, including the infield delineation of the systems, are considered to be valid for a period of five (5) years unless new/additional information warrants a change in project findings. This is based on the likelihood of changes within the systems (e.g. changes in vegetation composition or altered flow patterns) and the associated catchment areas (e.g. increased runoff or establishment of streamflow reduction activities.

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GroundTruth Water, Wetlands and Environmental Engineering (GroundTruth), established in 2004, hereby acknowledge that it does not have any invested interests in the following project, and is thus independent to the proponent as required in terms of Section 33 of Government Notice Regulation 358 published under Section 24 of the National Environmental Management Act (Act 107 of 1998). Furthermore, in line with Appendix 6 of the 2014 EIA regulations (GN R982) GroundTruth under directorship of Dr Mark Graham, declares that:

- The independent specialists in this application; do not have and will not have any vested interest (either business, financial, personal or other) in the undertaking of the proposed activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014;
- All the work relating to the project will be performed in an objective manner, even if this results in views and findings that are not favourable to the client;
- That there are no circumstances that may compromise the objectivity of GroundTruth in performing such work;
- The expertise required in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity, are possessed by all involved;
- Compliance with the Act, regulations and all other applicable legislation;
- There are no conflicting interests, and none shall be engaged in, during the undertaking of the assigned activity;
- GroundTruth undertakes to disclose to the applicant and the competent authority all material information it may be in possession of that reasonably has or may have the potential of influencing - any decision to be taken with respect to the outcome of the project by the competent authority; and - the objectivity of any report, plan or document to be prepared by GroundTruth for submission to the competent authority;
- All the particulars furnished by team members in this document are true and correct; and
- GroundTruth is aware that any person(s) is guilty of an offence in terms of Regulation 48 (1) of the EIA Regulations, 2014, if that person provides incorrect or misleading information. A person who is convicted of an offence in terms of sub-regulation 48(1) (a) to (e) is liable to the penalties as contemplated in section 49B(1) of the National Environmental Management Act, 1998 (Act 107 of 1998).

Signed:	
Date:	November 2025
Steven Ellery	
Pr. Sci. Nat. (Ecology) Reg. No. 132408	

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LIST OF ACRONYMS

Acronym	Explanation
CR	Critically Endangered
CVB	Channelled Valley-Bottom Wetland
DEPR	Depression
DEDTEA	Department of Economic Development, Tourism and Environmental Affairs
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	Eastern Cape
ECO	Environmental Control Officer
EIS	Ecological Importance and Sensitivity
EN	Endangered
ETS	Ecosystem Threat Status
FEPA	Freshwater Ecosystem Priority Area
GIS	Geographic Information System
GPS	Global Positioning System
Gs	Sub-Escarpment Grassland
Gs10	Drakensberg Foothills Moist Grassland
Gs14	Mthata Moist Grassland
HGM	Hydrogeomorphic
IHI	Index of Habitat Integrity
LT	Least Threatened
MAP	Mean Annual Precipitation
NFEPA	National Freshwater Ecosystem Priority Areas
NP	Not Protected
NWA	National Water Act (No. 36. 1998)
MAP	Mean Annual Precipitation
PES	Present Ecological State
PET	Potential Evapotranspiration
RIP	Riparian Area
SANBI	South African National Biodiversity Institute
SEEP	Hillslope Seep
WT	Wetland Type

1. INTRODUCTION

GroundTruth was appointed by Indwe Environmental Consulting to conduct an aquatic ecosystem study for a proposed water supply scheme at the village located in Ngqondo, near Engcobo in the Eastern Cape. The aquatic ecosystem study consists of a detailed wetland assessment and a riverine study, which are required to inform the Environmental Impact Assessment (EIA) and Water Use License (WUL) application processes associated with the proposed development.

Local, regional, and national regulatory bodies, such as the Departments of Water and Sanitation (DWS) and Economic Development, Environmental Affairs and Tourism (DEDEAT), have adopted legislation, policies and guidelines that regulate the use of freshwater ecosystems1 (wetland and riverine systems) to protect and maintain these systems' benefits and services to society and the natural environment. To be regulated, these systems must first be identified, delineated and assessed.

The objective of the delineation procedure is to identify the boundary between the aquatic ecosystems and adjacent terrestrial areas. The process of aquatic ecosystem delineation identifies the extent of these ecosystems based on the following legal definitions[2]:

- "Wetland means land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."
- "Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas."

Hydrology is considered to be the primary biophysical driver of freshwater ecosystems, but due to its variability, it is not possible to efficiently and accurately delineate these systems based on water levels (Richardson and Vepraskas 2001). The delineation of freshwater ecosystems, therefore, relies on indirect indicators, such as vegetation, topography and soils.

This study includes the delineation and assessment of freshwater ecosystems that may be impacted by the proposed activities associated with the Ngqondo Water Supply Scheme. The client is currently undertaking an Environmental Impact Assessment (EIA) and is applying for a Water Use License (WUL) for the development, which involves the construction of various different water pipeline types and its associated infrastructure. In accordance with the DWS regulations, all freshwater ecosystems within a 500m radius of the proposed development footprint were identified, delineated, and assessed to determine potential risks and inform appropriate mitigation measures.

1 Freshwater ecosystems refers specifically to inland wetlands and rivers. Aquatic ecosystems can also include estuarine and marine ecosystems, which are not relevant in this study
2 National Water Act 36 of 1998.

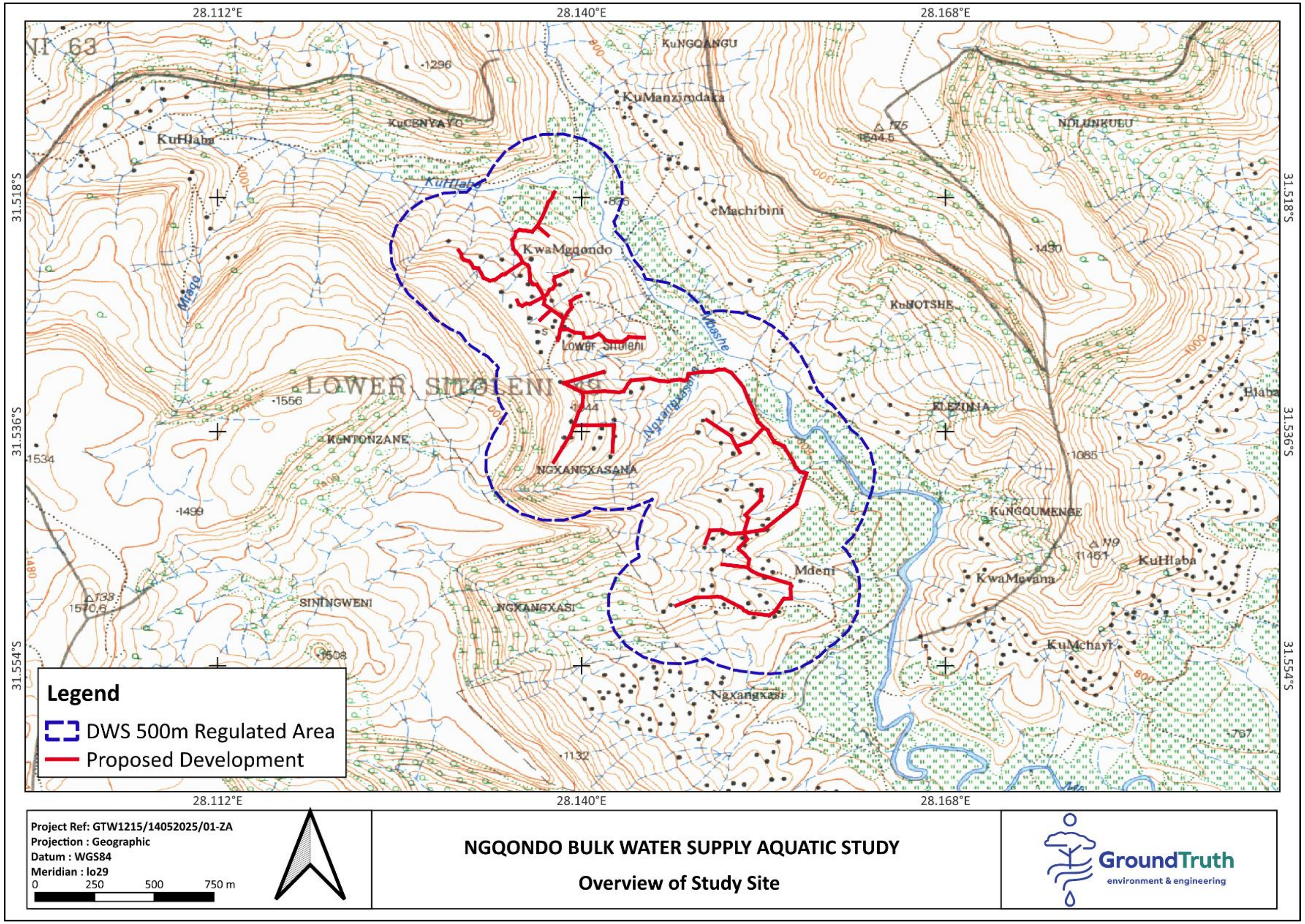

Figure 1-1 Proposed water supply development

2. TERMS OF REFERENCE

The study area is located in Ngqondo, close to Engcobo, in the Eastern Cape. Based on information supplied by the client, the water supply scheme will consist of approximately 1.2km of uPVC pipes of sizes ranging from 63mm in diameter across various classes, 5km of HDPE pipes of 50mm diameter, 4.5km of Klambon steel pipes of sizes ranging from 50mm diameter to 90mm diameter. The construction of stand taps, valve chambers, and all associated pipe fittings are included in the development. These include some new and some reinstated stormwater infrastructure along the reticulation mains. The proposed routing of the water supply scheme (hereafter referred to as the proposed development) falls within 500m of freshwater ecosystems, and as such the client is required to undergo an aquatic ecosystem study to determine potential risks to the hydrologically linked aquatic ecosystems. Given this, the terms of reference for the study are as follows:

- In field delineation and/or verification of the boundary of aquatic ecosystems that are hydrologically linked and potentially impacted by the proposed development, and within the DWS 500m regulated area.
- Functional assessment[3] of the aquatic habitat hydrologically linked to the proposed developments along with their ecological importance and sensitivity.
- Description of the current state of the aquatic ecosystems hydrologically linked to the proposed developments.
- Description of the likely impacts (as per the National Environmental Management Act and EIA regulations) and risks (as per the National Water Act and WUL regulations) associated with the proposed development and appropriate mitigation measures to avoid unnecessary impacts to the aquatic ecosystems.
- Determining appropriate construction and operational phase buffer requirements for the aquatic ecosystems.
- Identification of other sensitivities and important issues not identified within the assessment process, if applicable.
- Specification of mitigation measures to reduce the impacts on aquatic biodiversity as far as possible.

3 Functional assessments refer to the assessment of the delivery of ecosystem goods and services.

3. KNOWLEDGE GAPS

The following sections highlight the assumptions and limitations associated with this study that may influence the type of information collected and the accuracy of the data.

3.1 Assumptions

Studies relating to natural ecosystems and understanding historical conditions rely on various assumptions, with the following assumptions being made during the assessment of these particular systems:

- When undertaking a wetland delineation, three environmental indicators are generally considered namely, landscape position, soil properties and vegetation indicators. Wetlands seldom form on hill sides and scarp slopes and as such, assessing the landscape position can often preclude the need to assess the soil and vegetation indicators. As such, areas where there is a high chance that wetland conditions may exist were assessed in detail, whereas areas precluded by their position in the landscape were only briefly assessed for wetland conditions.
- Mapping and classification of the wetlands and watercourses that are hydrologically isolated from the study site within the 500m radius should be considered preliminary as they were only briefly verified infield. Therefore, the extent of these systems cannot be used in any other authorisations.
- Given the limited footprint and expected impact of well-constructed pipelines, only aquatic ecosystems that fall within 100m of the pipelines were delineated in detail. Linear features like pipelines (especially clean water supply pipelines) generally have limited spatial impacts to the surrounding landscape. The other freshwater ecosystems beyond 100m of the pipeline were delineated in less detail.
- No post-development assessments were conducted as part of this study. The environmental impacts associated with constructing linear infrastructure, such as pipelines, are typically limited to the physical disturbance caused during construction—e.g., vehicle movement, earthworks, and temporary material storage. These impacts are generally short-term and minor in both spatial extent and intensity. As a result, they do not register meaningfully on assessment tools. Therefore, it is assumed that the post-development scores for PES (Present Ecological State), EGS (Ecosystem Goods and Services), and EIS (Ecological Importance and Sensitivity) remain unchanged from the current scores.
- Alien invasive plants would be maintained at low levels (<1% cover) within the wetland systems and their immediate buffer areas (assuming a 15m buffer). It is acknowledged that construction activities often create prime habitat for alien invasive plants.
- The development layout that was provided to GroundTruth by the client on the 21st of October 2025 is accurate and will not change once this report has been finalised and approved. Should the development layout change, the assessments in this report may need to be suitably adjusted.
- The development activities will not extend beyond the proposed development boundary as illustrated on all maps as the ‘Proposed Development’ or ‘Proposed Pipeline’.

- An appropriate maintenance and management plan will be compiled and implemented, to ensure the effectiveness of the proposed activities are sustained into the future.
- Given that the risk assessment matrix only considers the mitigated scenario, it is assumed that all mitigation measures that are suggested in Section 9 will be adopted during the construction and operational phases of the proposed development.
- An appropriate maintenance and management plan will be compiled and implemented, to ensure the effectiveness of the proposed activities are sustained into the future.
- The site assessment was conducted on 27th May 2025, during the winter season in the Eastern Cape. Consequently, it does not encompass the seasonal variations in site conditions. However, the specialist is of the opinion that this omission does not materially affect the validity or outcome of the assessment.
- The watercourses were delineated using a Trimble Catalyst DA2 receiver connected to a phone with an expected accuracy of 60cm or less. This is deemed sufficiently accurate based on the nature of the development.

3.2 Limitations

The following limitations apply to the studies undertaken for this report:

- Due to time constraints, soil descriptions are based on moist conditions, rather than the dry conditions stipulated in the DWS guidelines (DWAF 2005). Generally, the recorded Munsell colour values would increase as soil is dried. This was taken into consideration during the infield studies.
- In some areas, the soils within the site were highly disturbed due to historical and current agricultural practices, erosional features within the landscape, and additional water inputs, making the interpretation of soil profiles difficult at times.
- The freshwater ecosystem assessment techniques are considered to be the most appropriate at the time of the compilation of the report, however in some instances, such as for systems that have been highly modified/transformed, they may have shortfalls. This technique, however, has been compiled based on international best practice, to apply to South African conditions, having undergone a peer-review process during their development. This assessment technique should, therefore, be seen as the most appropriate tool for wetland assessments at this time.
- The assessment of the freshwater ecosystems’ ecological integrity includes catchment conditions, and it should be noted that changes in the hydro-geomorphic (HGM) units’ catchments may have an adverse effect on the systems’ integrity.
- The assessments of the identified freshwater ecosystems were based on an individual site visit, i.e., a 'snap-shot' in time, due to budgetary and time constraints. As such, changes in the recorded features and/or characteristics within the freshwater ecosystems and their catchments, which may be subject to the influences of seasonality and/or land use changes, may not be accounted for in the assessments.
- Any hydrologically isolated freshwater ecosystems have not been delineated in detail and were based predominantly on desktop mapping and review, and limited infield visual verification. Therefore, the mapping of these systems would not be appropriate for the authorisation of any future unrelated developments within the study area.

- No formal vegetation sampling was conducted, but general observations pertaining to vegetation composition were recorded onsite.
- WET-EcoServices (Kotze et al. 2020) assists in identifying the importance and sensitivity of specific freshwater ecosystems but is recognised as having limitations in terms of quantifying specific impacts linked to development or changes within the landscape; and accounting for the size of the ecosystem services strongly associated with the size of the systems.
- All assessments undertaken were based on the impacts that were noted during the time of the site visit. Should conditions onsite change, the assessments may not necessarily reflect such changes.
- This study does not consider freshwater ecosystems beyond the 500m study site radius.

The project deliverables, including the reported results, comments, recommendations, and conclusions, are based on the authors' professional knowledge as well as available information. This study is based on assessment techniques and investigations that are limited by time and budgetary constraints applicable to the type and level of survey undertaken. This study is, however, considered to be the most accurate and up-to-date assessment of the freshwater habitat associated with the study area, and should be used to inform the decision-making processes of the relevant authorities.

4. EXPERTISE OF THE SPECIALISTS

Due to the nature of the study, the project team included personnel with experience in mapping, delineation, and assessment of freshwater ecosystems, as well as personnel with experience in terrestrial faunal and floral assessments (**Table 4-1**).

Table 4-1 Team members, roles, experience levels and qualifications

Wetland Practitioner	Role in the Study	Experience Levels	Qualifications
Steven Ellery	• Compilation of the Project report. • Conducting In Field Delineation	7 years' experience, with input into various wetland studies, including: • Delineation and Wetland Assessments • Rehabilitation planning; and • Rehabilitation monitoring and evaluation.	M.Sc. (Geography) Pr. Sci.Nat - Ecology
Lindelani Hlongwane	• Compilation of the project report. • Desktop processing. • Conducting wetland Assessments.	~11 years' experience, with input into various wetland studies, including: • Rehabilitation monitoring and evaluation. • Delineation. • Assessments.	SASS 5 Accreditation
Zaniel April	• Desktop processing. • Conducting wetland assessments.	1 years' experience with input into various wetland studies, including • Delineation • Water quality and biomonitoring	Ndip (Nature Conservation) SASS5 Accreditation
Fiona Eggers	• Review of report	15 years' experience, with input into various wetland studies, including: • Delineation and Wetland Assessments • Rehabilitation planning; • Rehabilitation monitoring and evaluation; and • Wetland creation projects	M.Sc. (Boany) Pr. Sci.Nat - Ecology

5. STUDY SITE

The following section provides an overview of the study site, focusing on the regional context, climate, and ecosystem types.

5.1 Site Sensitivity Verification

The Department of Forestry, Fisheries and the Environment's (DFFE) National Environmental Screening Tool has flagged the aquatic biodiversity theme of the proposed Ngqondo Water Supply Scheme site as having "Very High" sensitivity. This is largely due to the presence of mapped wetlands and riverine systems within 500 metres of the planned development footprint (Hawley & Desmet, 2020). This sensitivity rating was not just taken at face value — it was confirmed by the Environmental Assessment Practitioner (EAP) from Indwe Environmental Consulting through a combination of desktop screening and a site visit, both of which formed part of the Environmental Impact Assessment process (**Figure 5-1**).

During the site verification, multiple wetland areas were identified, all of which are hydrologically connected to parts of the proposed development. While the nearby Mbashe River is not considered highly sensitive, it still plays an important ecological role in the area. Because of the close proximity and ecological importance of these water features, a detailed aquatic biodiversity specialist study is required. This assessment, guided by the National Environmental Management Act (Act No. 107 of 1998), as amended in 2020 (GNR 320), will help determine the current ecological condition of the wetlands and river, and guide appropriate mitigation measures to ensure the natural systems are protected during and after construction.

Figure 5-1 Aquatic biodiversity theme sensitivity map as extracted from the screening report on the DFFE screening website.

5.2 Regional context

South Africa is a semi-arid country, and thus rivers and wetlands are important features within the landscape as they provide ecosystem services directly related to water quantity and quality. It is estimated that over 50% of South Africa's wetlands have been lost (SANBI, 2018), and of the remaining systems, 48% are classified as Critically Endangered (SANBI, 2018). The country's river ecosystems are similarly under significant threat. The 2018 National Biodiversity Assessment highlighted that many rivers are in poor condition due to various pressures such as pollution, over-extraction of water, invasive species, and habitat destruction/transformation. For further information about the regional and biophysical context, please refer to the aquatic report

5.3 Climate

The study area falls under the T11E quaternary catchments (Midgley et al., 1994). The Mean Annual Precipitation (MAP) for T11E is 934,2 mm, and the Potential Evapotranspiration (PET) is 1677,7 mm (Schulze, 2007). This would suggest that any freshwater ecosystems within the T11E catchment would have a **moderately low** sensitivity to hydrological impacts (Macfarlane et al., 2020).

5.4 Vegetation types

Under natural conditions, the surrounding landscape and study site would have been characterised by particular vegetation types. The proposed development falls under two vegetation types present Drakensberg Foothills Moist Grassland (Gs10) and Mthata Moist Grassland (Gs14). Based on Mucina and Rutherford (2006), Drakensberg Foothills Moist Grassland is distributed within the KwaZulu-Natal and Eastern Cape Provinces: Broad arc of Drakensberg piedmonts covering the surrounds of Bergville in the north, Nottingham Road, Impendle, Bulwer in the east, and Kokstad, Mount Currie, Underberg KwaZulu Natal (KZN) and the surrounds of Mt Fletcher, Ugie, Maclear and Elliot (Eastern Cape).

The Drakensberg Foothill Moist Grassland is classified as Least Threatened, with 23% under conservation. Only 2–3% of this area is legally protected, located within the uKhahlamba Drakensberg Park, Ntsikeni Wildlife Reserve, and several nature reserves including Karkloof, Mount Currie, Coleford, Fort Nottingham, Impendle, Ngeli, and Umgeni Vlei. Unfortunately, nearly 20% of the grassland has already been transformed due to agriculture, plantations, and urban expansion. Invasive alien species such as *Rubus sp, Acacia dealbata*, and *Solanum mauritianum* pose a potential threat in some areas. Erosion levels in the region are reported as very low (49%), low (28%), and moderate (17%).

Mthata Moist Grassland falls under Eastern Cape Province: Plains between Mthatha and Butterworth parallel to the coastline and excluding the river valleys that intrude landwards into this unit. Altitude is 600 –1 080 m. The conservation status is Endangered, with a protection target of 23%. Only a small fraction is statutorily conserved in the Luchaba and Nduli Wildlife Reserves. More than 40% has been transformed for cultivation and plantations or by dense rural human settlements. Previously cultivated or fallow lands possibly constitute an estimated additional 25% (Steenkamp et al. 2005). *Acacia mearnsii, Solanum mauritianum* and *Richardia humistrata* are the most common alien invasive plant species. Erosion is a serious problem, with high to very high erosion levels (Mucina and Rutherford, 2006).

5.5 Wetland classification

To allow for the differentiation between wetland systems and the prioritisation of systems either for conservation or management purposes, the wetlands were classified in accordance with the South African National Biodiversity Institute’s (SANBI) wetland classification system (**Table 5-1**) (Ollis et al., 2013). However, for the purpose of assessing each Hydrogeomorphic (HGM) unit, Kotze et al., (2008) was used to classify the wetland systems as particular HGM units rather than Level 4 of the SANBI system. The HGM unit types defined by Kotze et al. (2007) differ from Ollis et al. (2013), with the river classification being excluded and flat wetlands being grouped with the depression wetlands. The HGM units identified within the study site are classified as the following (**Table 5-1**):

- One channelled valley-bottom wetland (CVB).
- Four depression wetlands (DEP).
- Seven hillslope seep wetlands (SEEP).

Table 5-1 A description of the onsite wetlands based on the SANBI classification and (Ollis et al., 2013)

System (Level 1)	Bioregion (Level 2)	Landscape Unit (Level 3)	HGM Unit (Level 4)	Description of HGM Units (Ollis et al. 2013)
Inland systems	Drakensberg Grassland Bioregion (Gd1)	Hillslope landscape unit	Hillslope seep (SEEP)	A wetland area located on gently to steeply sloping land and dominated by colluvial (i.e., gravity-driven), unidirectional movement of water and material downslope. Seeps are often located on the side-slopes of a valley, but they do not typically extend onto a valley floor.
		Bench landscape unit	Depression wetland (DEPR)	A closed-basin wetland that collects water from rainfall, runoff, or groundwater. Typically isolated from streams, it may be seasonally or permanently wet and supports specialized vegetation adapted to changing water levels
		Valley floor landscape unit	Channeled valley-bottom wetland (CVB)	A valley-bottom wetland that relies on flood flows from a channeled river for hydrological inputs.

5.6 River classification

Rivers are classified into seven geomorphological zones, based on their characteristic gradient and diagnostic channel characteristics. These classes were used to define the type of riverine systems identified within the study site. The rivers were split into the following river zones according to the characteristics described (Rowntree et al., 2000):

- *Mountain Headwater Stream:* A very steep gradient stream dominated by vertical flow over bedrock with waterfalls and plunge pools. Normally first or second order. Reach types include bedrock fall and cascades.
- *Mountain Stream:* Steep gradient stream dominated by bedrock and boulders, locally cobble or coarse gravels in pools. Reach type include cascades, bedrock fall, step-pool. Approximate equal distribution of vertical' and 'horizontal' flow compartments.
- *Transitional:* Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plain-bed, pool-riffle, or pool-rapid reach types. Length of pools and riffles/rapids similar. Narrow floodplain of sand, gravel, or cobble often present.
- *Upper Foothills:* Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plain-bed, pool-riffle, or pool-rapid reach types. Length of pools and riffles/rapids similar. Narrow floodplain of sand, gravel, or cobble often present.
- *Lower Foothills:* Lower gradient mixed bed alluvial channel with sand and gravel dominating bed, locally may be bedrock controlled. Reach types typically include pool-

riffle or pool- rapid, sand bars common in pools. Pools of significantly greater extent than rapids or riffles. Flood plain often present.

- *Lowland River:* Low gradient alluvial fine bed channel, typically regime reach type. May be confined, but fully developed meandering pattern within a distinct flood plain develops in unconfined reaches where there is increased silt content in bed or banks.

Based on the above characteristics, eighteen riverine units were identified onsite. The following riverine units were delineated:

- One lower foothills river associated with the Mbashe River.
- Ten mountain headwater streams.
- Four mountain streams.
- Two transitional rivers.
- One upper foothills river.

5.7 National wetland mapping (National Wetland Map 5) and the threat status of wetlands and rivers

Mapping of all wetlands within South Africa has been an ongoing exercise for many years, as data has been collated and improved upon over time. SANBI has recently released the latest National Wetland Map 5 (NWM5_AEA) in an attempt to improve the wetland inventory available to users at a national level (Van Deventer et al., 2018). This layer includes inland wetlands and estuaries; and has been determined through extensive consultation with many other datasets within the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) 2018.

For the sake of this report, the development site has been contextualised within the broader landscape (**Figure 5-2**). According to the NWM layer, two distinct wetland types have been classified within the study area, namely a depression wetland (shown as DEPR on the map) and a hillslope seep (shown as SEEP on the map). Depression wetlands are considered among the most threatened inland wetland ecosystem types in South Africa, often falling within the Critically Endangered or Endangered categories due to their isolation, small size, and vulnerability to land-use change. Hillslope seeps, while more widespread, are also sensitive to disturbance and hydrological alteration. Although the seeps in this study area are currently classified as Least Concern, their ecological function remains vital, particularly in maintaining baseflow to downstream systems. The deterioration of remaining healthy examples of both wetland types must be avoided, and their conservation should be prioritised.

While the NWM5_AEA layer identified a river in the vicinity, the National Freshwater Ecosystems Priority Areas (NFEPA) layer (Nel et al., 2011) was used to determine its conservation status. The Mbashe River, which intersects a portion of the 500 m DWS-regulated buffer, has been flagged as a non-FEPA river and is currently in a moderately modified ecological condition (Ecological Category C). Although not prioritised for fish conservation, its proximity to sensitive wetland systems and its role in regional hydrological connectivity warrant careful consideration during planning and construction.

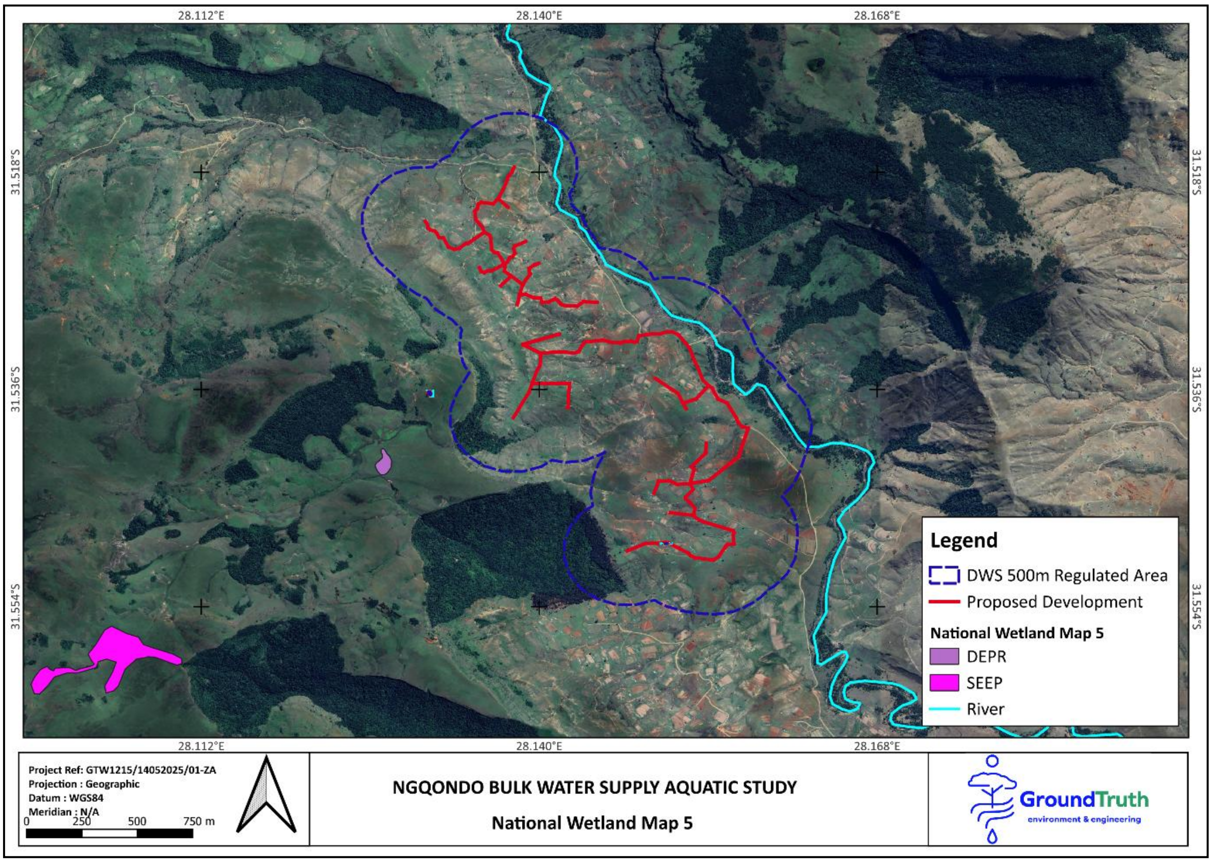

Figure 5-2 Overview of the National Wetland Map 5 coverage of the study area

6. LEGISLATIVE REQUIREMENTS

As noted in previous sections, the construction of these pipelines will involve activities that will trigger various legislative requirements. The key pieces of legislation that need to be taken into consideration from an aquatic biodiversity perspective are outlined below.

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

The National Environmental Management Act (NEMA, Act No. 107 of 1998) is the overarching framework legislation for environmental management in South Africa. Section 24 of the Act deals with Environmental Authorisations (EAs), establishing the framework for managing activities that may impact the environment and outlining the process for obtaining EAs, whilst the Environmental Impact Assessment (EIA) Regulations (Government Notice R982 of 2014, as amended) set out the detailed procedural requirements for obtaining an EA, including the different assessment processes: namely, Basic Assessments (BAs) for lower-risk activities and Scoping and Environmental Impact Reporting (S&EIR) for higher-risk activities. Under NEMA and the EIA regulations, listed activities specified in Listing Notices 1, 2, and 3 require either a BA or S&EIR, depending on the type and scale of the proposed development. The DFFE Screening Tool, mandatory since July 2021, is a web-based planning tool required by EIA Regulations. The screening tool identifies environmental sensitivities (themes) associated with a site and the specialist studies and protocol that may be required for a development, based on the site's sensitivity.

Government Notice No. 320 of 20 March 2020 (Government Gazette 43110) outlines the procedures for the assessment and minimum criteria for reporting on identified environmental themes in terms of Sections 24 (5)(a) and (h) and 44 of NEMA (1998). The requirements stipulated in the Notice supersede those of Appendix 6 of the EIA Regulations. The minimum report requirements as stipulated in GN No.320, and compliance with these requirements, is indicated below. Given that the environmental sensitivities associated with the site were identified as being "Very High", the requirements for an aquatic biodiversity specialist assessment are presented below.

Item Number	Reporting Requirement Description	Note
2.2	The assessment must be undertaken on the preferred site and within the proposed development footprint	Sections 1 and 8
2.3	*The assessment must provide a baseline description of the site which includes, as a minimum, the following aspects:*	
2.3.1	A description of the aquatic biodiversity and ecosystems on the site, including aquatic ecosystem types and presence, composition, habitat, distribution and movement patterns of aquatic species and communities.	Section 8.1
2.3.2	The threat status of the ecosystem and species as identified by the screening tool.	Section 5.1

2.3.3	An indication of the national and provincial priority status of the aquatic ecosystem, including a description of the criteria for the given status.	Section 5.7
2.3.4	A description of the ecological importance and sensitivity of the aquatic ecosystem, including the description of ecosystem processes that operate and the historic ecological condition as well as present ecological state of rivers, wetlands, and/or estuaries.	Sections 8.2.1, 8.2.2 and 8.2.3
2.4	The assessment must identify alternative development footprints within the preferred site which would be of a "low" sensitivity as identified by the screening tool and verified through the site sensitivity verification and which were not considered appropriate.	Section 8.7.2
2.5	*A detailed assessment of the potential impacts of the proposed development on the following aspects must be undertaken to answer the following questions:*	
2.5.1	Is the proposed development consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal?	Section 8.2.1
2.5.2	Is the proposed development consistent with maintaining the resource quality objectives for the aquatic ecosystems present?	Section 8.3
2.5.3	How will the proposed development impact on fixed and dynamic ecological processes that operate within or across the site?	Section 8.2
2.5.4	How will the proposed development impact on the functioning of the aquatic feature?	Section 8.2
2.5.5	How will the proposed development impact on key ecosystems regulating and supporting services especially flood attenuation, streamflow regulation, sediment trapping, phosphate assimilation, nitrate assimilation, toxicant assimilation, erosion control, and carbon storage?	Section 8.2
2.5.6	How will the proposed development impact community composition and integrity of the faunal and vegetation communities inhabiting the site?	Section 8.2
2.6	Where applicable, impacts to the frequency of estuary mouth closure should be considered.	N/A
2.7	*The findings of the specialist assessment must be written up in an Aquatic Biodiversity Specialist Assessment Report that contains, as a minimum, the following information:*	
2.7.1	Contact details of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae.	Page iv and Appendix 5
2.7.2	A signed statement of independence by the specialist.	Page iv

2.7.3	A statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment.	Section 1, 2 and 3
2.7.4	The methodology used to undertake the site inspection and the specialist assessment, including equipment and modelling used, where relevant.	Section 7
2.7.5	A description of the assumptions made, any uncertainties or gaps in knowledge or data.	Section 3
2.7.6	The location of areas not suitable for development, which are to be avoided during construction and operation, where relevant.	Section 8.5
2.7.7	Additional environmental impacts expected from the proposed development.	Section 8.7
2.7.8	Any direct, indirect and cumulative impacts of the proposed development on site.	Section 8.7
2.7.9	The degree to which impacts and risks can be mitigated.	Section 8.7
2.7.10	The degree to which the impacts and risks can be reversed.	Section 8.7
2.7.11	The degree to which the impacts and risks can cause loss of irreplaceable resources.	Section 8.7
2.7.12	A suitable construction and operational buffer for the aquatic ecosystem, using the accepted methodologies.	Section 8.5
2.7.13	Proposed impact management actions and impact management outcomes for inclusion in the Environmental Management Programme (EMPr).	Section 9
2.7.14	A motivation must be provided if there were development footprints identified as per paragraph 2.4 above that were identified as having a "low" aquatic biodiversity sensitivity and that were not considered appropriate.	Section 8.7
2.7.15	A substantiated statement, based on the findings of the specialist assessment, regarding the acceptability or not of the proposed development and if the proposed development should receive approval or not.	Section 10
2.7.16	Any conditions to which this statement is subjected.	Section 9.3

6.2 National Water Act (NWA, Act No.36 of 1998)

The National Water Act (NWA, Act No. 36 of 1998) provides the framework for the sustainable management of South Africa's water resources, in line with the constitutional right of access to water and the equitable allocation of water. The Act regulates the use of water and activities which may impact water resources, outlining the circumstances under which water use authorisations may be required. Section 21 of the NWA identifies the activities that constitute a water use and require authorisation.

Given the nature of the development, a Water Use Licence (WUL) will likely be required. A mandatory requirement for obtaining a WUL is a Risk Assessment. This is a key tool for determining the likelihood and significance of potential impacts of a proposed activity of water resources, including watercourses and wetlands. In light of this, a Risk Assessment is included in this study.

7. METHODS

7.1 Site visit

A site visit was conducted on 27th May 2025 to verify the extent of the freshwater ecosystems within the study site and to delineate the freshwater ecosystems hydrologically linked to the proposed developments and within the DWS 500 m regulated area.

7.2 Freshwater Ecosystem Assessment

Local, regional and national regulatory bodies, such as the Departments of Water and Sanitation (DWS) and the Department of Economic Development, Environmental Affairs and Tourism (DEDEAT), have adopted legislation, policies and guidelines that regulate the use of freshwater ecosystems to protect and maintain these systems' benefits and services to society and the natural environment. In order to be regulated, these systems must first be identified, delineated and assessed.

7.2.1 *Freshwater ecosystem identification and mapping*

The preliminary identification and mapping of all freshwater ecosystems within a 500m radius of the proposed development was undertaken at a desktop level utilising available aerial imagery and contour data. The freshwater ecosystems that are hydrologically linked to the study site were also verified infield in accordance with the DWS guideline documents (DWAF, 2005 & 2008). The derived boundaries were determined at appropriate intervals within the study area and recorded using a mapping grade Global Positioning System (GPS)[4]. The subsequent information was used to inform the production of a Geographic Information System (GIS) spatial coverage of the boundaries of the identified features. In accordance with the preferences of the regional DWS, the study also attempted to identify and/or describe the zones of wetness of the wetland habitat within the study area (**Figure 7-1**) and classify the riverine and riparian habitat refer to **Section 5.6** and **Figure 7-2.**

[4] Trimble Catalyst DA2 receiver connected to a handheld unit, a professional sub-meter accurate receiver.

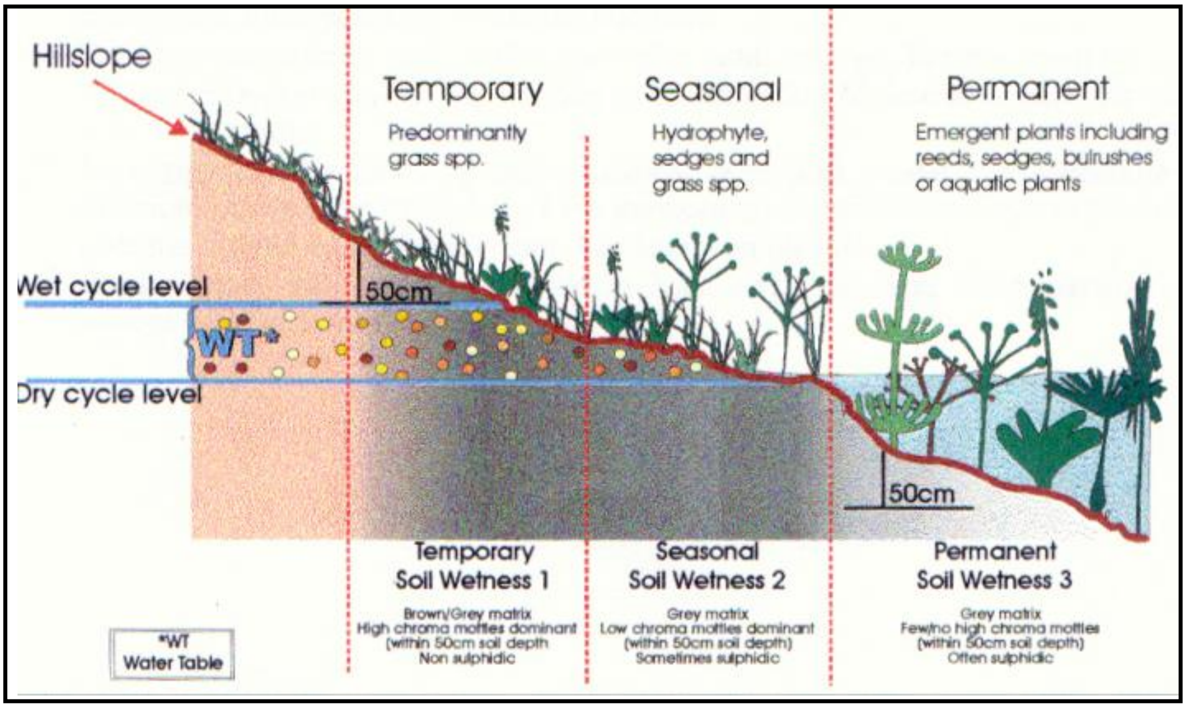

Figure 7-1 Wetness zones within wetland ecosystems

(DWAF, 2005, p.6)

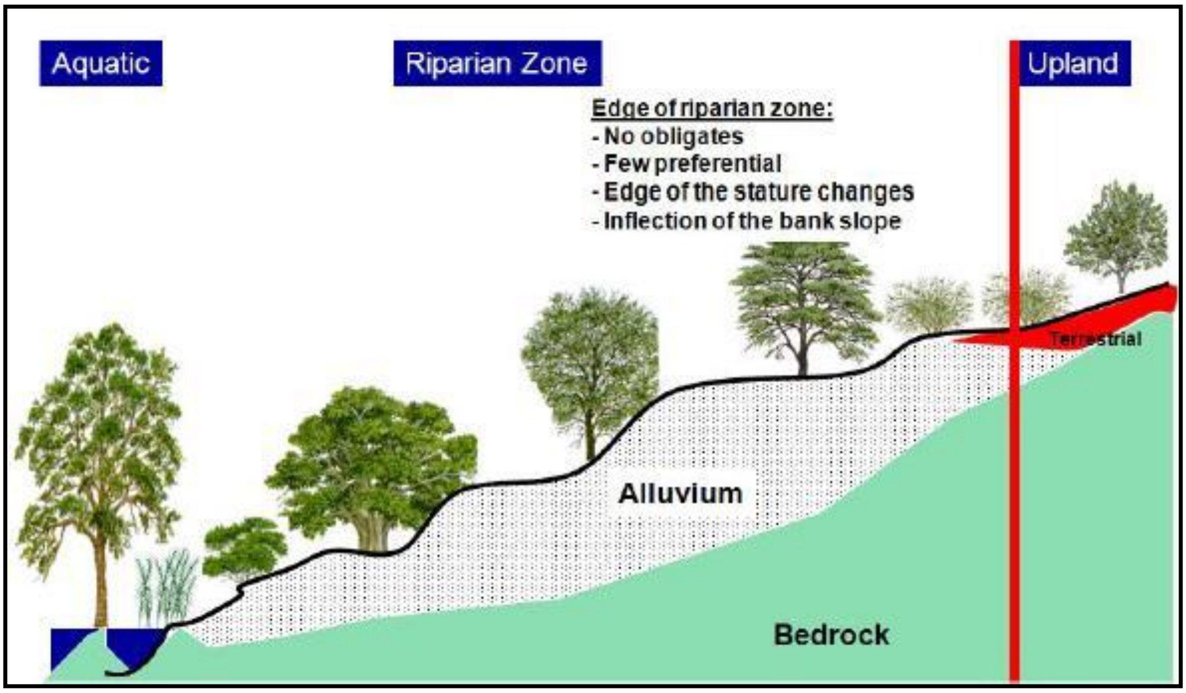

Figure 7-2 A schematic diagram illustrating the edge of the riparian zone on one bank of a large river

(DWAF, 2008, p.54)

7.2.2 *Assessment of wetland functioning and ecological condition*

The three wetland types that have been identified within the study site were classified as a hillslope seep wetland, depression wetlands and a channelled valley-bottom wetland. In order to provide a comprehensive and up-to-date assessment report for the wetlands within the study site, the assessment of the wetland functioning and condition were updated using the most recent assessment methods for the **current** scenarios as outlined in the following sections.

7.2.2.1 *Assessment of wetland functioning*

A WET-EcoServices Version 2 (Kotze et al., 2021) assessment was performed for the wetland systems associated for the proposed development to quantify the level of functionality of the wetland systems, and to highlight their relative importance in providing ecosystem benefits and services at a landscape level. The assessment provides a method to measure the ability of a wetland or riparian area to provide sixteen (16) ecosystem services (**Table 7-1**).

The WET-EcoServices assessment technique focuses on assessing the extent to which a benefit is being supplied by each freshwater ecosystem, based on both:

- The supply of the wetland to provide the benefits; and
- The demand of the particular wetland in providing the benefit.

The ecosystem services mentioned above, include an assessment of direct and indirect benefits to society and the surrounding landscape, by rating various characteristics of the wetlands and their surrounding catchments based on the categories shown in **Table 7-1** as presented within Kotze et al. (2021).

It should be noted that WET-EcoServices assists in identifying the importance and sensitivity of specific wetlands, but is recognised as having limitations in terms of:

- Quantifying specific impacts linked to development or changes within the landscape; and
- Accounting for the size of the wetland and ecosystem services strongly associated with the size of the systems.

Table 7-1 Ecosystem services supplied by wetlands
(Kotze *et al.,* 2021, p3)

Services contributing to indirect benefits	Regulating and supporting services	Flood attenuation		The spreading out and slowing down of floodwaters in the wetland/riparian area, thereby reducing the severity of floods downstream
		Stream flow regulation		Sustaining streamflow during low flow periods
		Water quality enhancement benefits	Sediment trapping	The trapping and retention in the wetland/riparian area of sediment carried by runoff waters
			Phosphate assimilation	Removal by the wetland/riparian area of phosphates carried by runoff water, thereby enhancing water quality
			Nitrate assimilation	Removal by the wetland/riparian area of nitrates carried by runoff water, thereby enhancing water quality
			Toxicant assimilation	Removal by the wetland/riparian area of toxicants (e.g. metals, biocides and salts) carried by runoff water, thereby enhancing water quality
			Erosion control	Controlling of erosion at the wetland/riparian area, principally through the protection provided by vegetation
		Carbon storage		The trapping of carbon by the wetland/riparian area, principally as soil organic matter
Services contributing to direct benefits	**Biodiversity maintenance**[5]			Through the provision of habitat and maintenance of natural process by the wetland/riparian area, a contribution is made to maintaining biodiversity
	Provisioning services	Provision of water for human use		The provision of water which is taken directly from the wetland/riparian area for domestic, agricultural or other purposes
		Provision of harvestable resources		The provision of natural resources from the wetland/riparian area - including craft plants, fish, wood etc.
		Food for livestock		The provision of grazing for livestock
		Provision of cultivated foods		The provision of cultivated foods from within the wetland/riparian area
	Cultural (non-material) benefits	Cultural heritage		Places of special cultural significance in the wetland/riparian area - e.g. for baptisms or gathering of culturally significant plants
		Tourism and recreation		Sites of value for tourism and recreation in the wetland/riparian area, often associated with scenic beauty and abundant birdlife6
		Education and research		Sites of value in the wetland/riparian area for education or research (McInnes and Everard 2017)

7.2.2.2 *Ecological Importance and Sensitivity*

In accordance with (Rountree et al., 2013), the ecological importance of a water resource provides an expression of its importance to the maintenance of ecological diversity and functioning at local and wider scales. As WET-EcoServices does not provide a consolidated score that can be used as a target, the assessment scores were incorporated into the Ecological

5 It is recognised that biodiversity maintenance is not an ecosystem service in the strict sense and is framed in less anthropocentric terms than all of the other services, but it underpins many other services and is widely acknowledged as having high value to society broadly, even in the absence of any local or downstream beneficiaries.

6 WET-EcoServices focusses on recreational services which are specifically nature-based, e.g. bird watching. It does not account specifically for recreational services from wetland/riparian areas that have been converted into sports grounds, children's playgrounds, or other built infrastructure.

Importance and Sensitivity (EIS) assessment framework to provide an EIS score based on scores for ecological importance and sensitivity, hydro-functional importance, and direct human benefits (Rountree *et al.*, 2013). It should be noted that the EIS categories have been slightly modified in accordance with approach adopted by the DWS (2023), in which all the categories now reflect a range of scores. This was described as a crucial amendment, as only systems scoring a 4 and/or 100% could be classified as being of 'Very High' importance, which is considered to be largely impossible to attain thereby, excluding systems of significance from scoring in the 'Very Important' category despite their high importance. Allowing for range in this upper category means that some systems that did not score a 4 on all indicators of the EI/ES rating system are now considered to be of 'Very High' importance. Additionally, including a range for the EIS scores is consistent with the PES scoring range (DWS, 2023b). **Table 7-2** provides an overview of the ratings used to interpret the derived EIS scores.

Table 7-2 Ecological Importance and Sensitivity Classes
(DWA, 2013, p43)

Category	EIS Description	Range of EIS Score
A	Very High Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers	≥3.5
B	High Wetlands that are ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quality and quantity of water in major rivers.	>2.5 and <3.5
C	Moderate Wetlands that are ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major river	>1.5 and ≤2.5
D	Low/Marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers	>0.5 and ≤1.5
E	None Wetlands that are rarely sensitive to changes in water quality/hydrological regime	≤0.5

7.2.2.3 *Assessment of wetland condition/integrity*

The assessment of ecosystem integrity was undertaken using the assessment framework, WET-Health level 1B (Macfarlane et al., 2020), which was performed for the HGM Units primarily affected by the proposed development. The WET-Health assessment technique gives an indication of the deviation of the systems from the wetlands' natural reference condition for the following biophysical drivers:

- **Hydrology** – defined as the distribution and movement of water through a wetland its soils.
- **Water quality** – defined as the physio-chemical attributes of the water in the wetland.
- **Geomorphology** – is defined as the physical processes that are currently shaping and modifying wetland evolution as well as the three-dimensional shape (structure) of sediment deposits on which wetland habitat is established.
- **Vegetation** – defined as the structural and compositional state of the vegetation within a wetland.

The impacts on the wetland, determined by features of the wetlands and their catchments, were scored based on the extent and intensity of the disturbance units. These disturbance units, derived for each of the components, were scored based on a suite of sub-categories using a scale of 0-10, prior to being combined to determine the overall magnitude-of-impact scores. From these scores, the overall impact score and Ecological Categories (**Table 7-3**) were determined, which reflects the extent to which anthropogenic changes have impacted the wetland from the benchmark/desired state.

Table 7-3: Description of the Ecological Categories typically used for PES assessments of inland freshwater ecosystems in South Africa, together with the applicable range of Impact Scores and PES Scores for each category (after Kleynhans, 1996; Macfarlane et al., 2008).
(Macfarlane et al., 2020, p.30)

Impact Category	Description	Impact Score Range (0-10)	PES Score	Ecological Category
None	Unmodified, natural.	0-0.9	**90-100**	**A**
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	**80-89**	**B**
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2-3.9	**60-79**	**C**
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9	**40-59**	**D**
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	**20-39**	**E**
Critical	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	**0-19**	**F**

7.2.3 *Riverine habitat assessments*

The methodology that was applied drew on the latest available tools within South Africa for the assessment of the Present Ecological State (PES) of riverine and riparian habitats. The appropriate selection of the various tools used was informed by the available habitat on site, the flow conditions at the time of sampling and any other biophysical limitations.

7.2.3.1 *Index of Habitat Integrity (IHI)*

The Index of Habitat Integrity (IHI) assessment was used to establish the condition of the riparian habitat's integrity (**Table 7-4**). The IHI assessment forms part of the published methods for the eco-classification of South African rivers (Kleynhans et al., 2008). The rapid version of the IHI method based on Kleynhans (1996) was applied, which takes into account impacts within river buffer areas (500m) associated with the upstream quaternary catchment.

Table 7-4 Scores used to define river health class boundaries for IHI (Kleynhans et al. 2008)

River health classes	Ecological perspective	Management perspective
Natural	No or negligible modification of in-stream and riparian habitats and biota.	Protected rivers; relatively untouched by human hands; no discharges or impoundments allowed.
Good	Ecosystems essentially in good state; biodiversity largely intact.	Some human-related disturbance but mostly of low impact potential.
Fair	A few sensitive species may be lost; lower abundances of biological populations may occur.	Zones of competing uses; developmental pressures are dominant feature.
Poor	Habitat diversity and availability have declined; mostly only tolerant species present; species present are often diseased; population dynamics have been disrupted (e.g. biota can no longer breed, or alien species have invaded the ecosystem).	Often characterised by high human densities or extensive resource exploitation. Management intervention is needed to improve river health – e.g. to restore flow patterns, river habitats or water quality.
Seriously Modified	Loss of habitat availability and high levels of pollution, result in few families being present due to the loss on most intolerant forms.	Often characterised by high human densities, pollution or extensive resource exploitation and modification. Management intervention is needed for improvement to occur.

7.3 Recommended Ecological Category

The method for determining the Recommended Ecological Category (REC) for freshwater ecosystems is outlined by Rountree et al. (2013). The REC is established after assessing both the Present Ecological State (PES) and the Ecological Importance and Sensitivity (EIS) of the freshwater ecosystem. Its purpose is to guide the appropriate management objective for the freshwater ecosystem, based on the following principles (from Rountree et al., 2013: 18-19):

- Freshwater ecosystems classified as PES Category A (unmodified) cannot undergo rehabilitation. As such, the management goal is always to maintain this existing ecological state.
- Freshwater ecosystems falling into PES Categories B, C, or D that have a "Low-marginal" or "Moderate" EIS score must also be maintained in their current (pre-development) ecological condition.

- Freshwater ecosystems in PES Categories B, C, or D with a “High” or “Very High” EIS score should be rehabilitated, where practically possible, to an ecological category one level higher than the current (pre-development) PES. For example, a wetland currently at PES Category C with a “High” EIS score should be improved to PES Category B.
- If such rehabilitation is not feasible, the management objective becomes maintaining the existing PES category.
- Freshwater ecosystems in PES Categories E or F are regarded as unsuitable in their current state and must be rehabilitated to at least PES Category D.

7.4 Buffer assessment

To protect freshwater ecosystems from impacts linked to adjacent land uses, appropriate buffer zones should be adopted. Freshwater buffer zones should therefore be determined for all water resources in close proximity to a particular land use, during the construction and operational phases thereof, thereby limiting negative impacts. According to Macfarlane & Bredin, (2017), freshwater buffer zones offer a range of functions that protect the water resource and associated biodiversity, including inter alia:

- Maintaining freshwater processes such as infiltration of surface water, promoting diffuse flow of water into the water course, stream bank stability and flood control;
- Reducing impacts from upstream and adjacent land uses through sediment control and the removal of pathogens, toxicants and nutrients;
- Providing habitat for freshwater, semi-freshwater and terrestrial species; and
- Providing societal benefits such as reducing flood risk, noise control, improved air quality and recreational prospects.

It is, however, important to emphasise that buffers zones are limited with respect to addressing certain impacts (Macfarlane & Bredin, 2017) which include but are not limited to:

- Streamflow regulation;
- Mitigating point source impacts such as sewage discharges; and
- Prevention of groundwater contamination.

The newly developed buffer guideline document for rivers, wetlands and estuaries derives two variable-width buffers for the construction and operational phases of the development, with the greater buffer distance being selected as the appropriate buffer distance. It should be noted that in order to account for the practical management of the buffer zone and to protect the freshwater ecosystems from direct disturbances, a minimum buffer distance of 15m has been defined within the guideline document.

To determine the buffer distance to be adopted for the study site, a rapid infield assessment was undertaken for the identified freshwater ecosystems, and the adjacent landscape in accordance with the guideline document. The infield assessment included determining the slope, soil texture, vegetation, and microtopography characteristics of the buffer and incorporated the findings of the freshwater ecosystems assessments. This information was then captured into the buffer model, whereby the appropriate buffer distances were derived.

7.5 Freshwater ecosystem risk and impact assessment

7.5.1 *Risk assessment*

The risk assessment matrix (DWS, 2023a) assesses the likely impact the proposed development may have on the freshwater ecosystems hydrologically linked to the pipelines. A broad outline of the criteria considered are as follows:

- Nature of the impact;
- Scale/extent of the impact;
- Duration of the impact;
- Intensity/severity of the impact; and
- Probability/likelihood of the impact occurring.

Identified risks were evaluated according to the above-mentioned criteria. The significance of impacts was derived through a synthesis of ratings of all criteria into a series of calculations.The significance of a potential risk on decision-making was indicated through significance points, which are described in **Table 7-5**.

Table 7-5 List of descriptors for the significance score of an impact. (DWS, 2023a)

Rating	Class	Management description	Authorisation
1 – 29	(L) Low Risk OR (+) Positive	Acceptable as is or with proposed mitigation measures. Impact to watercourses and resource quality small and easily mitigated, or positive.	GA
30 – 60	(M) Moderate Risk	Risk and impact on watercourses are notable and require mitigation measures on a higher level, which costs more and requires specialist input.	WUL
61-100	(H) High Risk	Watercourse(s) impacted by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.	WUL

7.5.2 *Impact assessment*

To assess the significance of environmental impacts associated with the proposed development, in compliance with the NEMA EIA regulations, the following methodology was applied. The consequence (C) of a specific impact is calculated by considering the following factors using the equation presented below:

- Consequence (C)
- Nature (N): either positive or negative
- Extent (E): Spatial scale of the impact
- Duration (D): Temporal scale
- Magnitude (M): Severity of impact
- Reversibility (R): Ease of recovery

$$\mathrm{C} = \frac{(E + D + M + R)\,N}{4}$$

Environmental risk is calculated by evaluating the consequence (C) of an impact and its probability (P) of occurrence using the following equation:

$$\mathrm{ER} = \mathrm{CP}$$

The ER score is then refined to give an overall environmental significance (S) based on the public response (PR), the potential for cumulative impacts (CI) and the likelihood of the impact resulting in the irreplaceable loss of resources (LR):

$$\mathrm{S} = (\mathrm{PR} + \mathrm{CI} + \mathrm{LR})ER$$

The resulting S score was then given an impact class based on the classes presented in **Table 7-6**. This process was undertaken for both a poor mitigation scenario and a realistic 'good' mitigation scenario.

Table 7-6 List of descriptors and associated classes and rating system for the impact assessment method that was used for the impact assessment

Rating	Class	Description
<10	Very Low	The potential impact is negligible and should not have an influence on the decision regarding the proposed activity.
≥10; <20	Low	The potential impact is very small and should not have any meaningful influence on the decision regarding the proposed activity.
≥20; <30	Moderate	Where this impact would not have a direct influence on the decision to develop in the area
≥30; <40	High	Where the impact could influence the decision to develop in the area unless it is effectively mitigated
≥40	Very High	Where the impact must have an influence on the decision process to develop in the area

8. RESULTS

The results of the investigations undertaken to inform the freshwater ecosystem study are outlined in the following sections. It is generally accepted that the impacts associated with linear features such as pipelines such as the proposed development, are limited to within 50m of the development position. As such, detailed delineation of the freshwater ecosystems was only undertaken within a 50m buffer on either side of each pipeline. Thereafter, less detailed delineation was undertaken. Additionally, given the extent and scope of the area, and constraints in field, freshwater ecosystems located over 500m away from the proposed pipelines were not delineated or assessed

8.1 Freshwater ecosystem delineation

8.1.1 *Onsite systems*

A total of 48 watercourses7 were observed to be hydrologically connected to and within 500m of the proposed water supply pipelines (**Figure 8-1**). These watercourses are made up of the following hydrogeomorphic types:

- One lower foothills river (LF) associated with the Mbashe River
- Ten mountain headwater streams (MHS)
- Four mountain streams (MS)
- Two transitional rivers (TR)
- One upper foothills river (UF)
- One channelled valley-bottom (CVB) wetland;
- Four depression (DEPR) wetlands;
- Seven hillslope seep (SEEP) wetlands;
- Eighteen watercourses (WC) with no riverine or wetland indicators.

Given the steep nature of the landscape, many of the watercourses have experienced extensive natural erosion. However, some of the erosion has likely been accelerated by grazing and the development of roads and houses in the catchments of these systems. All of the DEPR wetlands are located on flat 'bench' like features on the hillside, likely coinciding with a layer of rock that has not eroded at the same rate as the surrounding landscape. The CVB wetland coincides with an area of deposition and is controlled by a bedrock sill at its toe. The SEEP wetlands are all located on relatively steep hillsides which likely have an impervious lithology below them, which forces interflow to the ground surface. The LF River is the Mbashe River which flows along the eastern portion of the study site and the UF River is a tributary of the Mbashe River which defines the northern side of the study area. The TR and MHS riverine units all flow from the hillside where the pipelines will be constructed into the Mbashe River. These smaller riverine systems are all relatively steep in their gradient and are non-perennial systems. The WC's are scattered across the study site, and have been classified as watercourses because they have natural channel

[7] The term 'watercourse' is used here because it encompasses the broad range of ecosystems that were observed onsite. Watercourse includes wetlands and rivers in its definition as well as a 'natural channel in which water flows regularly or intermittently'

characteristics, but do not have the soil or vegetation characteristics that would have them be categorised as wetlands or riverine systems.

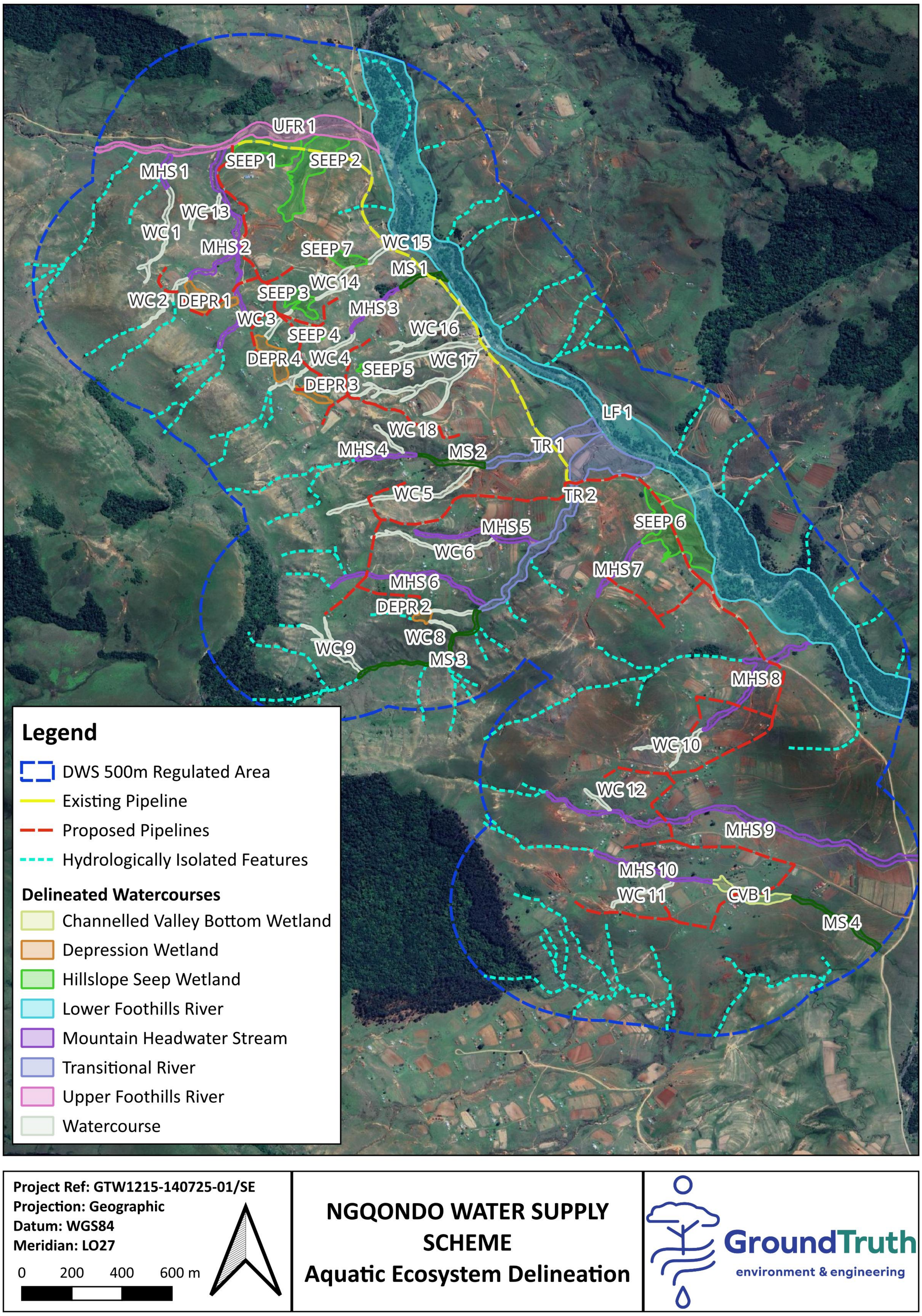

Figure 8-1 **Freshwater ecosystems and hydrologically isolated features within 500m of the proposed development.**

8.2 Ecological Condition, Functionality and Importance and Sensitivity of the Delineated Watercourses

The following section provides a summary of the ecological condition (i.e. the PES), their provision of ecosystem goods and services (EGS) and the ecological importance and sensitivity (i.e. the EIS) of the delineated freshwater ecosystems. It should be noted that the watercourses were not assessed in terms of their PES, EGS and EIS given that they do not have the habitat characteristics necessary to conduct these assessments. Furthermore, it should be noted that no post-development assessments were undertaken for this study. The impacts associated with the construction of small features such as pipelines generally relate to the physical disturbance footprint of the construction activities, such as vehicle movements, earth moving and storage etc. These impacts are typically temporary and are too small in terms of their spatial scale and intensity to register on the assessment tools that are widely used and accepted. Therefore, the post-development PES, EGS and EIS are deemed to be the same as the current PES, EGS and EIS scores presented below (see **Table 8-1** - **Table 8-30**).

8.2.1 *Freshwater ecosystem ecological condition*

The PES of the wetland ecosystems was assessed for the hydrology, geomorphology, vegetation and water quality components. Similarly, the PES of the riverine ecosystems was assessed for multiple ecological components including alteration of hydrology, vegetation, freshwater fauna, physico-chemistry and other indicators of ecological condition. Generally, the ecological condition of the freshwater ecosystems ranged from being ***largely natural*** to being ***moderately*** to ***largely*** modified. Generally, the impacts across the freshwater ecosystems were similar and included:

- Cultivation within the freshwater ecosystems (predominantly within the wetland areas) which has resulted in the disturbance of the soil and a complete shift in the vegetation composition within the freshwater ecosystems.
- Construction of infrastructure such as roads or houses within the freshwater ecosystems has resulted in the infilling of some of the freshwater ecosystems and has also resulted in the modification of channel characteristics within the freshwater ecosystems thereby modifying patterns of flow distribution and retention.
- The landscape is extremely steep, so there is some level of natural erosion that is going to occur. However, excavation of material and road construction through the freshwater ecosystems have accelerated some of these erosional processes and led to increased loss of soil from some freshwater ecosystems.
- The proliferation of invasive alien species in some of the freshwater ecosystems has resulted in the alteration of vegetation characteristics in these ecosystems.
- The widespread rearing of livestock in the area means many of the freshwater ecosystems are heavily grazed, especially in winter. Furthermore, the movement of livestock (particularly cattle) results in the trampling and erosion of some of the more well used areas of the freshwater ecosystems.

8.2.2 *Freshwater ecosystem goods and service delivery*

The EGS of the freshwater ecosystems was assessed using the WET-EcoServices (Level 2) assessment technique for both rivers and wetlands. Generally, the EGS delivery ranged from ***very low*** to ***moderately high*** for both rivers and wetlands. The EGS provided by the freshwater ecosystems included:

- Provisioning services including water supply, as many residents in the area rely on the multiple springs and rivers in the area as their main source of water, grazing for livestock, and cultivation as many cultivated areas were located within wetlands.
- Regulating services provided by freshwater ecosystems included:
    - Limited water quality enhancement given the demand for these services was low, and the ability of many of the ecosystems to supply them was also low
    - Erosion control and sediment trapping services
    - Streamflow regulation was specifically provided by seep and depression wetlands.

Given that the EGS assessment does not provide a single consolidated score, the scores for each freshwater ecosystem are not presented in this report. However, the EIS scoring process incorporates the EGS scores and provides a consolidated score for the EGS. Therefore, the EIS score can be taken as a fair representation of the EGS score for the freshwater ecosystems.

8.2.3 *Ecological importance and sensitivity*

The EIS of the freshwater ecosystems ranged from ***low/marginal*** to ***moderate***, with only the Mbashe River itself receiving a ***high*** EIS score. Generally, the factors that contributed to the EIS scores for the freshwater ecosystems were associated with the fact that some of the ecosystems fall within an endangered vegetation type and the other ecosystems fall within a vegetation type that currently receives little to no protection. A pair of crowned cranes were observed to be feeding in the northern portion of the study area, which indicated that the seep wetlands are certainly utilised for feeding by an endangered animal. The Mbashe River is an important fish nursery and also has an assemblage of important and rare freshwater fauna which contributed to its ***high*** EIS score.

Table 8-1 Seep 1 details (no direct crossing)

SEEP 1	**Crossing No:**	N/A	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-2
Habitat type	Hillslope Seep Wetland		**Latitude:**	-31.51744	**Longitude:**	28.13587
Photograph						
IHI/PES	**Category**	**Key current impacts**				
	C	Road crossing through the wetland, heavy grazing and modification of vegetation, signs of historical cultivation in the wetland.				
EIS Score	**C**	Moderate EIS (score of 1.7) with the score being derived from the ecological importance due to the presence of crowned cranes in the wetland at the time of the assessment.				
Risks	Minor risks are posed to this wetland given that there are no direct crossings that are proposed for this wetland. Minor risks include increased runoff from a burst pipe in the catchment of the wetland and infilling/compaction should the implementing agent stray too far east while constructing the pipeline to the west of this wetland.					

Table 8-2 Seep 2 details (no direct crossing)

SEEP 2	**Crossing No:**	N/A	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-2
Habitat type	Hillslope Seep Wetland		**Latitude:**	-31.51833	**Longitude:**	28.13758
Photograph						
IHI/PES	**Condition Score**	**Key current impacts**				
	D	Road crossing through the wetland, heavy grazing and modification of vegetation, extensive erosion within the wetland, the naturally unchanneled wetland is now channelled and hydrologically compromised.				
EIS Score	C	Moderate EIS (score of 1.7) with the score being derived from the ecological importance due to the presence of crowned cranes in the wetland at the time of the assessment.				
Risks	Minor risks are posed to this wetland given that there are no direct crossings that are proposed for this wetland. Minor risks include increased runoff from a burst pipe in the catchment of the wetland.					

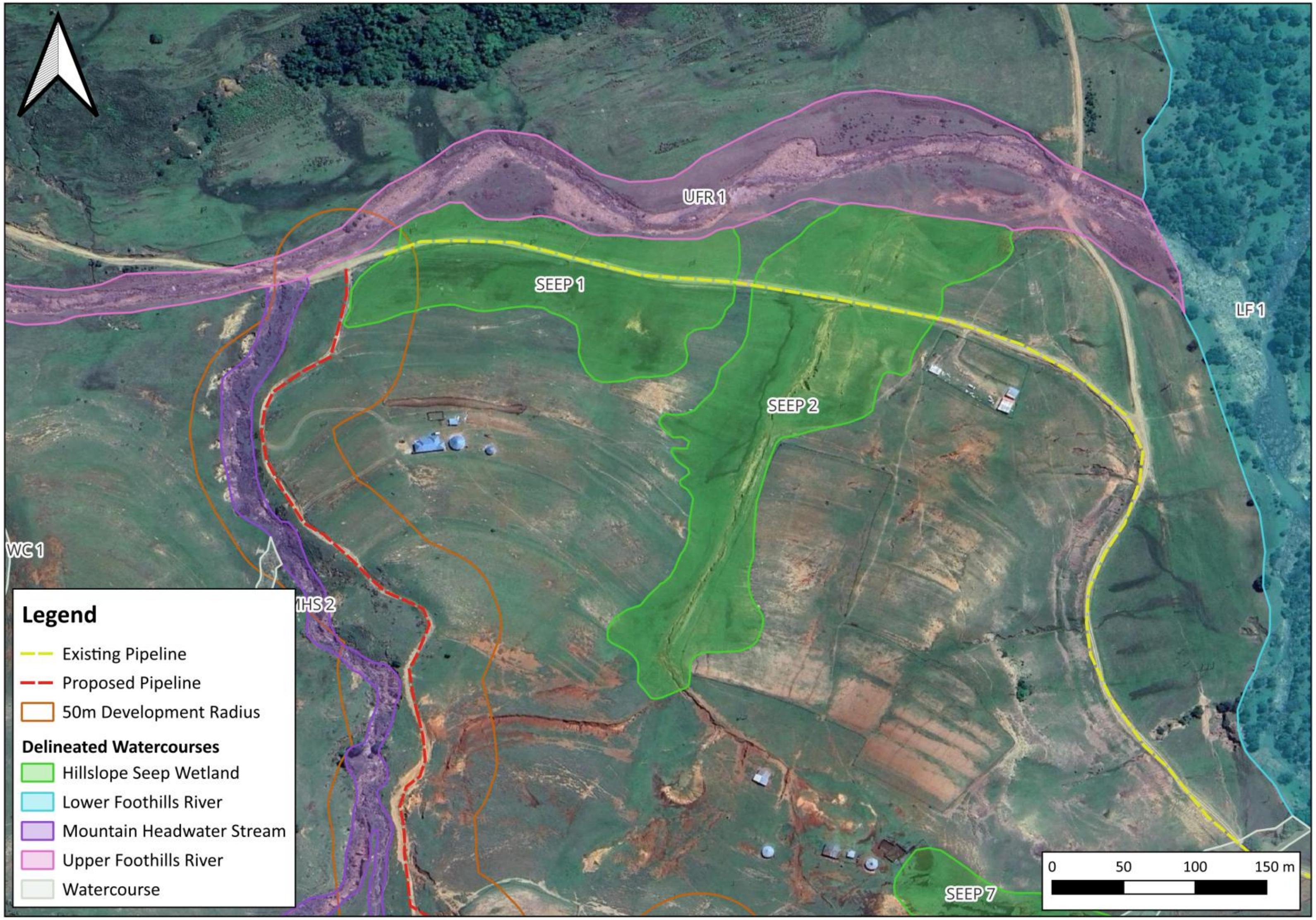

Figure 8-2 The proposed pipeline alignments in relation to the delineated freshwater ecosystems, specifically SEEP 1, SEEP 2 and UFR 1

Table 8-3 Seep 3 details (no direct crossing)

SEEP 3	**Crossing No:**	N/A	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-3
Habitat type	Hillslope Seep Wetland		**Latitude:**	-31.52392	**Longitude:**	28.13723
Photograph						
IHI/PES	**Condition Score**	**Key current impacts**				
	C	Heavy grazing and trampling by cattle, minor erosion.				
EIS Score	**D**	Low/Marginal EIS (score of 1.2) with the score being derived from the landscape scale ecological importance due to the relatively good ecological condition of C and the fact that these wetlands fall within a vegetation type that is poorly protected.				
Risks	Minor risks are posed to this wetland given that there are no direct crossings that are proposed for this wetland. Minor risks include increased runoff from a burst pipe in the catchment of the wetland or from sedimentation during the construction phase.					

Table 8-4 Seep 4 details (no direct crossing)

SEEP 4	Crossing No:	N/A	Quaternary Catchment	T11E	Map Reference	Figure 8-3
Habitat type	Hillslope Seep Wetland		Latitude:	-31.52522	Longitude:	28.13771
Photograph						
IHI/PES	Condition Score	Key current impacts				
	D	Heavy grazing and trampling by cattle, cultivation within the wetland.				
EIS Score	D	Low/Marginal EIS (score of 1.2) with the score being derived from the ecological sensitivity given that this is a seep wetland located on a mudstone lithology. It is moderately sensitive to changes in water quality, which is linked to land use practice.				
Risks	Minor risks are posed to this wetland given that there are no direct crossings that are proposed for this wetland. Minor risks include increased runoff from a burst pipe in the catchment of the wetland.					

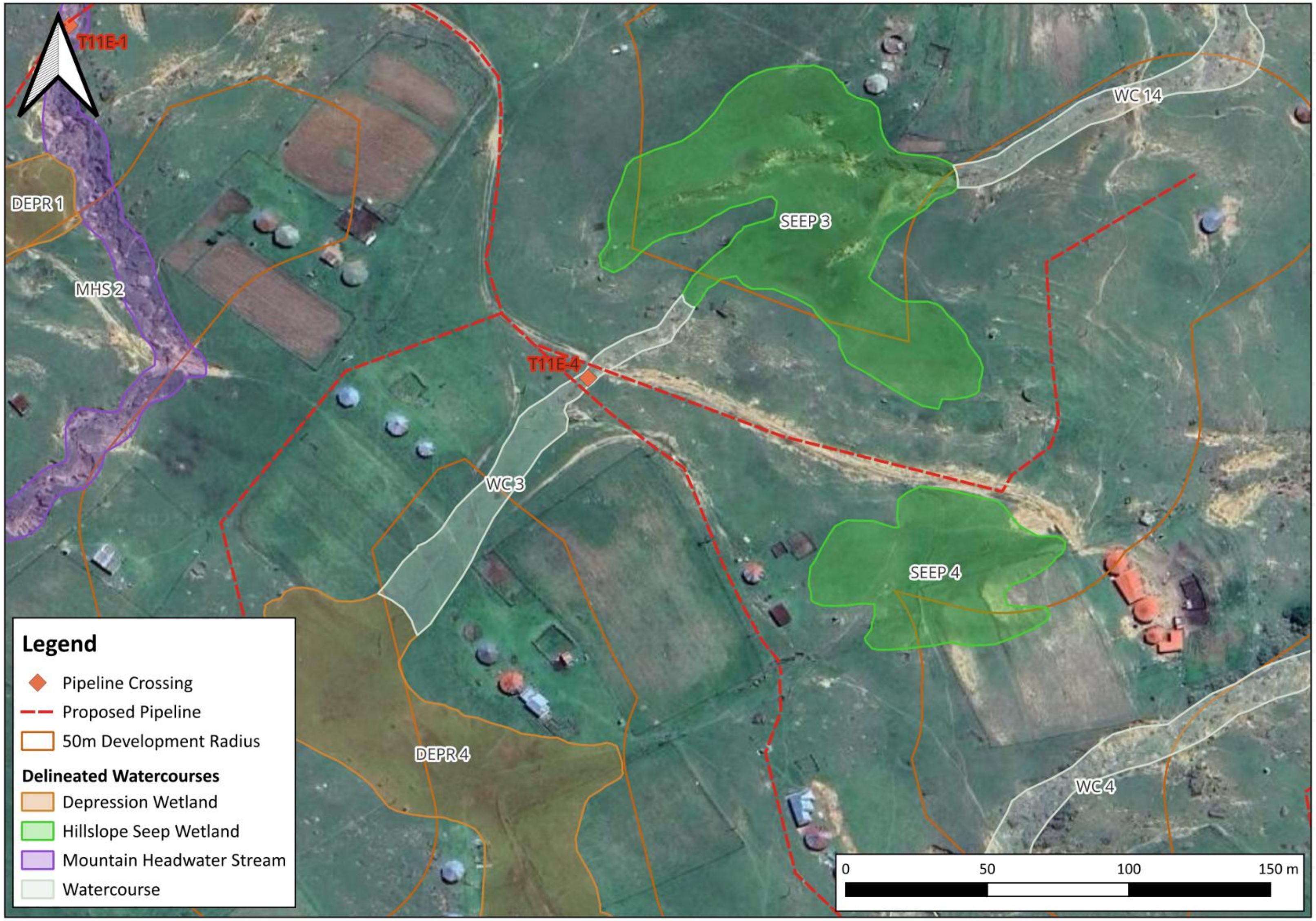

Figure 8-3 The proposed pipeline alignments in relation to the delineated freshwater ecosystems, specifically SEEP 3, SEEP 4 and WC 3.

Table 8-5 Seep 5 details (no direct crossing)

SEEP 5	Crossing No:	N/A	Quaternary Catchment	T11E	Map Reference	Figure 8-4
Habitat type	Hillslope Seep Wetland		**Latitude:**	-31.52667	**Longitude:**	28.13980
Photograph						
IHI/PES	**Condition Score**	**Key current impacts**				
	C	Heavy grazing and trampling by cattle, minor erosion within the wetland.				
EIS Score	**D**	Low/Marginal EIS (score of 1.2) with the score being derived from the landscape scale ecological importance due to the relatively good ecological condition of C and the fact that these wetlands fall within a vegetation type that is poorly protected.				
Risks	Minor risks are posed to this wetland given that there are no direct crossings that are proposed for this wetland. Minor risks include increased runoff from a burst pipe in the catchment of the wetland or from sedimentation during the construction phase.					

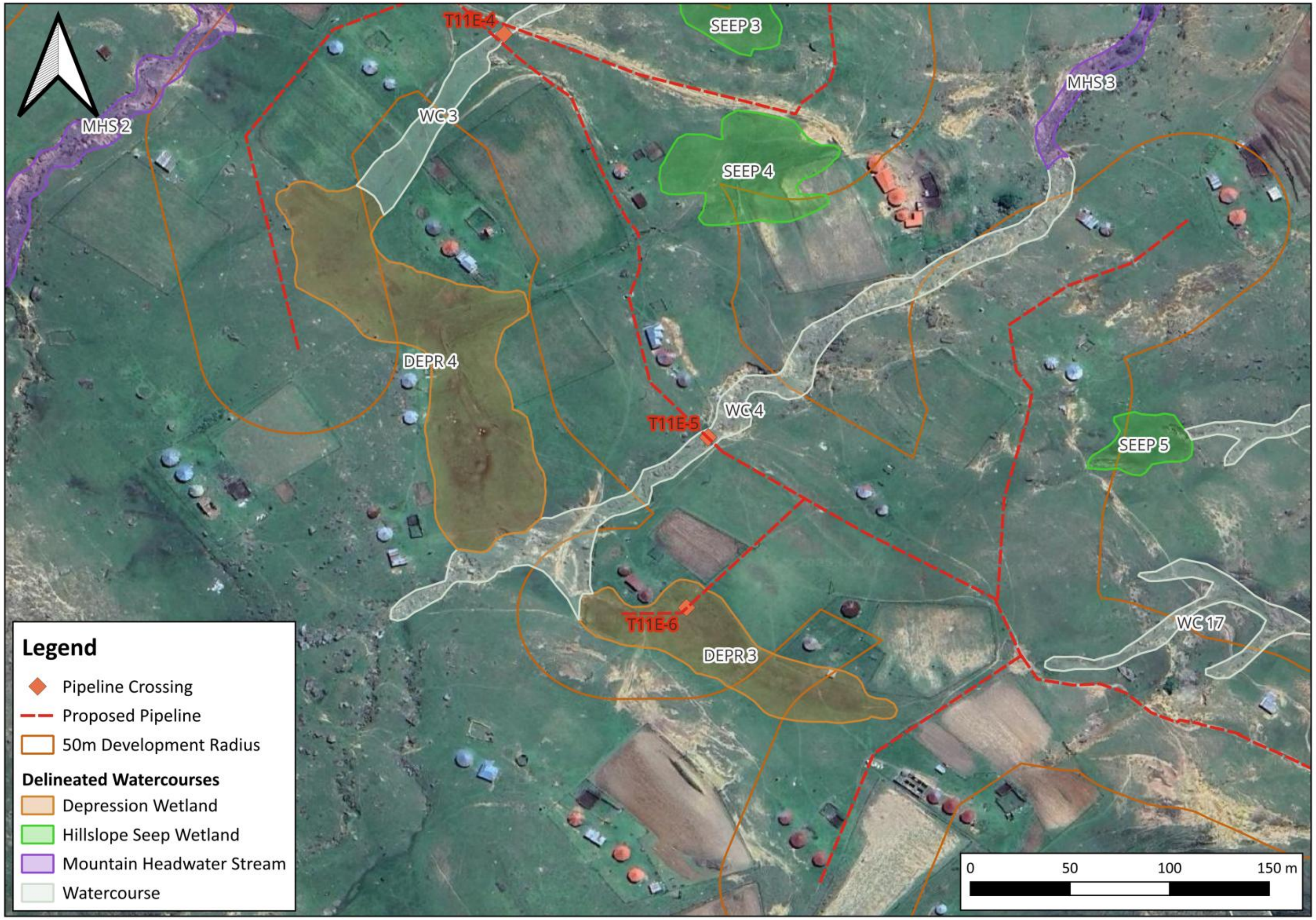

Figure 8-4 The proposed pipeline alignments in relation to the delineated freshwater ecosystems, specifically SEEP 5, DEPR 3, DEPR 4 and WC 4.

Table 8-6 Seep 6 details (crossing T11E-11)

<table>
<tr><td>SEEP 6</td><td>Crossing No:</td><td>T11E-11</td><td>Quaternary Catchment</td><td>T11E</td><td>Map Reference</td><td>Figure 8-5</td></tr>
<tr><td>Habitat type</td><td colspan="2">Hillslope Seep Wetland</td><td>Latitude:</td><td>-31.53355</td><td>Longitude:</td><td>28.15307</td></tr>
<tr><td>Photograph</td><td colspan="6"></td></tr>
<tr><td rowspan="2">IHI/PES</td><td>Condition Score</td><td colspan="5">Key current impacts</td></tr>
<tr><td>C</td><td colspan="5">Heavy grazing and trampling by cattle, road crossings with limited culverts for the transfer of water across the wetland, old cultivation within the wetland.</td></tr>
<tr><td>EIS Score</td><td>D</td><td colspan="5">Moderate EIS (score of 1.5) with the score being derived from the landscape scale ecological importance due to the relatively good ecological condition of C, the fact that these wetlands fall within a vegetation type that is poorly protected and this wetland provides a moderate level of habitat diversity.</td></tr>
<tr><td>Risks</td><td colspan="6">Moderate to low risks associated with the proposed pipeline alignment given that the pipeline will pass directly through the wetland but is located along an existing disturbance (i.e. the road). Provided that careful construction measures are followed, the risk should be low. Additionally, the wetland is located on a gentle slope, so the risk of erosion is reduced.</td></tr>
</table>

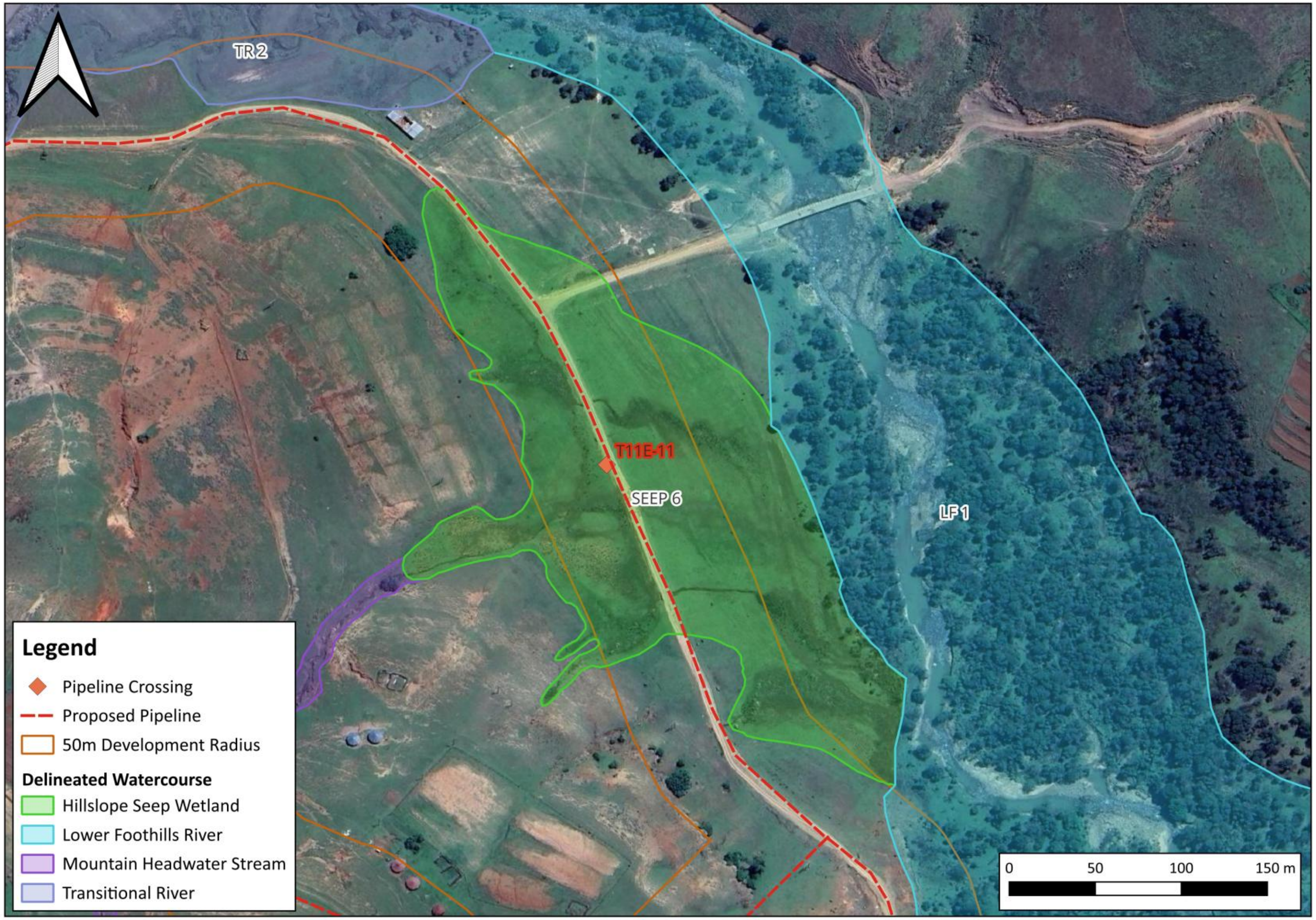

Figure 8-5 The proposed pipeline alignments in relation to the delineated freshwater ecosystems, specifically SEEP 6.

Table 8-7 Seep 7 details (no direct crossing)

<table>
<tr><th>SEEP 7</th><th>Crossing No:</th><td>N/A</td><th>Quaternary Catchment</th><td>T11E</td><th>Map Reference</th><td>Figure 8-6</td></tr>
<tr><th>Habitat type</th><td colspan="2">Hillslope Seep Wetland</td><th>Latitude:</th><td>-31.52207</td><th>Longitude:</th><td>28.13906</td></tr>
<tr><th>Photograph</th><td colspan="6">No photograph available</td></tr>
<tr><th rowspan="2">IHI/PES</th><th>Condition Score</th><th colspan="5">Key current impacts</th></tr>
<tr><td>C</td><td colspan="5">Heavy grazing and trampling by cattle, minor erosion within the wetland.</td></tr>
<tr><th>EIS Score</th><td>D</td><td colspan="5">Low/Marginal EIS (score of 1.2) with the score being derived from the landscape scale ecological importance due to the relatively good ecological condition of C and the fact that these wetlands fall within a vegetation type that is poorly protected.</td></tr>
<tr><th>Risks</th><td colspan="6">Low risks associated with the proposed pipeline alignment given that the pipeline is entirely located outside of the wetland. A low risk exists due to the possible risks associated with the construction phase of the pipeline, given that SEEP 7 is located downslope of the pipeline and may be impacted if unsuitable construction measures are adopted.</td></tr>
</table>

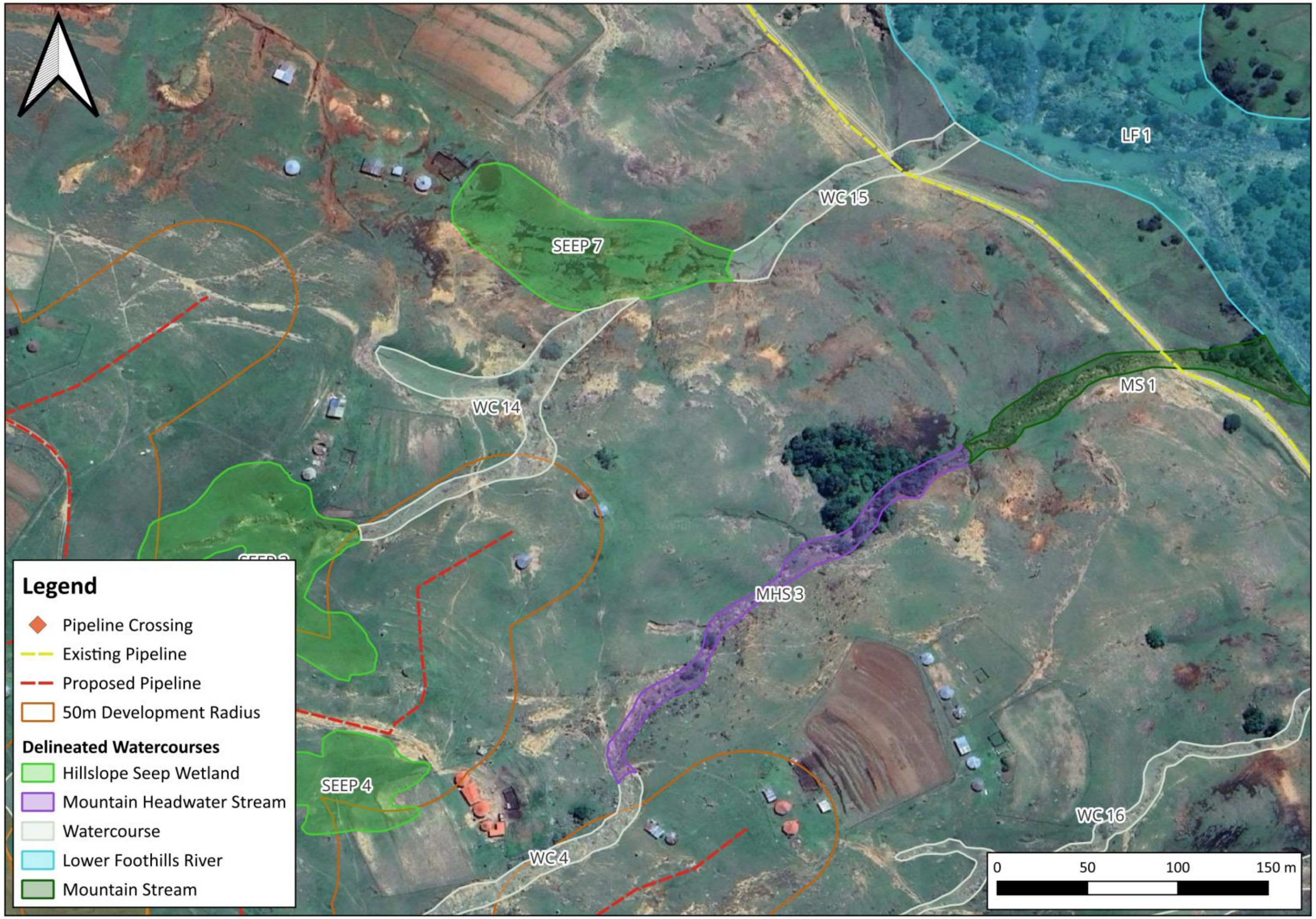

Figure 8-6 The proposed pipeline alignments in relation to the delineated freshwater ecosystems, specifically SEEP 7, MHS 3, MS 1, WC 14 and WC 15.

Table 8-8 Depression 1 details (crossing T11E-2)

DEPR 1	**Crossing No:**	T11E-2	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-7
Habitat type	Depression Wetland		**Latitude:**	-31.52379	**Longitude:**	28.13314
Photo and Map						
IHI/PES	**Condition Score**	**Key current impacts**				
	D	Heavy grazing and trampling by livestock, cultivation within the wetland and severe modification of vegetation assemblage				
EIS Score	**C**	Moderate EIS (score of 1.7) with the score being derived from the ecological sensitivity of the wetland due to it being a depression wetland located on a mudstone lithology. Depression wetlands are typically more sensitive to changes in water quality than other HGM units.				
Risks	Moderate risks associated with the proposed pipeline alignment given that the pipeline will pass directly through the eastern arm of the wetland, and hug the southern side of the wetland. The crossing point is located on a very steep slope portion of the wetland and will likely result in erosion within the wetland.					

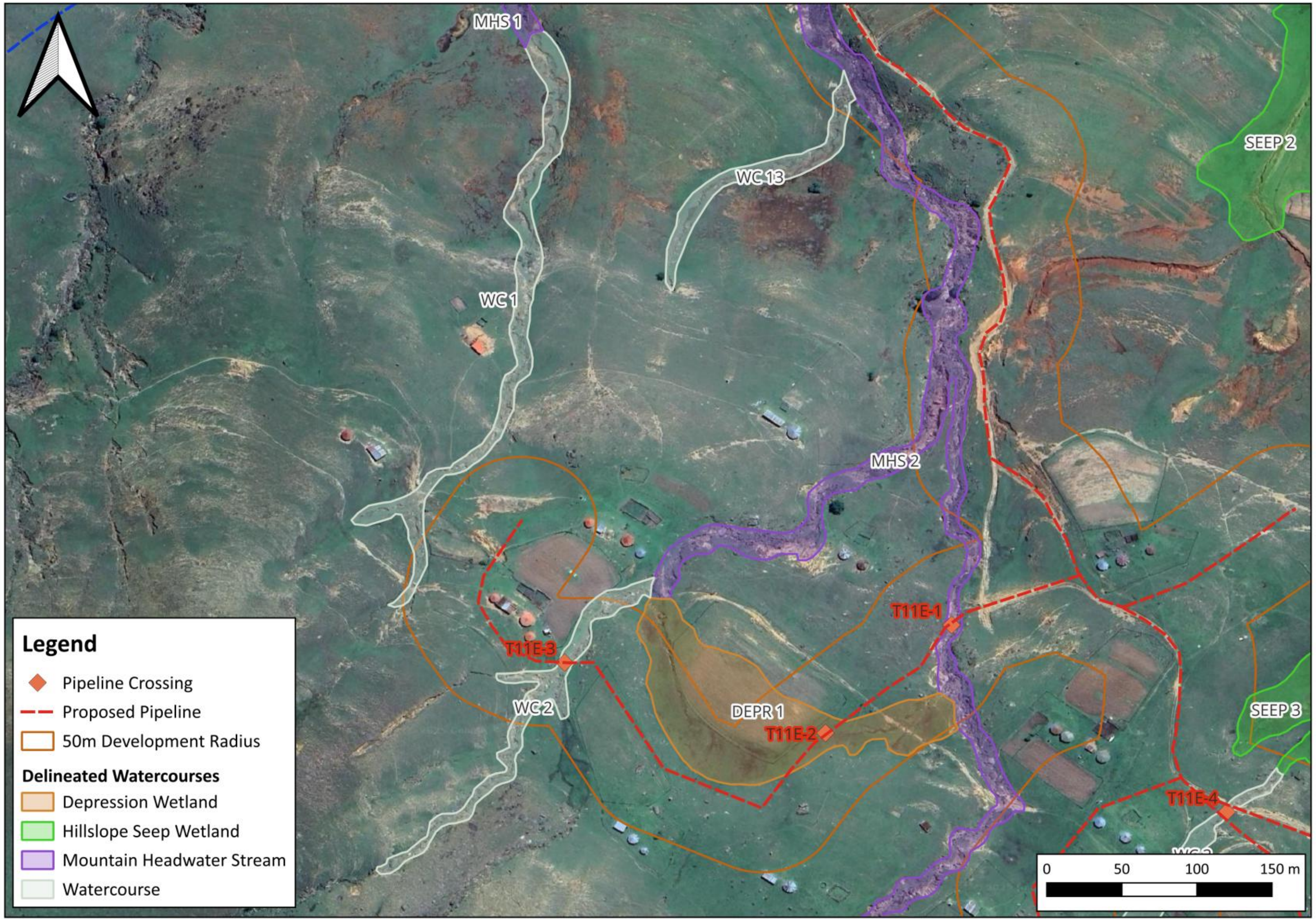

Figure 8-7 The proposed pipeline alignments in relation to the delineated freshwater ecosystems, specifically DEPR 1, WC 1, WC 2 and WC 13.

Table 8-9 Depression 2 details (no direct crossing)

DEPR 2	**Crossing No:**	N/A	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-8
Habitat type	Depression Wetland		**Latitude:**	-31.53713	**Longitude:**	28.14233
Photograph						
IHI/PES	**Condition Score**	**Key current impacts**				
	C	Moderate grazing and trampling by goats and sheep, minor erosion within the wetland.				
EIS Score	C	Moderate EIS (score of 1.7) with the score being derived from the ecological sensitivity of the wetland due to it being a depression wetland located on a mudstone lithology. Depression wetlands are typically more sensitive to changes in water quality than other HGM units.				
Risks	Minor risks are posed to this wetland given that there are no direct crossings that are proposed for this wetland. Minor risks include increased runoff from a burst pipe in the catchment of the wetland or from sedimentation during the construction phase.					

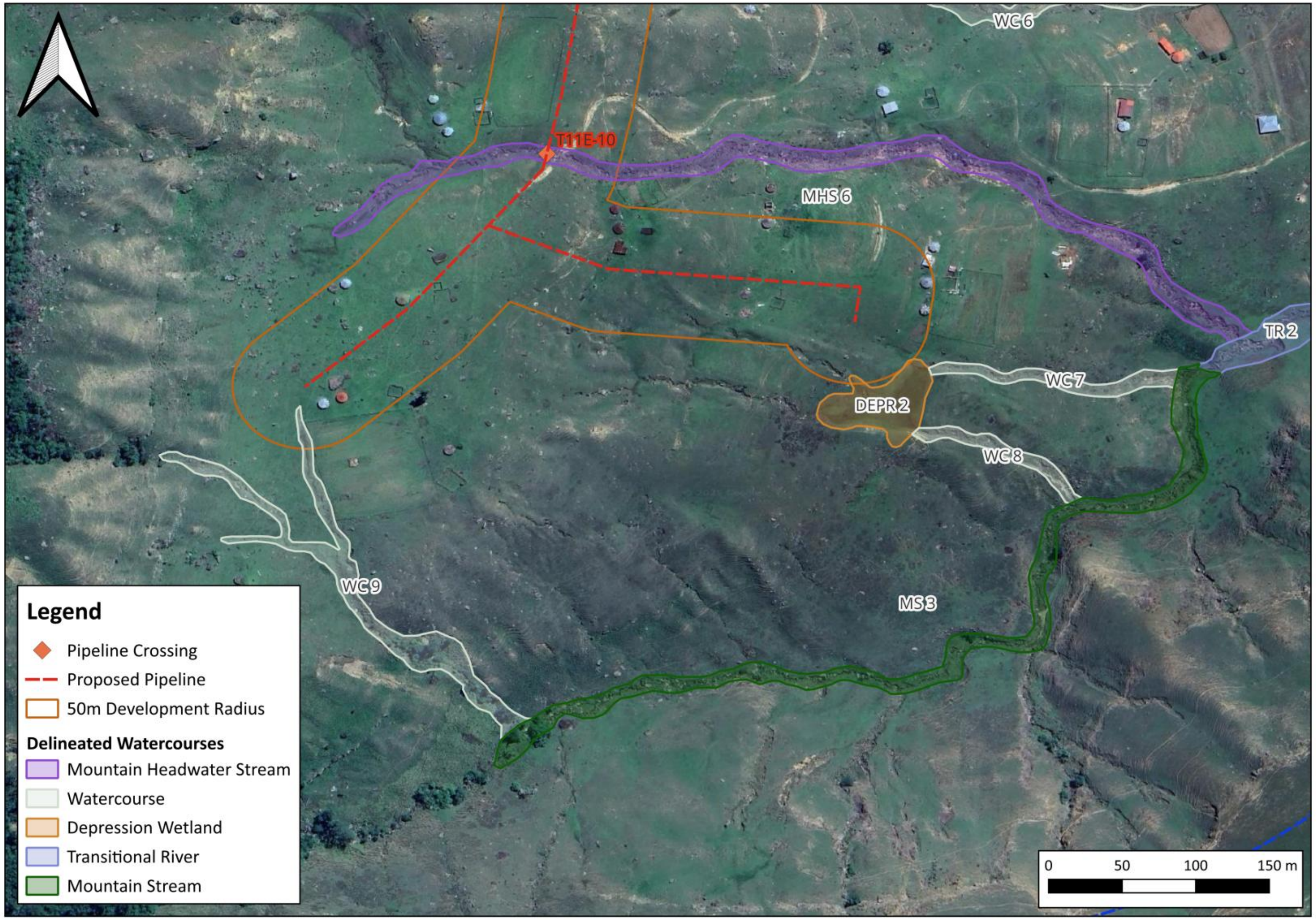

Figure 8-8 **The proposed pipeline alignments in relation to the delineated freshwater ecosystems, specifically DEPR 2, WC 7, WC 8, WC 9, MHS 6 and MS 3.**

Table 8-10 Depression 3 details (crossing T11E-6)

<table>
<tr><td>DEPR 3</td><td>Crossing No:</td><td>T11E-6</td><td>Quaternary Catchment</td><td>T11E</td><td>Map Reference</td><td>Figure 8-4</td></tr>
<tr><td>Habitat type</td><td colspan="2">Depression Wetland</td><td>Latitude:</td><td>-31.52778</td><td>Longitude:</td><td>28.13762</td></tr>
<tr><td>Photograph</td><td colspan="6"></td></tr>
<tr><td rowspan="2">IHI/PES</td><td>Condition Score</td><td colspan="5">Key current impacts</td></tr>
<tr><td>C</td><td colspan="5">Moderate grazing and trampling by goats and sheep, minor erosion within the wetland.</td></tr>
<tr><td>EIS Score</td><td>C</td><td colspan="5">Moderate EIS (score of 1.7) with the score being derived from the ecological sensitivity of the wetland due to it being a depression wetland located on a mudstone lithology. Depression wetlands are typically more sensitive to changes in water quality than other HGM units.</td></tr>
<tr><td>Risks</td><td colspan="6">Moderate risks associated with the proposed pipeline alignment given that the pipeline will pass directly through the western edge of the wetland. The crossing point is located on a steep slope and will likely result in erosion within the wetland.</td></tr>
</table>

Table 8-11 Depression 4 details (no direct crossing)

DEPR 4	**Crossing No:**	N/A	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-4
Habitat type	Depression Wetland		**Latitude:**	-31.52623	**Longitude:**	28.13603
Photograph						
IHI/PES	**Condition Score**	**Key current impacts**				
	D	Moderate grazing and trampling by livestock, cultivation within the wetland and loss of vegetation as a result of some infilling associated with some housing developments within the wetland.				
EIS Score	**C**	Moderate EIS (score of 1.7) with the score being derived from the ecological sensitivity of the wetland due to it being a depression wetland located on a mudstone lithology. Depression wetlands are typically more sensitive to changes in water quality than other HGM units.				
Risks	Minor risks are posed to this wetland given that there are no direct crossings that are proposed for this wetland. Minor risks include increased runoff from a burst pipe in the catchment of the wetland or from sedimentation during the construction phase.					

Table 8-12 Channelled-valley bottom 1 details (crossing T11E-16)

<table>
<tr><th>CVB 1</th><th>Crossing No:</th><td>T11E-16</td><th>Quaternary Catchment</th><td>T11E</td><th>Map Reference</th><td>Figure 8-9</td></tr>
<tr><th>Habitat type</th><td colspan="2">Channelled Valley-Bottom Wetland</td><th>Latitude:</th><td>-31.54878</td><th>Longitude:</th><td>28.15606</td></tr>
<tr><th>Photograph</th><td colspan="6"></td></tr>
<tr><th rowspan="2">IHI/PES</th><th>Condition Score</th><th colspan="5">Key current impacts</th></tr>
<tr><td>C</td><td colspan="5">Moderate grazing and trampling by cattle, goats and sheep, infilling associated with a minor road crossing and a small head cut at the toe of the wetland.</td></tr>
<tr><th>EIS Score</th><td>C</td><td colspan="5">Moderate EIS (score of 2.0) with the score being derived from the ecological sensitivity of the wetland due to it being a channelled valley-bottom wetland and it being sensitive to changes in flood regimes. Channelled valley-bottom wetlands are typically more sensitive to changes in flooding than most other HGM units as their hydrological operating rules are reliant of flooding.</td></tr>
<tr><th>Risks</th><td colspan="6">Moderate risks associated with the proposed pipeline alignment given that the pipeline will pass directly through the central portion of the wetland. The crossing point is located on an existing disturbance (i.e. a road crossing) but the wetland is relatively steep and any unmitigated disturbance will likely cause extensive erosion within the wetland</td></tr>
</table>

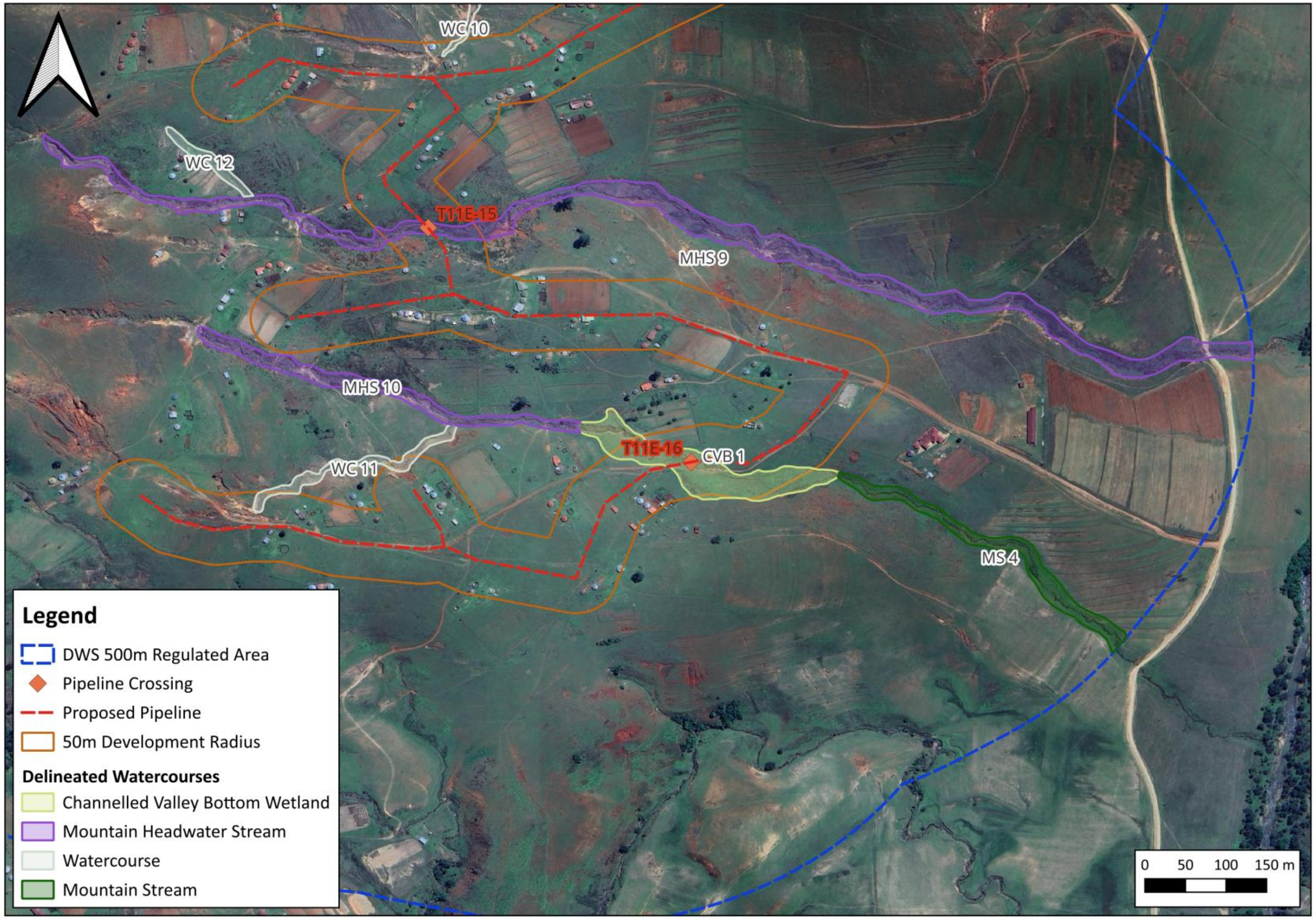

Figure 8-9 The proposed pipeline alignments in relation to the delineated freshwater ecosystems, specifically CVB 1, MHS 9, MHS 10, MS 4, WC 11, WC 12.

Table 8-13 Mountain headwater stream 1 (no direct crossing)

MHS 1	**Crossing No:**	N/A	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-10
Habitat type	Mountain Headwater Stream		**Latitude:**	-31.51834	**Longitude:**	28.13145
Photograph	No photograph available					
IHI/PES	**Condition Score**	**Key current impacts**				
	A/ B	Minor channel and bed modification due to erosion in the stream system with moderate bank erosion.				
EIS Score	**D**	Low/Marginal EIS (score of 1.0). The score is derived from the low ecological importance of the stream given it is a tributary of the Mbashe River.				
Risks	Low risks associated with the proposed development given that the pipeline alignments will not cross this stream system at all. A low risk exists because the pipeline is located in the catchment of the stream system.					

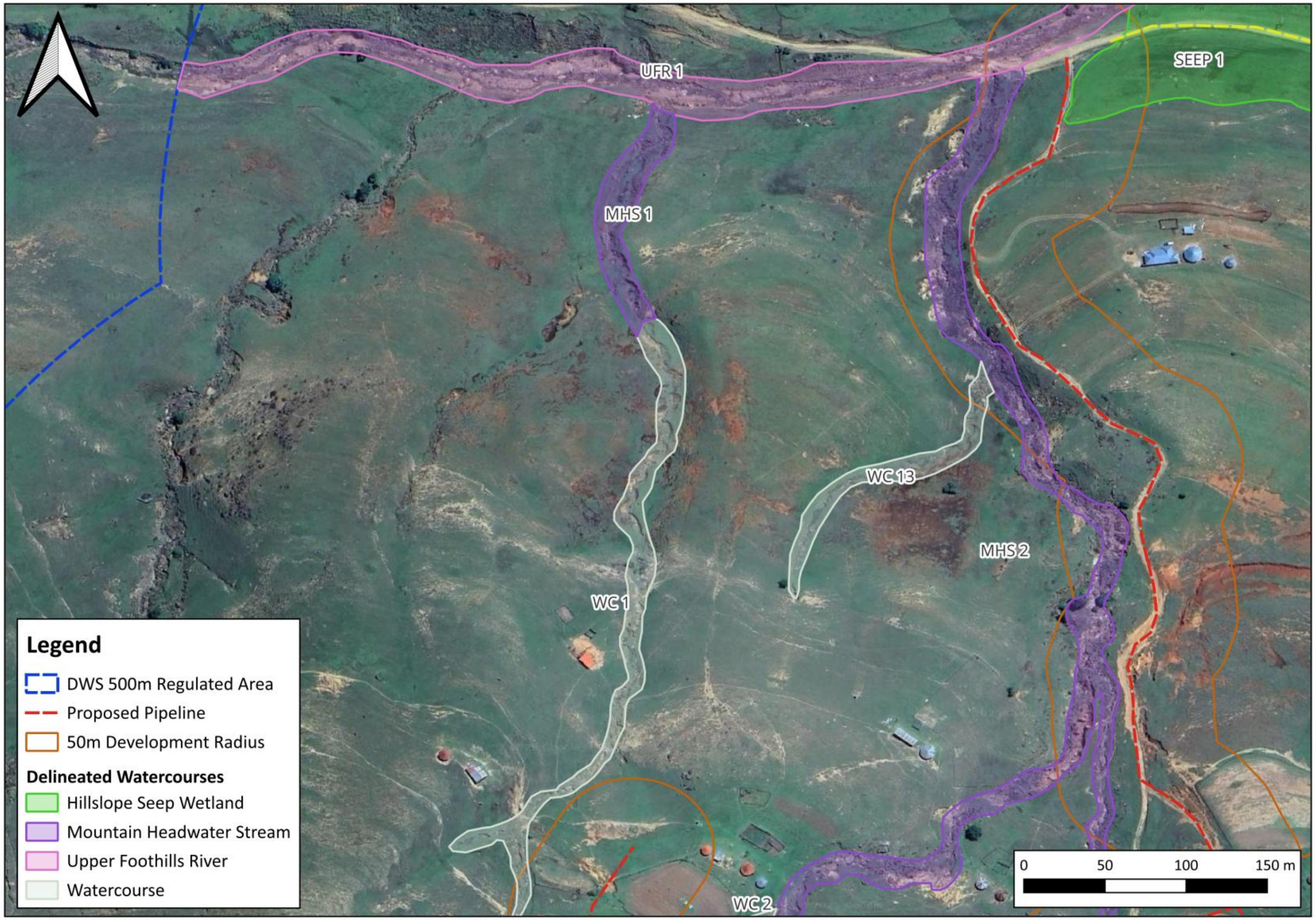

Figure 8-10 The proposed pipeline alignments in relation to the delineated freshwater ecosystems, specifically MHS 1.

Table 8-14 Mountain headwater stream 2 (crossing T11E-2)

MHS 2	Crossing No:	T11E-2	Quaternary Catchment	T11E	Map Reference	Figure 8-11
Habitat type	Mountain Headwater Stream		Latitude:	-31.52153	Longitude:	28.13400
Photograph						
IHI/PES	Condition Score	Key current impacts				
	A/ B	Minor channel and bed modification due to erosion in the stream system with moderate bank erosion. Introduction of a few invasive alien species				
EIS Score	D	Low/Marginal EIS (score of 1.2). The score is derived from the ecological importance of the stream given it is a tributary of the Mbashe River.				
Risks	Low to moderate risks associated with the proposed development given that the pipeline alignments cross this stream at a single point along its length, and the proposed crossing point is located on a bedrock shelf which will protect the system from erosion.					

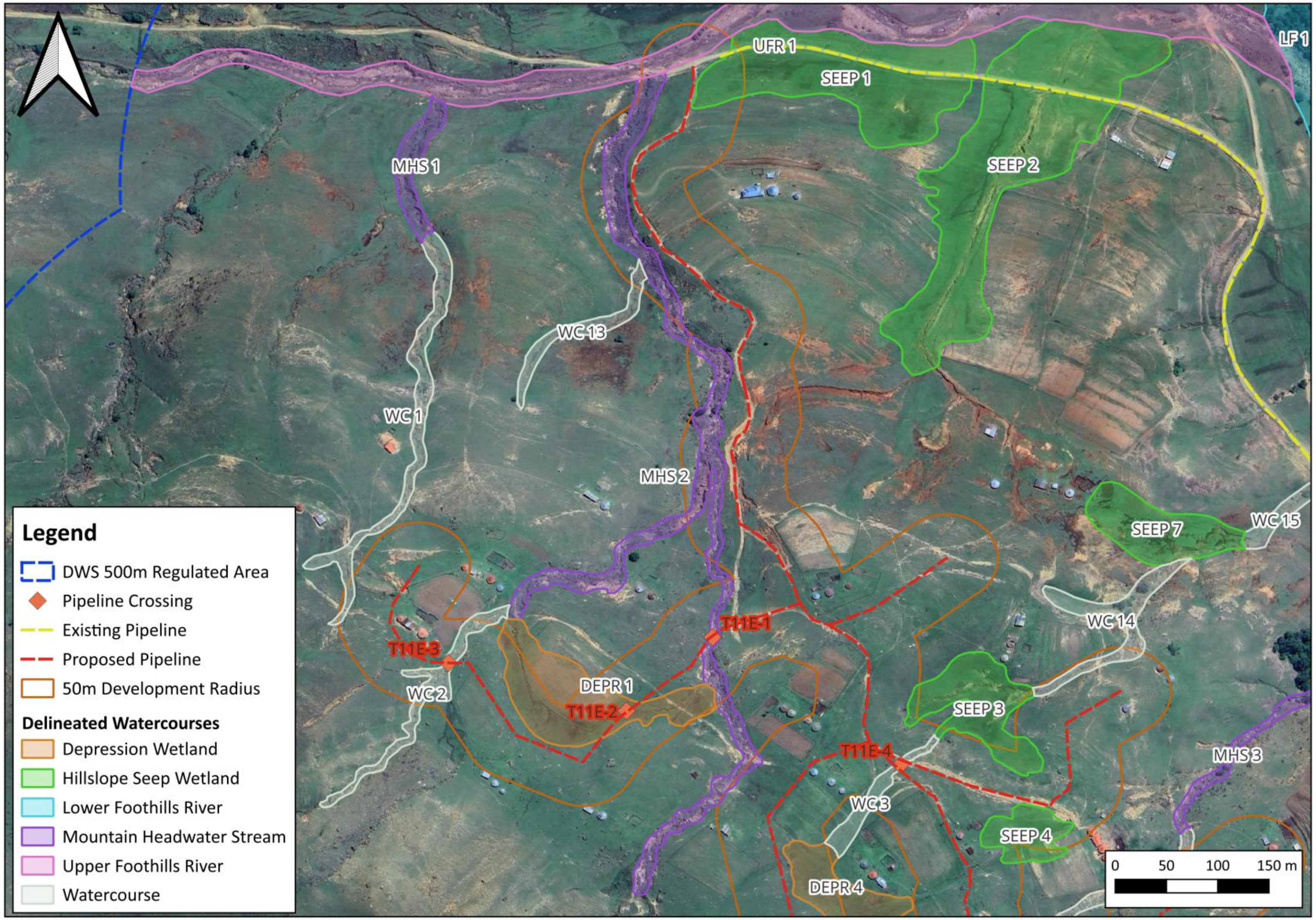

Figure 8-11 The proposed pipeline alignments in relation to the delineated freshwater ecosystems, specifically MHS 2.

Table 8-15 Mountain headwater stream 3 (no direct crossing)

MHS 3	**Crossing No:**	N/A	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-6
Habitat type	Mountain Headwater Stream		**Latitude:**	-31.52411	**Longitude:**	28.14259
Photograph	No photograph available					
IHI/PES	**Condition Score**	**Key current impacts**				
	A/ B	Minor channel and bed modification due to erosion in the stream system with moderate bank erosion. Introduction of a few invasive alien species				
EIS Score	**D**	Low/Marginal EIS (score of 1.1). The score is derived from the ecological importance of the stream given it is a tributary of the Mbashe River.				
Risks	Low risks associated with the proposed development given that the pipeline alignments will not cross this stream system at all. A low risk exists because the pipeline is located in the catchment of the stream system.					

Table 8-16 Mountain headwater stream 4 (no direct crossing)

MHS 4	**Crossing No:**	N/A	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-12
Habitat type	Mountain Headwater Stream		**Latitude:**	-31.53039	**Longitude:**	28.14079
Photograph	No photograph available					
IHI/PES	**Condition Score**	**Key current impacts**				
	A/ B	Minor channel and bed modification due to erosion and a road crossing at the toe of the stream.				
EIS Score	**D**	Low/Marginal EIS (score of 0.9). The score is derived from the ecological importance of the stream given it is a tributary of the Mbashe River.				
Risks	Low risks associated with the proposed development given that the pipeline alignments will not cross this stream system at all. A low risk exists because the pipeline is located in the catchment of the stream system.					

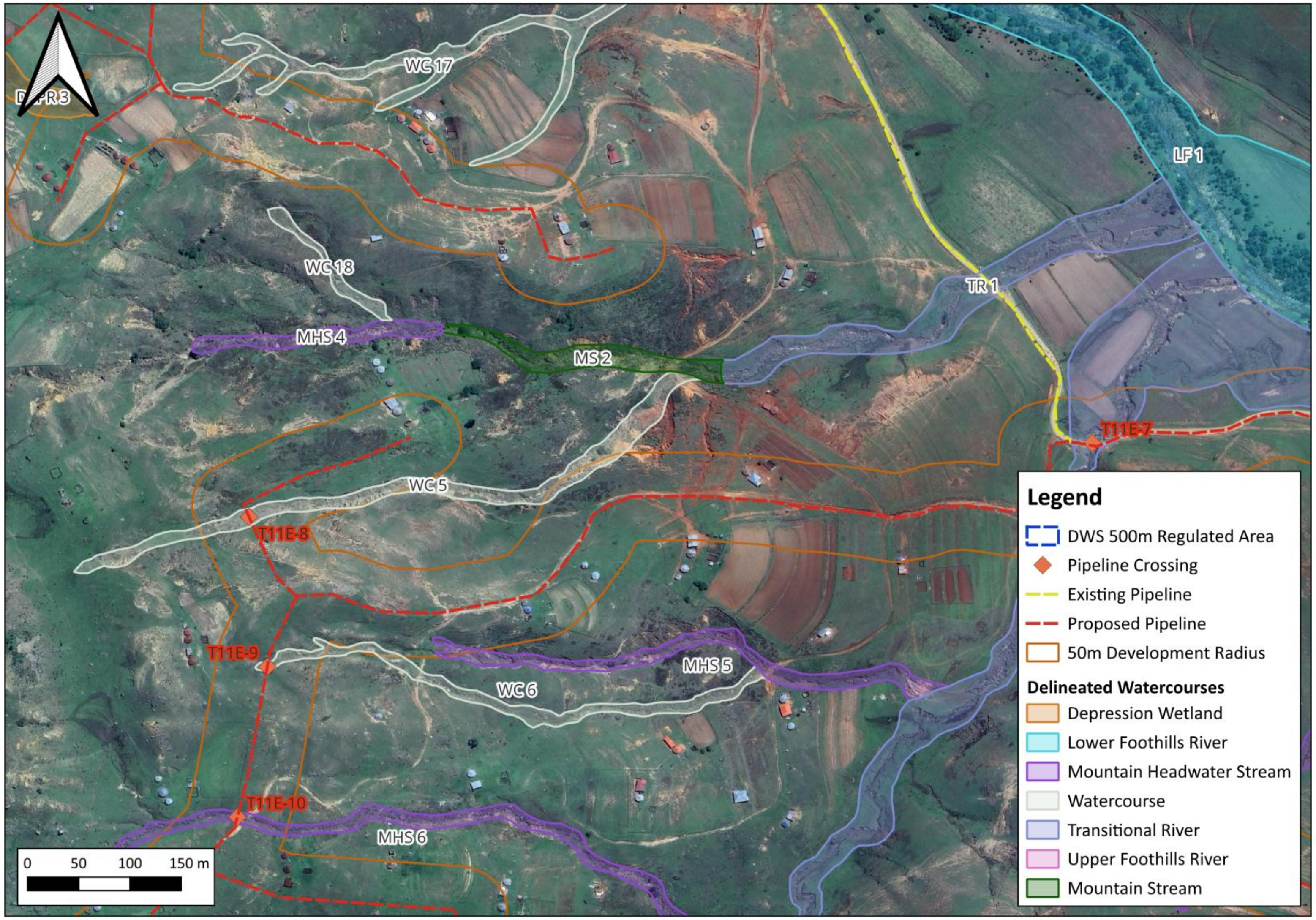

Figure 8-12 The proposed pipeline alignments in relation to the delineated freshwater ecosystems, specifically MHS 4, MHS 5, MS 2, WC 5, WC 6, WC 18, TR 1.

Table 8-17 Mountain headwater stream 5 (no direct crossing)

	Crossing No:	N/A	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-12
Habitat type	Mountain Headwater Stream		**Latitude:**	-31.53376	**Longitude:**	28.14477
Photograph	No photograph available					
IHI/PES	**Condition Score**	**Key current impacts**				
	A/ B	Minor channel and bed modification due to erosion and a road crossing at the toe of the stream.				
EIS Score	**D**	Low/Marginal EIS (score of 0.9). The score is derived from the ecological importance of the stream given it is a tributary of the Mbashe River.				
Risks	Low risks associated with the proposed development given that the pipeline alignments will not cross this stream system at all. A low risk exists because the pipeline is located in the catchment of the stream system.					

Table 8-18 Mountain headwater stream 6 (crossing T11E-10)

MHS 6	**Crossing No:**	T11E-10	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-8
Habitat type	Mountain Headwater Stream		**Latitude:**	-31.53563	**Longitude:**	28.14194
Photograph						
IHI/PES	**Condition Score**	**Key current impacts**				
	A/ B	Minor channel and bed modification due to erosion and a road crossing near the head of the stream. Some bank modification was evident from adjacent agricultural activities.				
EIS Score	D	Low/Marginal EIS (score of 0.9). The score is derived from the ecological importance of the stream given it is a tributary of the Mbashe River.				
Risks	Low to moderate risks associated with the proposed development given that the pipeline alignment crosses this stream at a single point along its length, and the proposed crossing point is located on a bedrock shelf which will protect the system from erosion.					

Table 8-19 Mountain headwater stream 7 (crossing T11E-12)

<table>
<tr><td>MHS 7</td><td>Crossing No:</td><td>T11E-12</td><td>Quaternary Catchment</td><td>T11E</td><td>Map Reference</td><td>Figure 8-13</td></tr>
<tr><td>Habitat type</td><td colspan="2">Mountain Headwater Stream</td><td>Latitude:</td><td>-31.53509</td><td>Longitude:</td><td>28.15051</td></tr>
<tr><td>Photograph</td><td colspan="6"></td></tr>
<tr><td rowspan="2">IHI/PES</td><td>Condition Score</td><td colspan="5">Key current impacts</td></tr>
<tr><td>B</td><td colspan="5">Minor channel and bed modification due to erosion and sedimentation from an extensive gully upstream of the stream. Introduction of invasive alien plants.</td></tr>
<tr><td>EIS Score</td><td>D</td><td colspan="5">Low/Marginal EIS (score of 0.8). The score is derived from the ecological importance of the stream given it is a tributary of the Mbashe River.</td></tr>
<tr><td>Risks</td><td colspan="6">Low to moderate risks associated with the proposed development given that the pipeline alignments cross this stream at a single point along its length, and the proposed crossing point is located on a bedrock shelf which will protect the system from erosion.</td></tr>
</table>

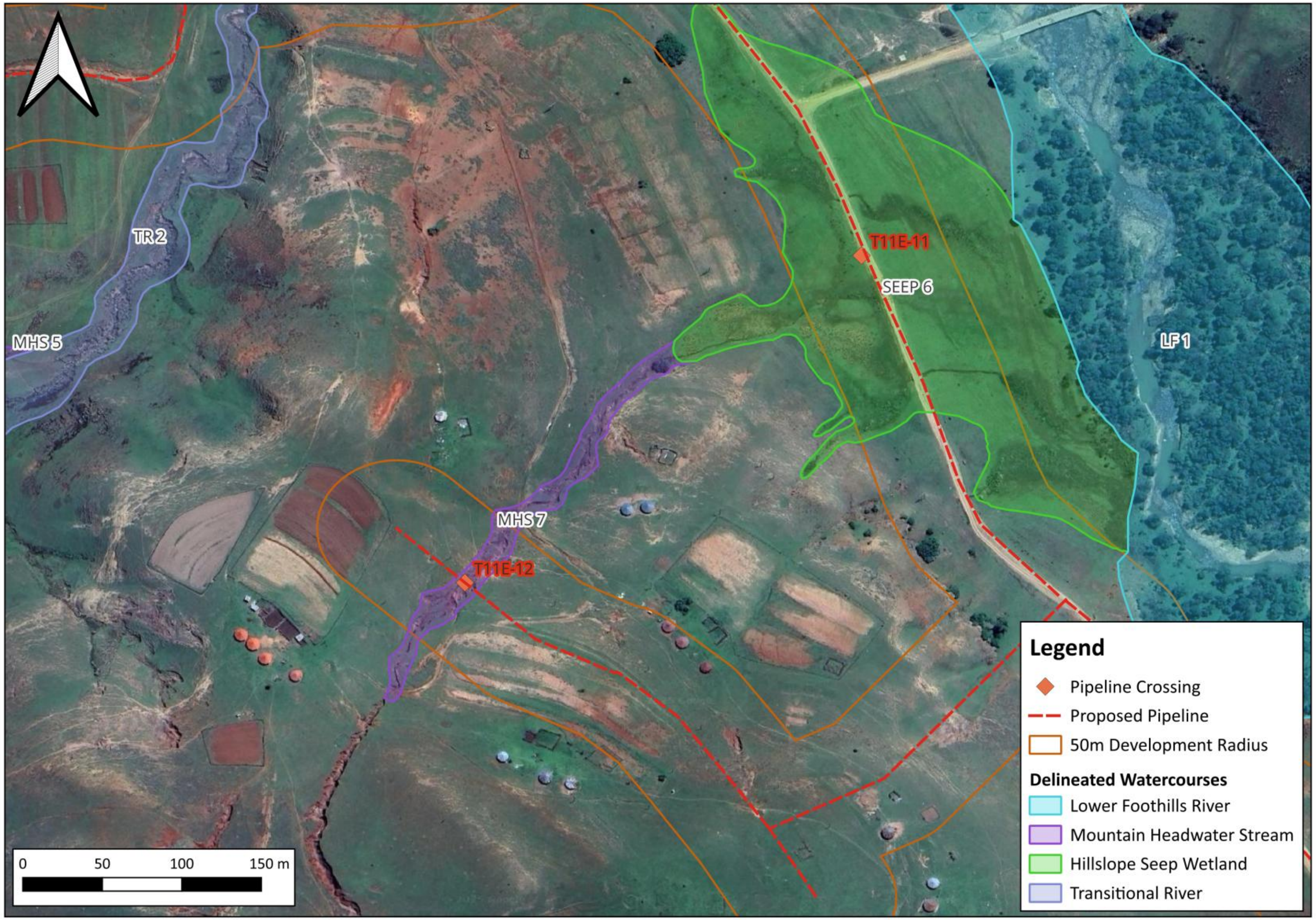

Figure 8-13 The proposed pipeline alignments in relation to the delineated freshwater ecosystems, specifically MHS 7.

Table 8-20 Mountain headwater stream 8 (crossing T11E-13 & T11E-14)

<table>
<tr><td>MHS 8</td><td>Crossing No:</td><td>T11E-13 & 14</td><td>Quaternary Catchment</td><td>T11E</td><td>Map Reference</td><td>Figure 8-14</td></tr>
<tr><td>Habitat type</td><td colspan="2">Mountain Headwater Stream</td><td>Latitude:</td><td>-31.53970</td><td>Longitude:</td><td>28.15632</td></tr>
<tr><td>Photograph</td><td colspan="6"></td></tr>
<tr><td rowspan="2">IHI/PES</td><td>Condition Score</td><td colspan="5">Key current impacts</td></tr>
<tr><td>A/ B</td><td colspan="5">Minor channel and bed modification due to the road crossing near the toe of the stream which has resulted in some erosion downstream. Additionally, the disturbance has likely resulted in the proliferation of Acacia mearnsii below the road crossing.</td></tr>
<tr><td>EIS Score</td><td>D</td><td colspan="5">Low/Marginal EIS (score of 0.9). The score is derived from the ecological importance of the stream given it is a tributary of the Mbashe River.</td></tr>
<tr><td>Risks</td><td colspan="6">Low to moderate risks associated with the proposed development given that the pipeline alignments cross this stream at a two points along its length, and the lowermost crossing point is located along an existing road and the topmost crossing is located on a bedrock shelf which will protect the system from erosion.</td></tr>
</table>

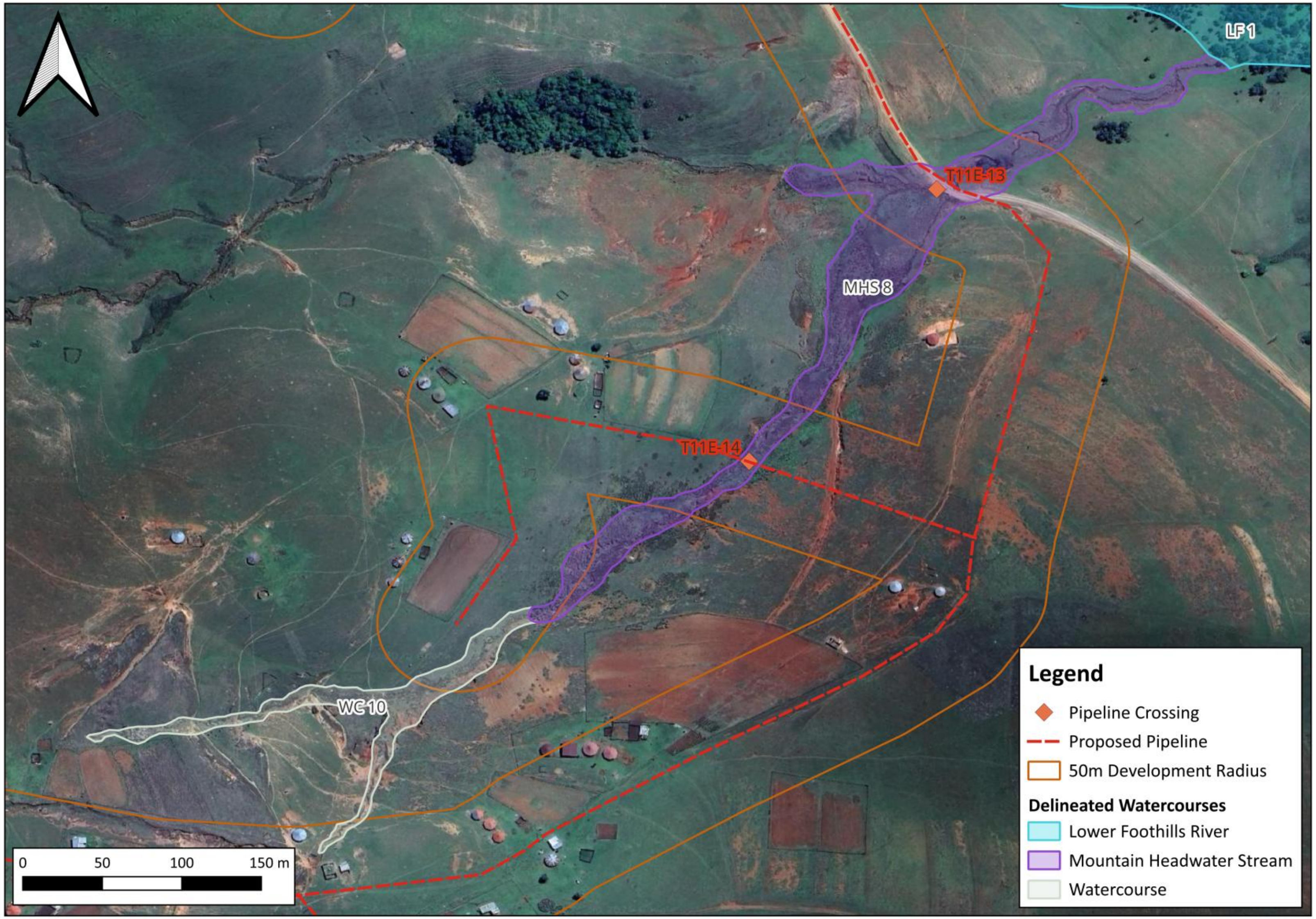

Figure 8-14 The proposed pipeline alignments in relation to the delineated freshwater ecosystems, specifically MHS 8 and WC 10.

Table 8-21 Mountain headwater stream 9 (crossing T11E-15)

MHS 9	**Crossing No:**	T11E-15	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-9
Habitat type	Mountain Headwater Stream		**Latitude:**	-31.54587	**Longitude:**	28.15513
Photograph						
IHI/PES	**Condition Score**		**Key current impacts**			
	A/	B	Minor bed modification due to erosion in the catchment and resultant sedimentation in the stream. The channel and banks have also been slightly eroded due to cattle action in the stream.			
EIS Score	D		Low/Marginal EIS (score of 1.1). The score is derived from the ecological importance of the stream given it is a tributary of the Mbashe River.			
Risks	Low risks associated with the proposed development given that the pipeline will cross the system once near its head. Risks related to the construction and operation of the pipeline are present.					

Table 8-22 Mountain headwater stream 10 (no direct crossing)

MHS 10	**Crossing No:**	N/A	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-9
Habitat type	Mountain Headwater Stream		**Latitude:**	-31.54775	**Longitude:**	28.15177
Photograph	No photograph available					
IHI/PES	**Condition Score**	**Key current impacts**				
	A/ B	Minor bed modification due to erosion in the catchment and resultant sedimentation in the stream. The channel and banks have also been slightly eroded due to cattle action in the stream.				
EIS Score	**D**	Low/Marginal EIS (score of 0.9). The score is derived from the ecological importance of the stream given it is a tributary of the Mbashe River.				
Risks	Low risks associated with the proposed development given that the pipeline alignments will not cross this stream system at all. A low risk exists because the pipeline is located in the catchment of the stream system.					

Table 8-23 Upper foothills river 1 (no direct crossing)

UFR 1	**Crossing No:**	N/A	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-2
Habitat type	Upper Foothills River		**Latitude:**	-31.51682	**Longitude:**	28.13678
Photograph						
IHI/PES	**Condition Score**	**Key current impacts**				
	B	Minor bed and bank modification due to the construction of a road crossing through the stream. This has resulted in artificial channel widening downstream and the moderate destruction of rapid and riffles in these areas thereby affecting freshwater fauna. Additionally, low levels of invasive alien species were observed in the riparian area, however, the system is largely natural.				
EIS Score	**C**	Moderate EIS (score of 2.2). The score is derived from the ecological importance of the stream given it is a tributary of the Mbashe River as well as the fact that it forms a key part of the fish support corridor associated with the Mbashe River.				
Risks	Low risks associated with the proposed development given that the pipeline alignments will not cross this stream system at all. A low risk exists because the pipeline is located in the catchment of the stream system.					

Table 8-24 Mountain stream 1 (no direct crossing)

MS 1	**Crossing No:**	N/A	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-6
Habitat type	Mountain Stream		**Latitude:**	-31.52289	**Longitude:**	28.14233
Photograph	No photograph available					
IHI/PES	**Condition Score**	**Key current impacts**				
	B	Minor bed and bank modification due to the construction of a road crossing through the stream. This has resulted in artificial channel widening both downstream and upstream. Additionally, low levels of invasive alien species were observed in the riparian area at the toe of the stream.				
EIS Score	**D**	Low/Marginal EIS (score of 1.0). The score is derived from the ecological importance of the stream given it is a tributary of the Mbashe River.				
Risks	Low risks associated with the proposed development given that the pipeline alignments will not cross this stream system at all. A low risk exists because the pipeline is located in the catchment of the stream system.					

Table 8-25 Mountain stream 2 (no direct crossing)

Ngqondo MS 2	**Crossing No:**	N/A	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-12
Habitat type	Mountain Stream		**Latitude:**	-31.53061	**Longitude:**	28.14359
Photograph	No photograph available					
IHI/PES	**Condition Score**	**Key current impacts**				
	A/ B	Minor bed modification due to erosion in the catchment and resultant sedimentation in the stream. The channel and banks have also become slightly eroded due to cattle action in the stream.				
EIS Score	**D**	Low/Marginal EIS (score of 1.0). The score is derived from the ecological importance of the stream given it is a tributary of the Mbashe River.				
Risks	Low risks associated with the proposed development given that the pipeline alignments will not cross this stream system at all. A low risk exists because the pipeline is located in the catchment of the stream system.					

Table 8-26 Mountain stream 3 (no direct crossing)

MS 3	**Crossing No:**	N/A	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-8
Habitat type	Mountain Stream		**Latitude:**	-31.53854	**Longitude:**	28.14259
Photograph						
IHI/PES	**Condition Score**	**Key current impacts**				
	A/ B	Minor bed modification due to erosion in the catchment and resultant sedimentation in the stream. The channel and banks have also been slightly eroded due to cattle action in the stream. The channel is also incised due to large landscape scale geomorphic processes occurring downstream.				
EIS Score	**D**	Low/Marginal EIS (score of 1.2). The score is derived from the ecological importance of the stream given it is a tributary of the Mbashe River.				
Risks	Low risks associated with the proposed development given that the pipeline alignments will not cross this stream system at all. A low risk exists because the pipeline is located in the catchment of the stream system.					

Table 8-27 Mountain stream 4 (no direct crossing)

MS 4	**Crossing No:**	N/A	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-9
Habitat type	Mountain Stream		**Latitude:**	-31.54974	**Longitude:**	28.15961
Photograph	No photograph available					
IHI/PES	**Condition Score**	**Key current impacts**				
	A/ B	Minor bed modification due to erosion in the catchment and resultant sedimentation in the stream. The channel is also incised due to large landscape scale geomorphic processes occurring downstream.				
EIS Score	**D**	Low/Marginal EIS (score of 1.0). The score is derived from the ecological importance of the stream given it is a tributary of the Mbashe River.				
Risks	Low risks associated with the proposed development given that the pipeline alignments will not cross this stream system at all. A low risk exists because the pipeline is located in the catchment of the stream system.					

Table 8-28 Transitional river 1 (no direct crossing)

	Crossing No:	N/A	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-12
Habitat type	Transitional River		**Latitude:**	-31.52986	**Longitude:**	28.14760
Photograph						
IHI/PES	**Condition Score**	**Key current impacts**				
	B	Minor to moderate channel modification from the construction of the road crossing and associated culverts. This has led to channel incision and bank erosion. Additionally, the narrow riparian area has been modified to cultivation.				
EIS Score	**D**	Low/Marginal EIS (score of 1.4). The score is derived from the ecological importance of the stream given it is a tributary of the Mbashe River.				
Risks	Low risks associated with the proposed development given that the pipeline alignments will not cross this stream system at all. A low risk exists because the pipeline is located in the catchment of the stream system.					

Table 8-29 Transitional river 2 (crossing T11E-7)

Ngqondo TR 2	**Crossing No:**	T11E-7	**Quaternary Catchment**	T11E	**Map Reference**	Figure 8-15
Habitat type	Transitional River		**Latitude:**	-31.53197	**Longitude:**	28.14891
Photograph						
IHI/PES	**Condition Score**	**Key current impacts**				
	B	Minor to moderate channel modification from the construction of the road crossing and associated culverts. This has led to channel incision and bank erosion and the abandonment of an old channel in favour of a straightened channel. Additionally, the riparian area has been modified to cultivation.				
EIS Score	**D**	Low/Marginal EIS (score of 1.4). The score is derived from the ecological importance of the stream given it is a tributary of the Mbashe River.				
Risks	Low risks associated with the proposed pipeline alignment given that the pipeline will pass directly through the wetland, but is located along an existing disturbance (i.e. the road). Provided that careful construction measures are followed, the risk should be low. Additionally, the wetland is located on a gentle slope, so the risk of erosion is reduced.					

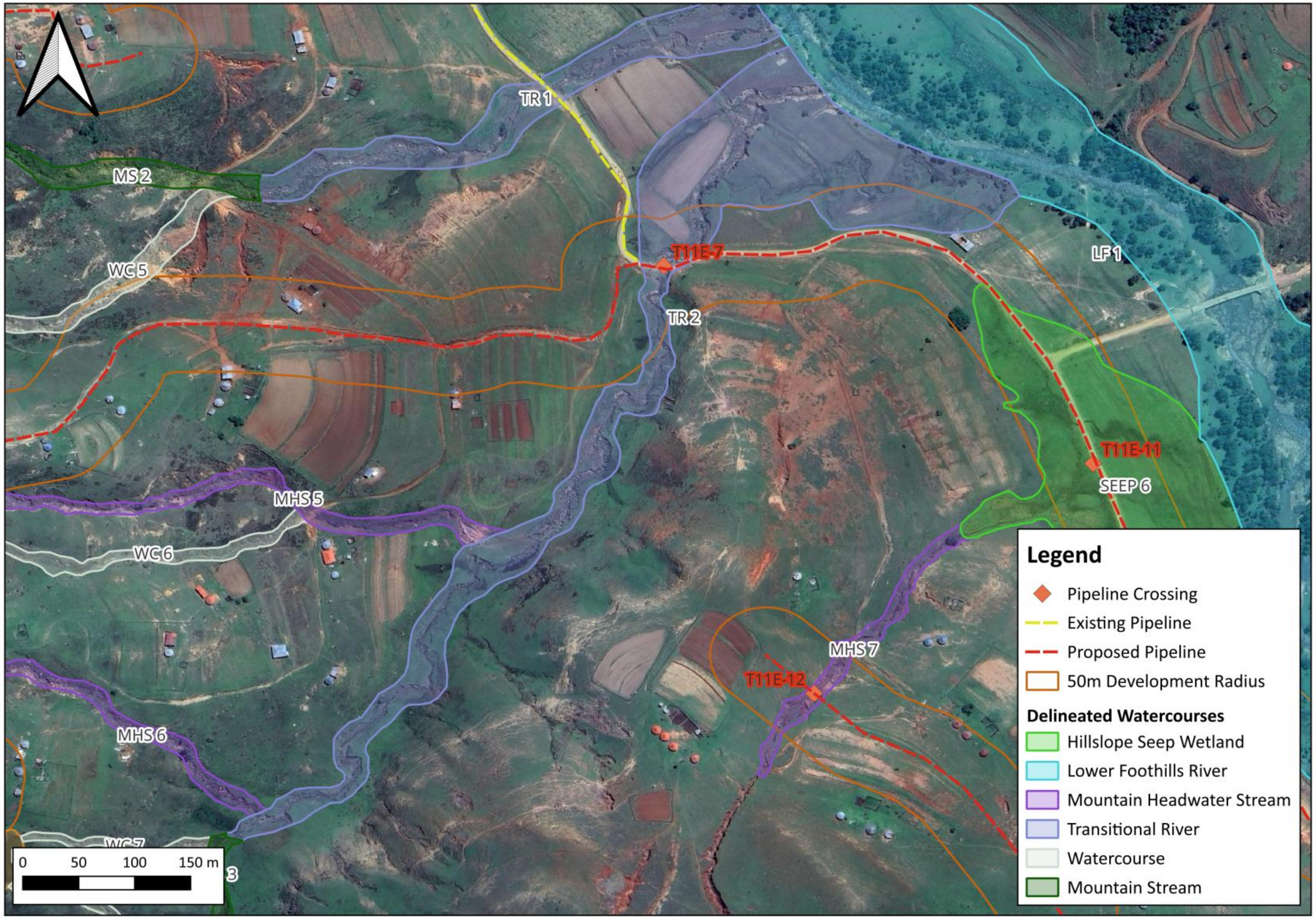

Figure 8-15 The proposed pipeline alignments in relation to the delineated freshwater ecosystems, specifically TR 2.

Table 8-30 Lower foothills river 1 (no direct crossing)

<table>
<tr><td>LF 1</td><td>Crossing No:</td><td>N/A</td><td>Quaternary Catchment</td><td>T11E</td><td>Map Reference</td><td>Figure 8-16</td></tr>
<tr><td>Habitat type</td><td colspan="2">Lower Foothills River</td><td>Latitude:</td><td>-31.53022</td><td>Longitude:</td><td>28.15172</td></tr>
<tr><td>Photograph</td><td colspan="6"></td></tr>
<tr><td rowspan="2">IHI/PES</td><td>Condition Score</td><td colspan="5">Key current impacts</td></tr>
<tr><td>C</td><td colspan="5">Moderate levels of degradation have occurred as a result of extensive invasive alien plant proliferation within the riparian area which is the main contributing factor to the decline in overall habitat integrity. Furthermore, sedimentation and slight modification of the bed and banks have occurred due to the increased sedimentation rates in the catchment.</td></tr>
</table>

EIS Score	**A**	High EIS (score of 3.5). The score is derived from a variety of important taxa ranging from fish to freshwater invertebrates[8]. Additionally, the river is deemed to be highly sensitive to changes in flow regimes given that many of the important taxa (both faunal and floral) are sensitive to changes in low flow conditions.
Risks	Low risks associated with the proposed development given that the pipeline alignment will not cross this stream system at all. A low risk exists because the pipeline is located in the catchment of the stream system.	

[8] Information from PESEIS project data on the DWS website: https://www.dws.gov.za/iwqs/rhp/eco/peseismodel.aspx

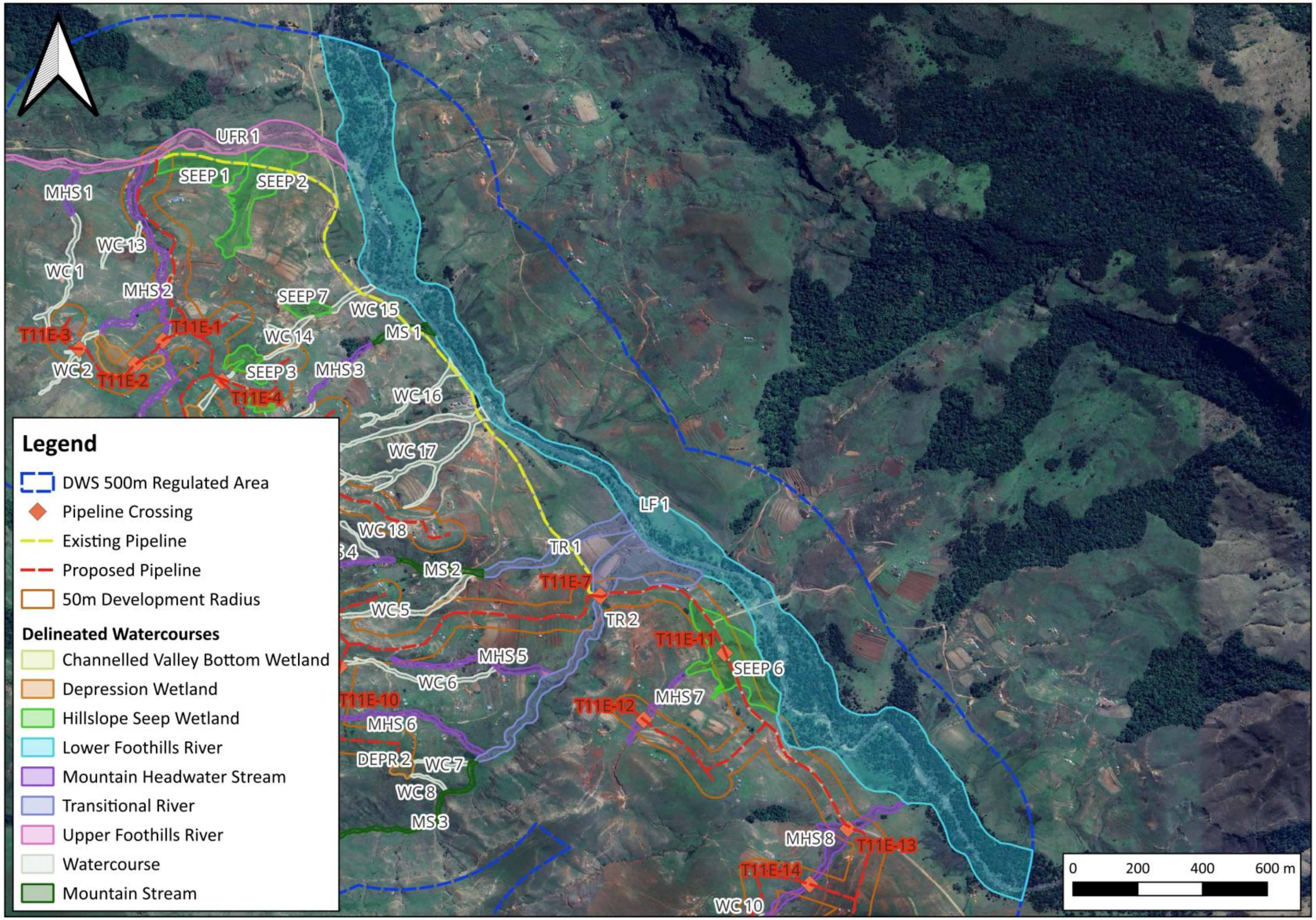

Figure 8-16 The proposed pipeline alignments in relation to the delineated freshwater ecosystems, specifically LF 1.

Table 8-31 Summary of the watercourses present onsite, their relevant crossing numbers and broad risk statements

Watercourse Code	Crossing Number	Map Reference	Risks
WC 1	N/A	Figure 8-7	Low to moderate risks associated with construction and operational phase.
WC 2	T11E-3	Figure 8-7	Low to moderate risks associated with construction and operational phase.
WC 3	T11E-4	Figure 8-3	Low to moderate risks associated with construction and operational phase.
WC 4	T11E-5	Figure 8-4	Low to moderate risks associated with construction and operational phase.
WC 5	T11E-8	Figure 8-12	Low to moderate risks associated with construction and operational phase.
WC 6	T11E-9	Figure 8-12	Low to moderate risks associated with construction and operational phase.
WC 7	N/A	Figure 8-8	Low risks associated with construction and operation of pipeline in the catchment
WC 8	N/A	Figure 8-8	Low risks associated with construction and operation of pipeline in the catchment
WC 9	N/A	Figure 8-8	Low to moderate risks associated with construction and operational phase.
WC 10	N/A	Figure 8-14	Low to moderate risks associated with construction and operational phase.
WC 11	N/A	Figure 8-9	Low to moderate risks associated with construction and operational phase.
WC 12	N/A	Figure 8-9	Low to moderate risks associated with construction and operational phase.
WC 13	N/A	Figure 8-7	Low risks associated with construction and operation of pipeline in the catchment
WC 14	N/A	Figure 8-6	Low risks associated with construction and operation of pipeline in the catchment
WC 15	N/A	Figure 8-6	Low risks associated with construction and operation of pipeline in the catchment

WC 16	N/A	Figure 8-16	Low risks associated with construction and operation of pipeline in the catchment
WC 17	N/A	Figure 8-16	Low risks associated with construction and operation of pipeline in the catchment
WC 18	N/A	Figure 8-12	Low risks associated with construction and operation of pipeline in the catchment

8.3 Resource Quality Objectives and the Recommended Ecological Category

The management objective for any watercourse is set by considering the pre-development PES and the EIS of the given watercourse. The Mbashe River does have resource quality objectives set for it, but the reach for which these RQOs have been set is located within the T11H catchment and does not coincide with this study area. Therefore, the reach of the Mbashe River and the catchments wherein the delineated watercourses lie do not have resource quality objectives prescribed for them. Therefore, individual REC's will be set for the 29 freshwater ecosystems across the site. Following the Rountree et al. (2013) method, all the systems except the Mbashe River itself will have to be maintained in their current PES category, considering that their EIS categories ranged from ***Low*** to ***Moderate***. However, given that the Mbashe River has a ***High*** EIS and is in a C PES category, according to the Rountree et al (2013) method, the Mbashe River has a REC of B.

Table 8-32 Summary of the RECs for the freshwater ecosystems located within the study area

Aquatic Ecosystem Code	EIS	PES	REC
SEEP 1	Moderate	C	C
SEEP 2	Moderate	D	D
SEEP 3	Low/Marginal	C	C
SEEP 4	Low/Marginal	D	D
SEEP 5	Low/Marginal	C	C
SEEP 6	Moderate	C	C
SEEP 7	Low/Marginal	C	C
DEPR 1	Moderate	D	D
DEPR 2	Moderate	C	C
DEPR 3	Moderate	C	C
DEPR 4	Moderate	D	D
CVB 1	Moderate	C	C
MHS 1	Low/Marginal	A/ B	A/ B
MHS 2	Low/Marginal	A/ B	A/ B
MHS 3	Low/Marginal	A/ B	A/ B
MHS 4	Low/Marginal	A/ B	A/ B

MHS 5	Low/Marginal	A/ B	A/ B
MHS 6	Low/Marginal	A/ B	A/ B
MHS 7	Low/Marginal	B	B
MHS 8	Low/Marginal	A/ B	A/ B
MHS 9	Low/Marginal	A/ B	A/ B
MHS 10	Low/Marginal	A/ B	A/ B
MS 1	Low/Marginal	B	B
MS 2	Low/Marginal	A/ B	A/ B
MS 3	Low/Marginal	A/ B	A/ B
MS 4	Low/Marginal	A/ B	A/ B
TR 1	Low/Marginal	B	B
TR 2	Low/Marginal	B	B
UFR 1	Moderate	B	B
LF 1	High	C	B

8.4 Potential impacts of the pipeline servitude and water supply scheme

It is important to understand the potential impacts on the freshwater ecosystems associated with any form of development. The proposed development indicated in **Figure 8-1** includes the construction of approximately 1.2km of uPVC pipes of sizes ranging from 63mm in diameter across various classes, 5km of HDPE pipes of 50mm diameter, 4.5km of Klambon steel pipes of sizes ranging from 50mm diameter to 90mm diameter. These pipes will provide clean drinking water to the residential houses located on the east-facing slopes where the study was undertaken. The proposed pipelines cross various freshwater ecosystems and watercourses and therefore there are direct impacts envisaged as a result of the construction of the water pipelines. The anticipated impacts have been split into three separate categories to keep the risk and impact assessments simple, considering the number of watercourses assessed. These three categories are 1) impacts and risks posed to watercourses from pipeline alignments within the catchment of the watercourse, but that fall outside of the construction and operational buffer zones, 2) impacts and risks posed to watercourses from pipeline alignments within the catchment of the watercourse and, that fall inside the construction and operational buffer zones, and 3) impacts and risks posed to watercourses from the pipeline alignment directly crossing the system.

The potential impacts to the hydrologically linked freshwater ecosystems are numbered and listed below:

Construction phase impacts

The impacts associated with the construction of linear features such as pipelines, generally relate to the physical disturbance footprint of the construction activities, such as vehicle movements, earth moving and storage etc., as well as the potential of the infrastructure to create impoundments, additional water inputs, and unfavourable sub-surface drainage within the watercourse.

i) Water contamination from the operation and washing of machinery in the catchments of the watercourses.
ii) Siltation in the freshwater ecosystems due to vegetation clearing and earthworks that will be undertaken within and in the catchments of the watercourses.
iii) Spread of invasive alien plants into the watercourses as a result of disturbance during construction.
iv) Direct loss of watercourse habitat due to the excavation and installation of pipelines which could be a result of water contamination, siltation or the spread of invasive alien plants (IAPs).

Operational phase impacts

Linear features tend to have spatially limited impacts during the operational phase unless they interrupt driving processes that shape watercourse structure and function. The impacts of linear features are generally limited to the construction phase, and the main impact associated with the operational phase is if the infrastructure fails. These can include:

v) Burst pipelines could result in additional water inputs into the watercourses and could cause erosion in the watercourses.

8.5 Buffer determination results

Generally, buffers are adopted to protect freshwater ecosystems from physical disturbance and to protect the water resource from pollution from the adjacent landscape and associated proposed development. The freshwater ecosystems within the study site have generally been slightly to moderately modified, with the alteration of the systems' integrity associated with current and historical disturbances. As such the buffer distances are largely associated with the buffer functions that contribute towards protecting the water resource rather than biodiversity. The width of a buffer is determined by the type of development proposed, which in this case has been classified as a service infrastructure development of pipelines for the delivery of clean water.

It should be noted that a core assumption about buffer zones is that *they will not be utilised for anything other than providing buffering capacity*. However, given the rural nature of the environment and the complex land tenure and land use agreements, this assumption does not stand and therefore has been factored into the buffer assessment. Initially the buffers were derived for the onsite freshwater ecosystem habitat using 'The Estuary, River and Wetland Buffer Guidelines' model (McFarlane & Bredin, 2017) and were based on the characteristics of the freshwater ecosystems, the potential impacts associated with the proposed development and the characteristics of the derived buffer zones. An unmitigated buffer assessment was undertaken to show the buffer requirements should a poor mitigation scenario be adopted by the developer for both the construction and operational phases of the development. Additionally, a mitigated buffer assessment was undertaken to show the buffer requirements should a best-case mitigation scenario be adopted by the developer. Detailed recommendations for the management and maintenance of the buffer areas have been provided in **Section 9**.

As visualised in **Figure 8-17**, **Figure 8-18** and **Figure 8-19**, and presented in **Table 8-33** the buffer for the proposed development is split up between the construction and the operational phases. There was no difference between the poor mitigation and the best-case mitigation scenarios and therefore the buffer areas have been consolidated into one buffer zone per phase. Furthermore, given the extensive number of ecosystems, and taking a pragmatic approach to defining buffer zones for so many systems, a general construction buffer zone and a general operational buffer zone has been applied to all ecosystems. This will reduce the possible confusion and administration for the contractor and the environmental control officer during implementation. The buffer zones can be considered as being 'conservative' (i.e. they are possibly wider than necessary), but it is the opinion of the specialist that, given the steep nature of the landscape, it is better to be cautious. While the development poses both **Low** and **Moderate** risks to the ecosystems, it is recommended that appropriate mitigation activities are adopted.

Table 8-33 Recommended buffer distance to be adopted for the freshwater ecosystems present within the development footprint

Freshwater Ecosystem	Buffer Distance per Phase	
	Construction	Operational
All freshwater ecosystems	28m	15m

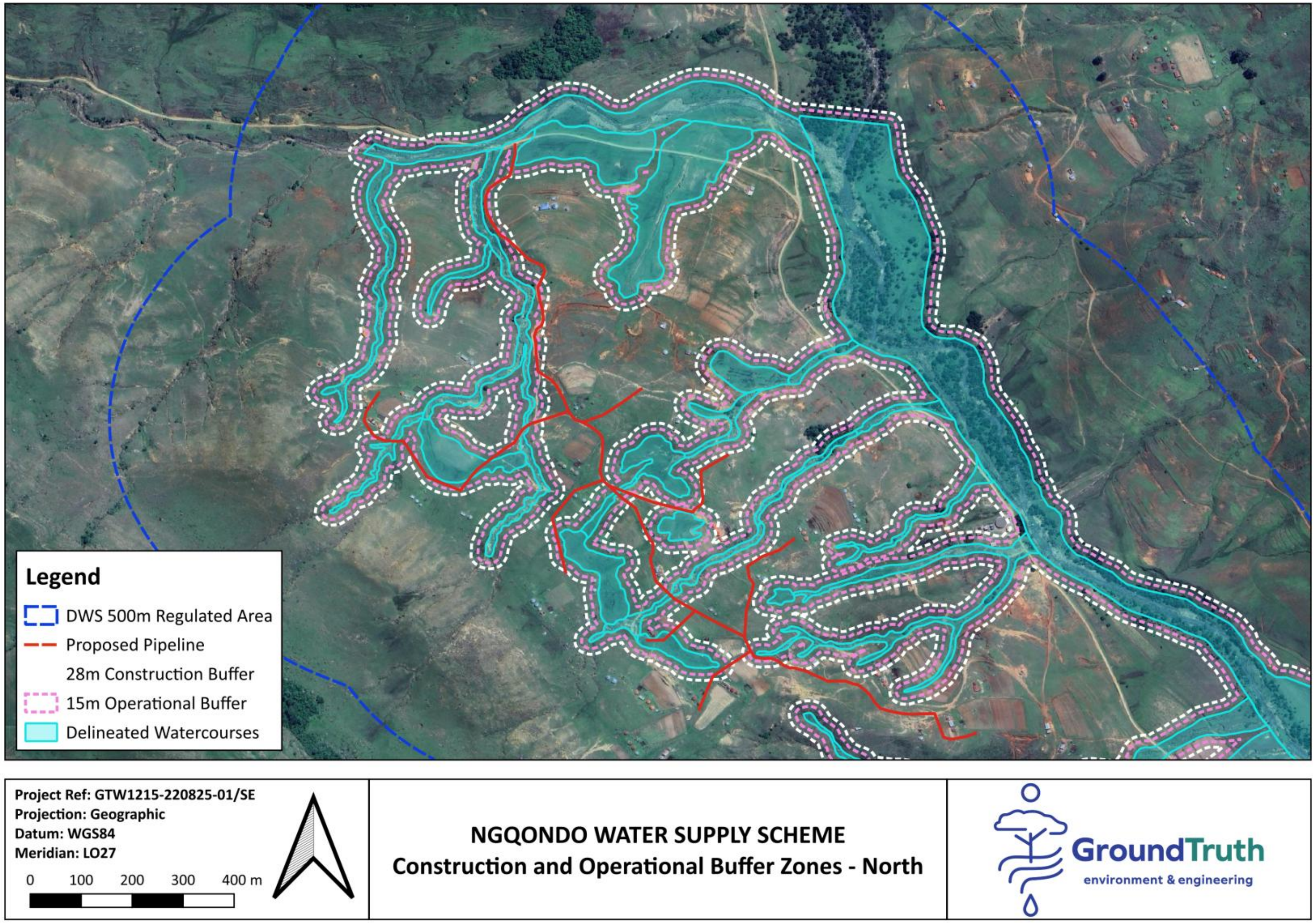

Figure 8-17 Results of the freshwater ecosystem buffer zone assessment for the construction and operational phase for the northern portion of the study area.

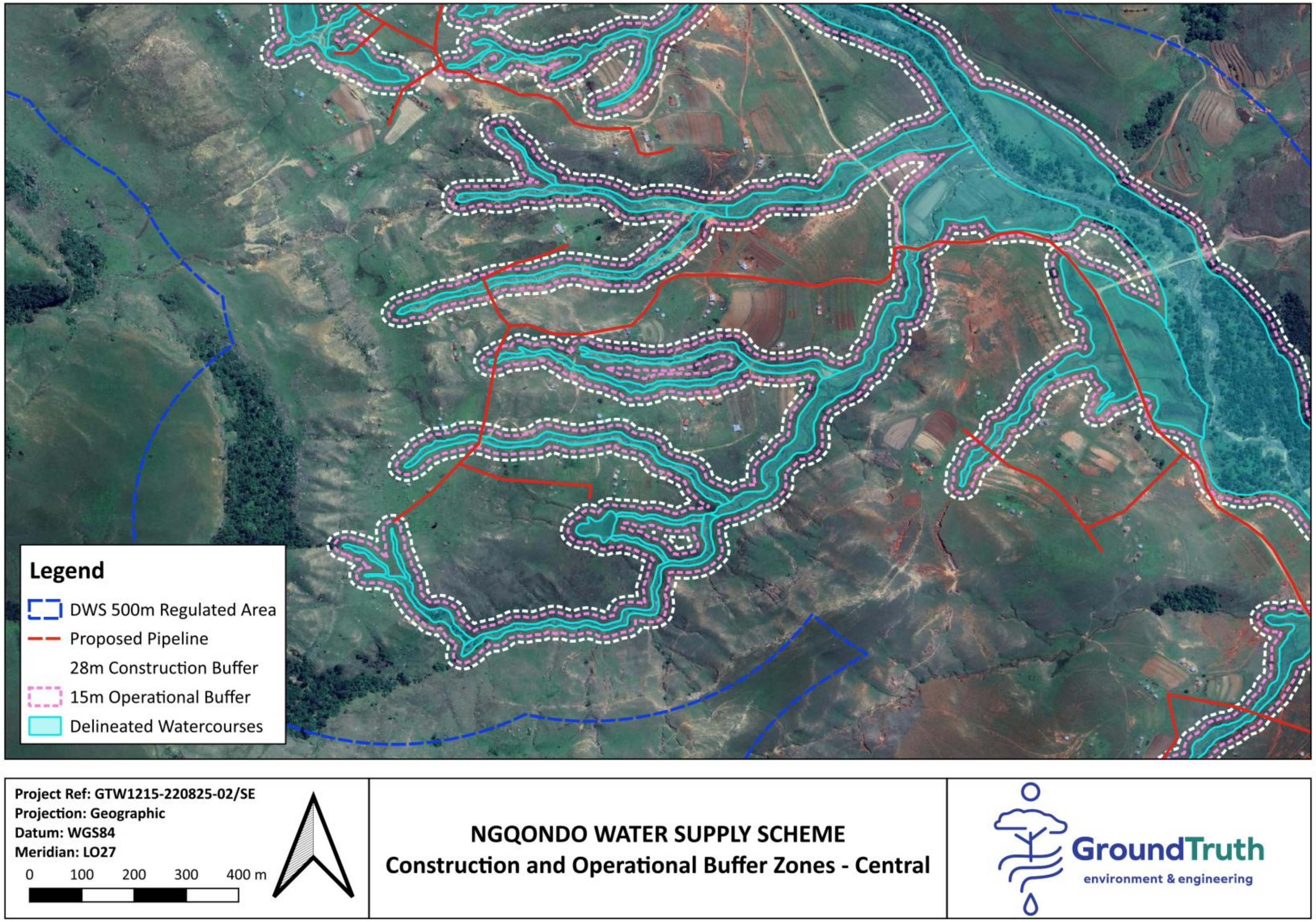

Figure 8-18 Results of the freshwater ecosystem buffer zone assessment for the construction and operational phase for the central portion of the study area.

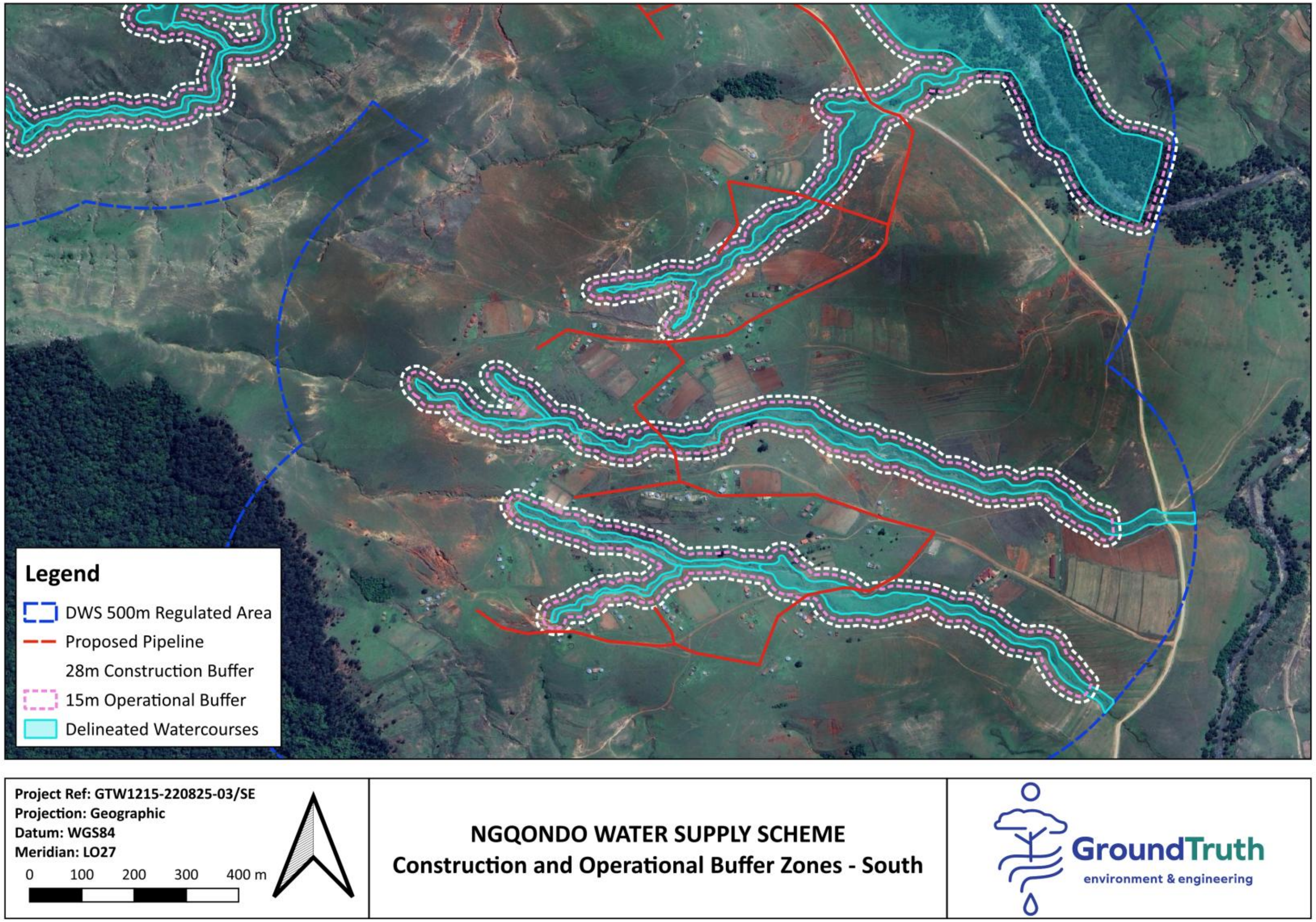

Figure 8-19 Results of the freshwater ecosystem buffer zone assessment for the construction and operational phase for the southern portion of the study area.

8.6 Watercourse risk assessment

Consideration of the principles and approach described in the DWS Risk Matrix (Gazette No. 49833, Notice 4167 of 2023), highlighted that the proposed pipeline infrastructure posed both ***low*** and ***moderate*** negative impacts to the directly impacted and downstream hydrologically linked watercourses under mitigated conditions (**Table 8-34**, **Table 8-35**, **Table 8-36** & **Table 8-37**).

The assessment considered the impacts of both the construction and operational phases of the development. During the construction phase, activities such as excavating trenches to bury the water pipelines, construction of access roads, vegetation clearing and machinery use were identified as potential risks to the watercourses. These include water contamination from machinery and siltation from earthworks and vegetation clearing. The wetlands in the study area are considered to be more vulnerable to sedimentation and water quality modifications due to their generally slightly gentler gradient and the likelihood that the sediment and pollutants e.g. hydrocarbons, would remain in these systems for longer. The riverine and watercourse systems are less vulnerable to these risks. The construction phase risks were deemed to be ***low*** for the systems that are hydrologically linked to the pipelines (i.e. the pipeline development is occurring within their catchments and not directly within them). However, the construction phase risks for a number of the systems that will be directly affected by the pipeline development (i.e. the pipeline crosses directly through them) were deemed to be ***moderate***. The ***moderate*** risks are predominantly due to the extremely steep nature of the entire study area, which generally increases the risk of erosion, especially when excavation is occurring. Very careful mitigation measures will be required to reduce the risk of erosion, vegetation loss and ultimately the longevity of the pipelines themselves.

The operational risks were all ***low*** given that the main risks are associated with burst pipelines, and with the correct mitigation measures in place, these risks are deemed to be ***low***.

Table 8-34 Watercourse risk assessment activities, impacts and risk ratings for the construction phase for watercourses where the proposed pipelines lie beyond the 28m construction buffer zone.

Phase	Activity	Impact (see Section 8.4)	Affected water-course	Overall intensity (max 10)	Spatial scale (max 5)	Duration (max 5)	Probability / Likelihood	Signifi-cance	Risk Rating	Mitigation Measure
Construction	Development within the catchment of a watercourse (outside the 28m construction buffer). The construction of pipeline infrastructure - assuming appropriate mitigation measures are implemented (refer to Section 9 for mitigation measures)	i) Water contamination from the operation and washing of machinery	Wetland habitat	2.0	4.0	1.0	20%	4.2	L	See 9.2.1 iii), iv), v), vii)
			Riverine habitat	2.0	4.0	1.0	20%	2.8	L	
			Watercourses	2.0	4.0	1.0	20%	2.8	L	
		ii) Siltation of watercourse due to vegetation clearing and earthworks in the catchments	Wetland habitat	2.0	3.0	2.0	20%	4.2	L	9.2.1 i), ii), vi)
			Riverine habitat	2.0	3.0	2.0	20%	2.8	L	
			Watercourses	2.0	3.0	2.0	20%	2.8	L	
		iii) Spread of invasive alien plants as a result of the construction phase disturbances	Wetland habitat	2.0	2.0	2.0	20%	3.6	L	9.2.1 viii), ix)
			Riverine habitat	2.0	2.0	2.0	20%	2.4	L	
			Watercourses	2.0	2.0	2.0	20%	2.4	L	

Table 8-35 Watercourse risk assessment activities, impacts and risk ratings for the construction phase for watercourses where the proposed pipelines lie within the 28m construction buffer zone.

Phase	Activity	Impact (see Section 8.4)	Affected water-course	Overall intensity (max 10)	Spatial scale (max 5)	Duration (max 5)	Probability / Likelihood	Signifi-cance	Risk Rating	Mitigation Measure
Construction	Development within the catchment of a watercourse (within the 28m construction buffer). The construction of pipeline infrastructure - assuming appropriate mitigation measures are implemented (refer to Section 9 for mitigation measures)	i) Water contamination from the operation and washing of machinery	Wetland habitat	2.0	4.0	1.0	20%	4.2	L	**See 9.2.1 iii), iv), v), vii)**
			Riverine habitat	2.0	4.0	1.0	20%	2.8	L	
			Watercourses	2.0	4.0	1.0	20%	2.8	L	
		ii) Siltation of watercourse due to vegetation clearing and earthworks in the catchments	Wetland habitat	2.0	3.0	2.0	20%	4.2	L	**9.2.1 i), ii), vi)**
			Riverine habitat	2.0	3.0	2.0	20%	2.8	L	
			Watercourses	2.0	3.0	2.0	20%	2.8	L	
		iii) Spread of invasive alien plants as a result of the construction phase disturbances	Wetland habitat	2.0	2.0	2.0	40%	7.2	L	**9.2.1 viii), ix)**
			Riverine habitat	2.0	2.0	2.0	40%	4.8	L	
			Watercourses	2.0	2.0	2.0	40%	4.8	L	

Table 8-36 Watercourse risk assessment activities, impacts and risk ratings for the construction phase for watercourses where the proposed pipelines cross the watercourses directly.

Phase	Activity	Impact (see Section 8.4)	Affected water-course and crossing no.	Overall intensity (max 10)	Spatial scale (max 5)	Duration (max 5)	Probability/ Likelihood	Signifi-cance	Risk Rating	Mitigation Measure
Construction	Development within a watercourse - the construction of pipeline infrastructure- assuming appropriate mitigation measures are implemented (refer to Section 9 for mitigation measures)	iv) Direct loss of watercourse habitat due to excavation and installation of pipelines which could be a result of water contamination, siltation or the spread of IAPs.	MHS 2 (T11E-1)	4.0	3.0	2.0	100%	18.0	L	9.2.1 x), xi), xii)
			DEPR 1 (T11E-2)	6.0	3.0	3.0	100%	36.0	M	
			WC 2 (T11E-3)	4.0	2.0	2.0	100%	16.0	L	
			WC 3 (T11E-4)	4.0	2.0	2.0	100%	16.0	L	
			WC 4 (T11E-5)	4.0	3.0	2.0	100%	18.0	L	
			DEPR 3 (T11E-6)	6.0	2.0	3.0	100%	33.0	M	
			TR 2 (T11E-7)	2.0	2.0	2.0	100%	18.0	L	
			WC 5 (T11E-8)	2.0	4.0	2.0	100%	16.0	L	
			WC 6 (T11E-9)	2.0	4.0	2.0	100%	16.0	L	
			MHS 6 (T11E-10)	2.0	4.0	2.0	100%	16.0	L	
			SEEP 6 (T11E-11)	4.0	3.0	2.0	100%	27.0	L	
			MHS 7 (T11E-12)	2.0	3.0	2.0	100%	14.0	L	
			MHS 8 (T11E-13 & T11E-14)	6.0	2.0	2.0	100%	22.0	L	
			MHS 9 (T11E-15)	4.0	3.0	2.0	100%	18.0	L	
			CVB 1 (T11E-16)	4.0	3.0	3.0	100%	30.0	M	

Table 8-37 Watercourse risk assessment activities, impacts and risk ratings for the operation phase

Phase	Activity	Impact (see Section 8.4)	Affected water-course	Overall intensity (max 10)	Spatial scale (max 5)	Duration (max 5)	Probability/ Likelihood	Signifi-cance	Risk Rating	Mitigation Measure
Operation	Operation of water supply pipeline in and around the watercourses (refer to Section 9 for mitigation measures)	v) Burst pipelines could result in additional water inputs into the watercourses and could cause erosion in the watercourses."	CVB 1	4.0	2.0	2.0	20%	4.8	L	9.2.2 i), ii), iii)
			DEPR 1	2.0	2.0	2.0	20%	3.6	L	
			DEPR 2	6.0	1.0	2.0	20%	5.4	L	
			DEPR 3	2.0	3.0	2.0	20%	4.2	L	
			DEPR 4	2.0	2.0	2.0	20%	3.6	L	
			LF 1	2.0	3.0	2.0	40%	11.2	L	
			MHS 1	0.0	4.0	2.0	20%	2.4	L	
			MHS 2	4.0	4.0	2.0	40%	8	L	
			MHS 3	0.0	4.0	2.0	20%	2.4	L	
			MHS 4	0.0	2.0	2.0	20%	1.6	L	
			MHS 5	0.0	4.0	2.0	20%	2.4	L	
			MHS 6	2.0	4.0	2.0	20%	3.2	L	
			MHS 7	4.0	3.0	2.0	40%	7.2	L	
			MHS 8	2.0	2.0	2.0	20%	2.4	L	
			MHS 9	4.0	3.0	2.0	20%	3.6	L	
			MHS 10	0.0	2.0	2.0	20%	1.6	L	
			MS 1	0.0	4.0	2.0	20%	2.4	L	
			MS 2	0.0	4.0	2.0	20%	2.4	L	
			MS 3	0.0	3.0	2.0	20%	2	L	
			MS 4	2.0	4.0	2.0	20%	3.2	L	

Phase	Activity	Impact (see Section 8.4)	Affected water-course	Overall intensity (max 10)	Spatial scale (max 5)	Duration (max 5)	Probability/ Likelihood	Signifi-cance	Risk Rating	Mitigation Measure
			SEEP 1	0.0	2.0	2.0	20%	2.4	L	
			SEEP 2	6.0	3.0	2.0	60%	19.8	L	
			SEEP 3	2.0	2.0	2.0	20%	3.6	L	
			SEEP 4	4.0	3.0	2.0	40%	10.8	L	
			SEEP 5	2.0	3.0	2.0	20%	4.2	L	
			SEEP 6	4.0	3.0	2.0	20%	5.4	L	
			SEEP 7	2.0	2.0	2.0	20%	3.6	L	
			TR 1	0.0	4.0	2.0	20%	2.4	L	
			TR 2	2.0	2.0	2.0	20%	2.4	L	
			UFR 1	2.0	2.0	2.0	20%	3.6	L	
			WC 1	2.0	3.0	2.0	40%	5.6	L	
			WC 2	4.0	2.0	2.0	40%	6.4	L	
			WC 3	4.0	2.0	2.0	40%	6.4	L	
			WC 4	4.0	4.0	2.0	40%	8.0	L	
			WC 5	2.0	4.0	2.0	40%	6.4	L	
			WC 6	2.0	4.0	2.0	40%	6.4	L	
			WC 7	2.0	4.0	2.0	20%	3.2	L	
			WC 8	2.0	4.0	2.0	20%	3.2	L	
			WC 9	4.0	3.0	2.0	20%	3.6	L	
			WC 10	2.0	3.0	2.0	40%	5.6	L	
			WC 11	2.0	3.0	2.0	40%	5.6	L	

Phase	Activity	Impact (see Section 8.4)	Affected water-course	Overall intensity (max 10)	Spatial scale (max 5)	Duration (max 5)	Probability/ Likelihood	Signifi-cance	Risk Rating	Mitigation Measure
			WC 12	2.0	4.0	2.0	20%	3.2	L	
			WC 13	0.0	4.0	2.0	20%	2.4	L	
			WC 14	2.0	4.0	2.0	20%	3.2	L	
			WC 15	2.0	4.0	2.0	20%	3.2	L	
			WC 16	0.0	4.0	2.0	20%	2.4	L	
			WC 17	2.0	4.0	2.0	20%	3.2	L	
			WC 18	2.0	4.0	2.0	20%	3.2	L	
			WC 19	2.0	4.0	2.0	40%	6.4	L	

8.7 Impact Assessment

The five possible impacts to the watercourses were assessed first for a poor mitigation scenario and then for a best-case mitigation scenario. Most of the potential impacts scored ***very low*** or ***low*** in the poor mitigation scenario with the exception of the possible spread of IAPs in the construction and operational phase scoring a ***moderate*** significance rating (**Table 8-38, Table 8-39**). All of the potential impacts in the realistic good mitigation scenario fell within the ***very low*** impact category.

Table 8-38 Impact assessment results for the potential construction phase related impacts

Construction Phase					
Potential Impact	Poor Mitigation		Realistic Good Mitigation		Mitigation Measure Reference
	Aspect	Score	Aspect	Score	
i) Water contamination from the operation and washing of machinery in the catchments of the watercourses.	Intensity	2.0	Intensity	2.0	See 9.2.1 iii), iv), v), vii)
	Extent	2.0	Extent	2.0	
	Duration	1.0	Duration	1.0	
	Reversibility	2.0	Reversibility	2.0	
	Probability	3.0	Probability	1.0	
	Public response	1.0	Public response	1.0	
	Cumulative Impact	1.0	Cumulative Impact	1.0	
	Irreplaceable Loss	1.0	Irreplaceable Loss	1.0	
	Significance Rating	5.3	Significance Rating	1.8	
ii) Siltation in the watercourses due to vegetation clearing and earthworks that will be undertaken in the catchments of the watercourses.	Intensity	3.0	Intensity	2.0	See 9.2.1 i), ii), vi)
	Extent	2.0	Extent	2.0	
	Duration	2.0	Duration	2.0	
	Reversibility	3.0	Reversibility	2.0	
	Probability	5.0	Probability	2.0	
	Public response	1.0	Public response	1.0	
	Cumulative Impact	1.0	Cumulative Impact	1.0	
	Irreplaceable Loss	1.0	Irreplaceable Loss	1.0	
	Significance Rating	12.5	Significance Rating	4.0	
iii) Spread of invasive alien plants into the watercourses as a result of the disturbance during construction.	Intensity	3.0	Intensity	2.0	See 9.2.1 viii), ix)
	Extent	3.0	Extent	2.0	
	Duration	3.0	Duration	2.0	
	Reversibility	3.0	Reversibility	2.0	
	Probability	5.0	Probability	2.0	
	Public response	1.0	Public response	1.0	
	Cumulative Impact	2.0	Cumulative Impact	2.0	
	Irreplaceable Loss	2.0	Irreplaceable Loss	1.0	
	Significance Rating	22.5	Significance Rating	4.5	

Potential Impact	Poor Mitigation Aspect	Score	Realistic Good Mitigation Aspect	Score	Mitigation Measure Reference
iv) Direct loss of watercourse habitat due to excavation and installation of water pipelines.	Intensity	3.0	Intensity	1.0	See 9.2.1 x), xi), xii)
	Extent	2.0	Extent	1.0	
	Duration	3.0	Duration	1.0	
	Reversibility	2.0	Reversibility	1.0	
	Probability	5.0	Probability	5.0	
	Public response	1.0	Public response	1.0	
	Cumulative Impact	1.0	Cumulative Impact	1.0	
	Irreplaceable Loss	1.0	Irreplaceable Loss	1.0	
	Significance Rating	12.5	Significance Rating	5.0	

Table 8-39 Impact assessment results for the potential operational phase related impacts

Operational Phase					
Potential Impact	Poor Mitigation		Realistic Good Mitigation		Mitigation Measure Reference
	Aspect	Score	Aspect	Score	
v) Increased flood peaks, runoff velocity and water quantity due to the increase in hardened surfaces in the catchments, thereby causing increased water inputs (flow modification).	Intensity	2.0	Intensity	2.0	See 9.2.2 i), ii), iii)
	Extent	2.0	Extent	2.0	
	Duration	1.0	Duration	1.0	
	Reversibility	3.0	Reversibility	3.0	
	Probability	3.0	Probability	1.0	
	Public response	1.0	Public response	1.0	
	Cumulative Impact	1.0	Cumulative Impact	1.0	
	Irreplaceable Loss	1.0	Irreplaceable Loss	1.0	
	Significance Rating	6.0	Significance Rating	2.0	

8.7.1 *Cumulative and residual impacts*

In accordance with the EIA requirements, both cumulative and residual impacts were evaluated in the context of this development, as well as other projects planned within the project area. However, a full cumulative impact assessment was not undertaken in this study due to the need for detailed information on future developments within the freshwater ecosystem broader catchments.

To the knowledge of the specialist, there are no additional developments planned in the catchments of the majority of the watercourses, and while there is a higher likelihood of there being developments in the catchments of the Mbashe River (LF 1) and the UFR 1, the details of these developments are not yet known. Further developments with the potential to alter sediment inputs will also contribute to the cumulative impacts to the Mbashe River. Therefore, all developments located within the catchment have to adopt stringent sediment management and monitoring protocols to ensure that their impacts do not further contribute to the cumulative impact on the turbidity and sediment load in the river. Furthermore, the proliferation of IAPs across the length of the Mbashe River is another cumulative impact that needs to be considered. Unchecked and unmanaged proliferation of IAPs along the Mbashe River represents a serious possible cumulative impact. As such, strict mitigation measures and IAP clearing and management plans have to be enforced on all additional developments in the Mbashe River catchment and on properties that are adjacent to the river course.

8.7.2 *Assessment of alternative sites and alternative developments types*

No alternative development types were considered for this project as there are no real practical alternatives to deliver water to houses other than via pipeline. No alternative development locations were assessed either. However, as discussed in **Section 9**, it is the specialists opinion that a number of the currently proposed pipeline alignments should be adjusted in order to reduce the risk and potential impact to the associated watercourses.

9. *MITIGATION MEASURES AND RECOMMENDATIONS*

Considering the loss of freshwater ecosystems within the Eastern Cape, it is recommended that the planning and implementation of any development should adopt a 'nett-gain' approach. This would include the following options for a proposed development:

- Maintaining the current levels of ecosystem integrity and service delivery of the systems within the study area; and/or
- Mitigating impacts of the proposed development on the systems by rehabilitating the habitat within the study area and introducing mitigation measures during the construction and operational phases.

9.1 Pipeline realignments

The specialist is of the opinion that several of the pipeline alignments should be reconsidered prior to construction given their perceived risk and possible impact to the watercourses in the study area. While the mitigation measures that are suggested below would alleviate some of the risks and possible impacts, the most effective mitigation measure would be to realign the pipelines given the inherent risks associated with their current alignments. The realignments include:

- The current pipeline alignment through DEPR 1 crosses the wetland at a very steep and vulnerable point in the wetland, and will likely result in the erosion and destruction of a large portion of the wetland unless very stringent erosion control and stabilisation are instituted while installing the pipeline. A simple realignment, which may reduce the length of pipe required, has been suggested in **Figure 9-1**.
- The current pipeline alignment through DEPR 3 crosses the wetland at a very steep and vulnerable point in the wetland and will similarly likely result in its erosion. A simple realignment, which may reduce the length of pipe required, has been suggested in **Figure 9-2**.
- The current pipeline alignment through CVB 1 crosses the wetland along a slope in the wetland. There is already an existing road crossing and an associated disturbance within the wetland. It is recommended that the pipeline crossing follows the road crossing as depicted in **Figure 9-3**.

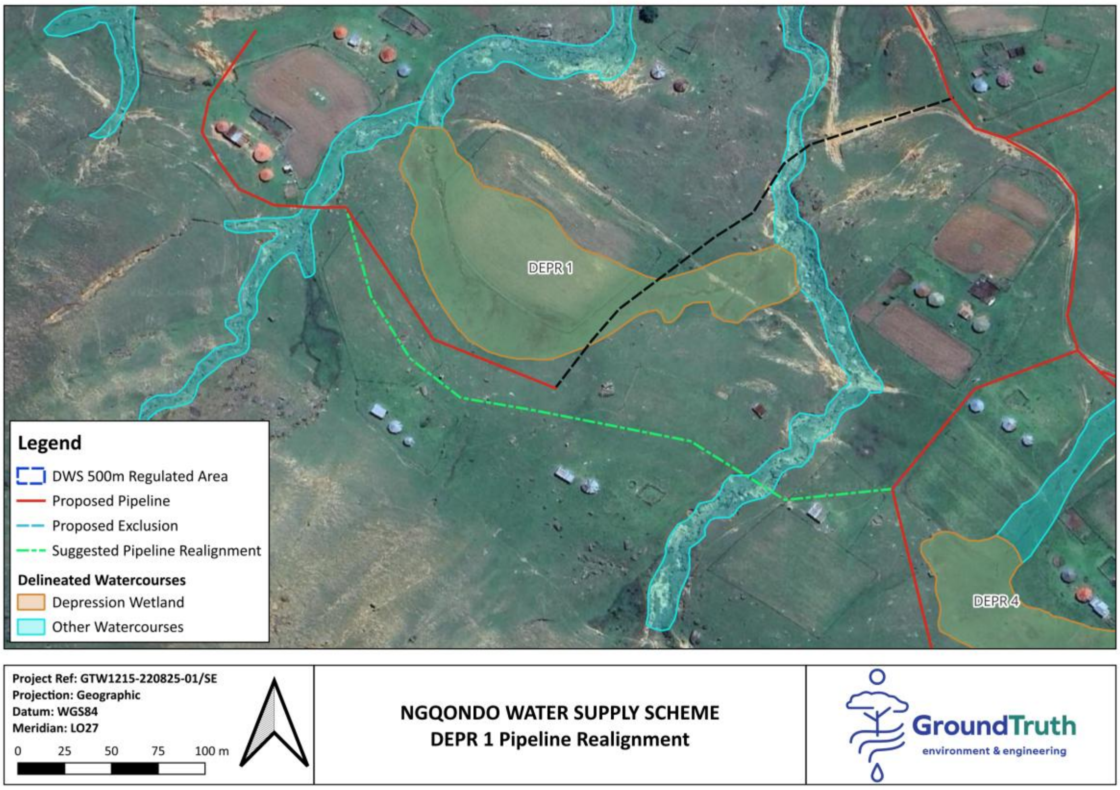

Figure 9-1 **Suggested pipeline alignment to circumvent DEPR 1 and reduce the risk to the freshwater ecosystem.**

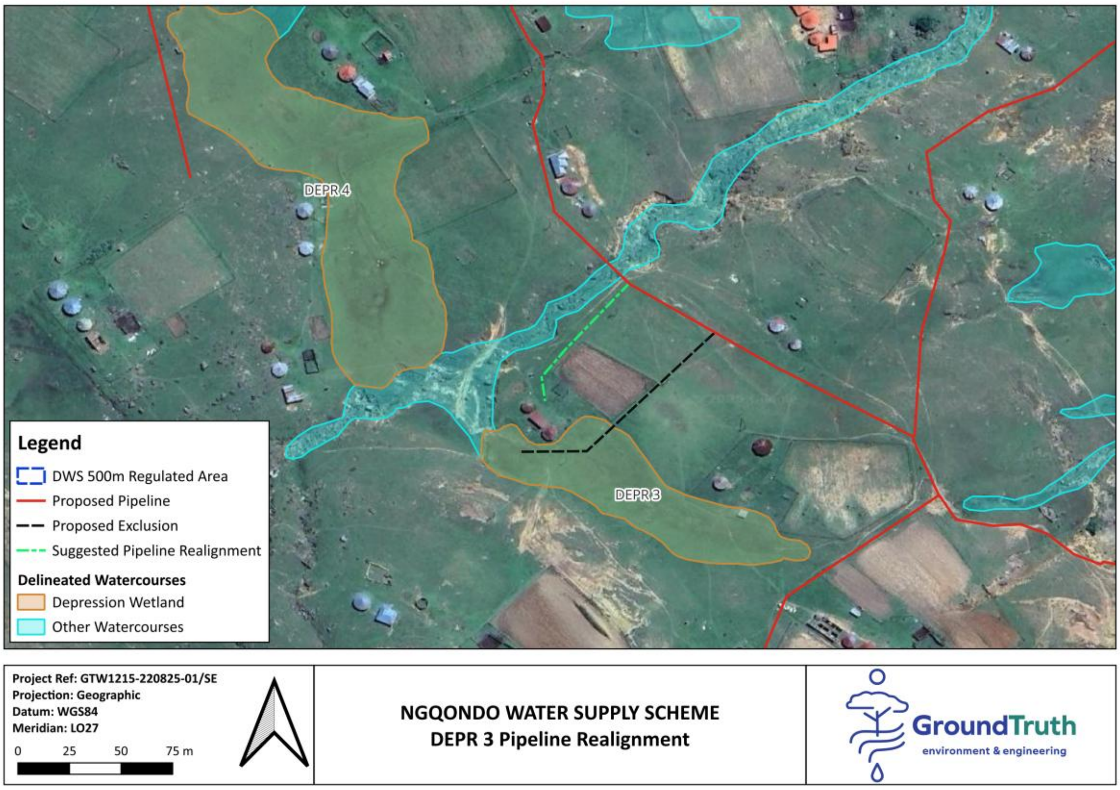

Figure 9-2 **Suggested pipeline alignment to circumvent DEPR 3 and reduce the risk to the freshwater ecosystem.**

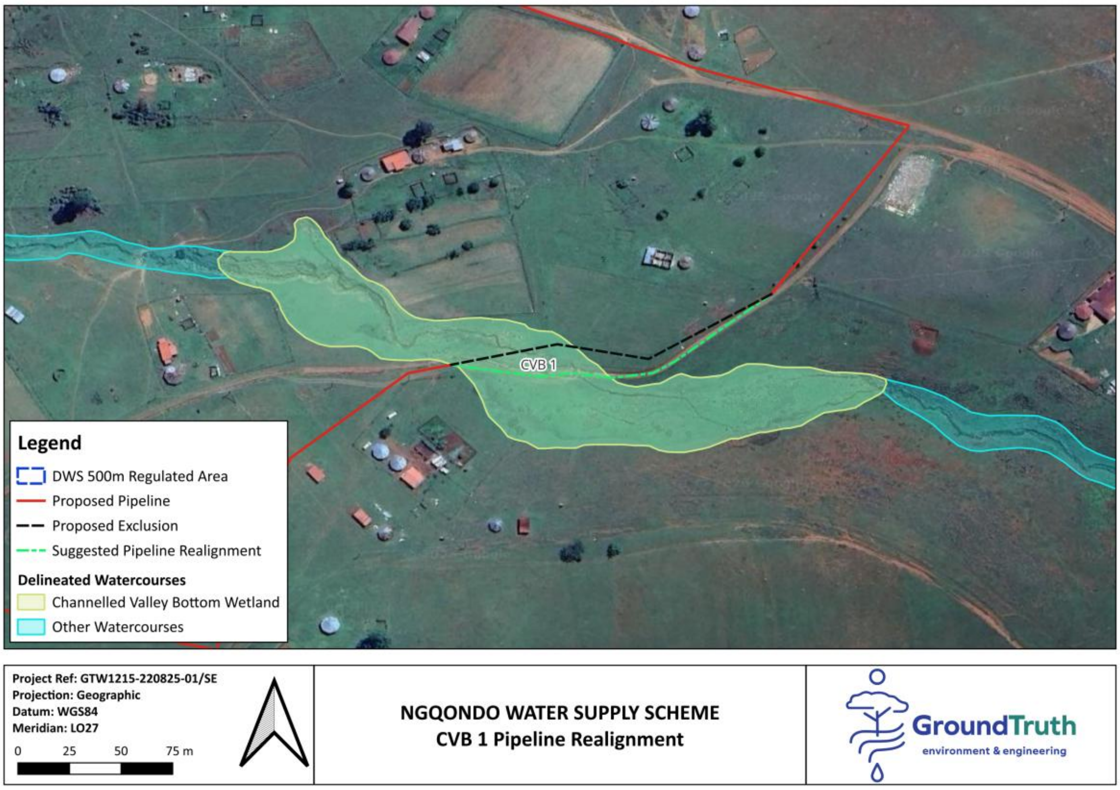

Figure 9-3 Suggested pipeline alignment to cross the wetland along the existing road and reduce the risk to the freshwater ecosystem.

9.2 Mitigation measures

To protect watercourses from impacts linked to adjacent land uses/proposed development, during both the construction and operational phases of an activity, appropriate mitigation measures are generally adopted. In this instance, mitigation activities, including buffer zones, should be incorporated into the development plan. The mitigation measures below are divided between the construction and the operation phase of the development.

9.2.1 *Mitigation during the construction phase*

The following mitigation activities should be incorporated into the development plan to assist in reducing the impacts of the proposed development on the watercourses during the construction phase:

i) The construction zone must be clearly demarcated and the following activities that must be implemented to minimise the area of soil disturbance and the potential for mobilisation of sediments from bare areas include:
   - Soil stabilisation practices such as sediment blankets and mulching, introduced onsite.
   - Earth dikes and diversions to direct all storm flows from disturbed areas into silt traps.

ii) Vegetation should remain intact where possible during the construction phase to limit high surface flows and mobilisation of sediment.

iii) No mixed concrete should be directly deposited on the ground without a mixing tray and any concrete spilled out of the demarcated area should be removed immediately to avoid impacting on the freshwater ecosystems (Macfarlane et al., 2015).

iv) No concrete mixing machinery can be washed onsite. The concrete wash water contains high levels of chromium, which has the potential to contaminate ground and surface water.

v) All vehicles, plant and equipment shall be maintained on a regular basis, to ensure they are all in good working order; and
   - All of the equipment (including vehicles and plant) may only be operated by competent persons;
   - Designated entry and exit points should be demarcated and used by all construction vehicles to gain access to the site;
   - Vehicles must only utilize demarcated roads and turning areas within the construction site to limit the area of impact;
   - All fuels, oils, and lubricants must be stored appropriately. All containers must be inspected on a regular basis for leaks. Should a spill/leak occur, the source will be isolated, and the spill contained. All contaminated soil will be disposed of at the hazardous waste vessel for appropriate disposal at a registered land fill site. Absorbent material must be placed over the spill site, to ensure the complete removal of the spill.

vi) Ensure minimal or no disturbance outside of the development footprint area during construction, and all material arising from the development must be prohibited from entering the freshwater habitats and associated buffer zones.

vii) No hazardous chemicals used and/or spilled during the construction process must enter the riparian zones, wetlands or groundwater. If such a spill occurs during and/or on completion of the construction, a hazardous spill protocol must be implemented and the affected area cleaned up immediately.

viii) Develop and implement an alien plant control programme to manage problematic plant species and prevent further spread and establishment of problem species into all freshwater ecosystems and natural open spaces.

ix) Areas heavily infested with IAPs must be revegetated with indigenous plant species that are suited to the type and composition of the surrounding vegetation (e.g. thicket, forest or grassland).

x) The alignment of the pipeline infrastructure, together with the adjacent working area, should be clearly demarcated prior to the commencement of the excavations. The width of the working area within freshwater ecosystems must be kept to a minimum (12m) to ensure that impacts on these systems are minimised. All activities must be restricted to within the demarcated working area.

xi) Critically, all pipeline alignments that cross a watercourse <u>must</u> be constructed perpendicular to the direction of flow. This is vital to reduce the risk of erosion and scour within the watercourses.

xii) It is assumed that the pipelines will be a buried and therefore the following measures must be implemented when excavating through all watercourses:

  - The topsoil must be removed and stockpiled separately from the underlying sub-soil on either side of the trench.
  - The vegetation must be carefully removed, and suitably stored for replanting upon the completion of the backfilling process (if possible).
  - The excavation must be carried out immediately prior to the laying of the pipeline feature foundations in order to minimise the time during which the trench remains open.
  - The excavated material must be protected from erosion if it is anticipated that it will remain exposed for any length of time. Stockpiles of this material must be positioned on either side of the trenches, keeping the topsoil and the subsoil separate. The following mitigation measures must be put in place for the large-scale earthworks required onsite:
    - Ensure that the correct sediment control measures are put in place such as earth dikes and diversions to direct all storm flows from disturbed areas into silt traps and soil stabilisation practices, such as sediment blankets and mulching, introduced onsite.
  - The subsoil that is replaced over the pipelines must be suitably compacted to reduce risks of erosion.
  - It is critical that vegetation is established immediately after all major earthworks. An approved local indigenous grass seed mixture must be applied to the exposed areas.
  - The grass seed must be watered on a regular basis (i.e. every three days unless there is rain) until the vegetation has established and adequate cover is achieved (i.e. >75%).

xiii) Vegetation must remain intact where possible during the construction phase to limit high surface flows and mobilisation of sediment.

9.2.2 *Mitigation during the operational phase*

i) A leak detection system must be incorporated into the design of the pipelines such that any leaks are detected and dealt with expediently.

ii) Correct and continuous maintenance of infrastructure is essential for their continued functionality.

iii) While the current mitigation measures are considered sufficient for the proposed development footprint, any future expansion of infrastructure or increase in pipelines should trigger a reassessment of cumulative impacts, particularly on hydrology and geomorphology in the downstream freshwater ecosystems.

9.3 Conditions for inclusion in the environmental authorisation

The following items are a series of conditions for inclusion in the Environmental Authorisation for the proposed development:

- A competent environmental control officer (ECO) must oversee the construction and immediate post-construction phases of this development, with freshwater ecosystems as a priority to limit the listed impacts. The ECO must be supplied with a copy of this report and other specialist study reports conducted for this project to familiarise themselves with the mitigation measures and recommendations prior to the commencement of construction.

- The construction activities must be restricted to the approved actual footprint. Ensure minimal or no disturbance outside of the development footprint area during construction, and all material arising from the development must be prohibited from entering the freshwater habitats and associated buffer zones.
- Develop and implement an IAP control program to manage problematic plant species and prevent further spread and establishment of problem species into all freshwater ecosystems and natural open spaces. The development of an IAP management plan must occur prior to the construction and should be implemented simultaneously with the construction.
- In the event where erosion and sedimentation or pollution of the water resource occurs, and where environmental damage is caused, the holder of this environmental authorisation must take responsibility to recover and rehabilitate the damaged ecosystems expediently.

10. CONCLUSIONS

Multiple freshwater ecosystems (including both riverine and were identified within the study area (i.e. the 500m regulated area) and multiple watercourses were similarly identified to be located within the proposed development footprint. An assessment of the freshwater ecosystems' ecological condition indicated a range of PES scores between **A** and **D** for the current scenario. There is not substantial or overall change in the riverine or wetland PES categories from the current to post-development scenario given the limited extent of the proposed development. This is in alignment with the RECs which have been set for each of the wetland and riverine units which indicate that they should be maintained in their current PES category except for the Mbashe River, which should be improved by a category if possible.

An assessment of the overall risks posed to each watercourse indicated that the overall risk to the freshwater ecosystems (provided the mitigation measures are implemented) range from ***low*** to ***moderate***. It is envisaged that these risks could be reduced through the realignment of a number of the pipelines. The impact assessment revealed that without mitigation measures, there is a potential for a ***moderate*** impact to the surrounding environment, however, with appropriate mitigation measures in place, this potential impact can be reduced to a ***low*** or ***very low*** impact.

Considering the information presented in the report, it is the opinion of the specialists from the GroundTruth team that the proposed development could proceed due to the generally low significance of impacts identified, provided that the recommended mitigation measures are properly implemented to limit any potential impacts on sensitive features, particularly those associated with the freshwater environment.

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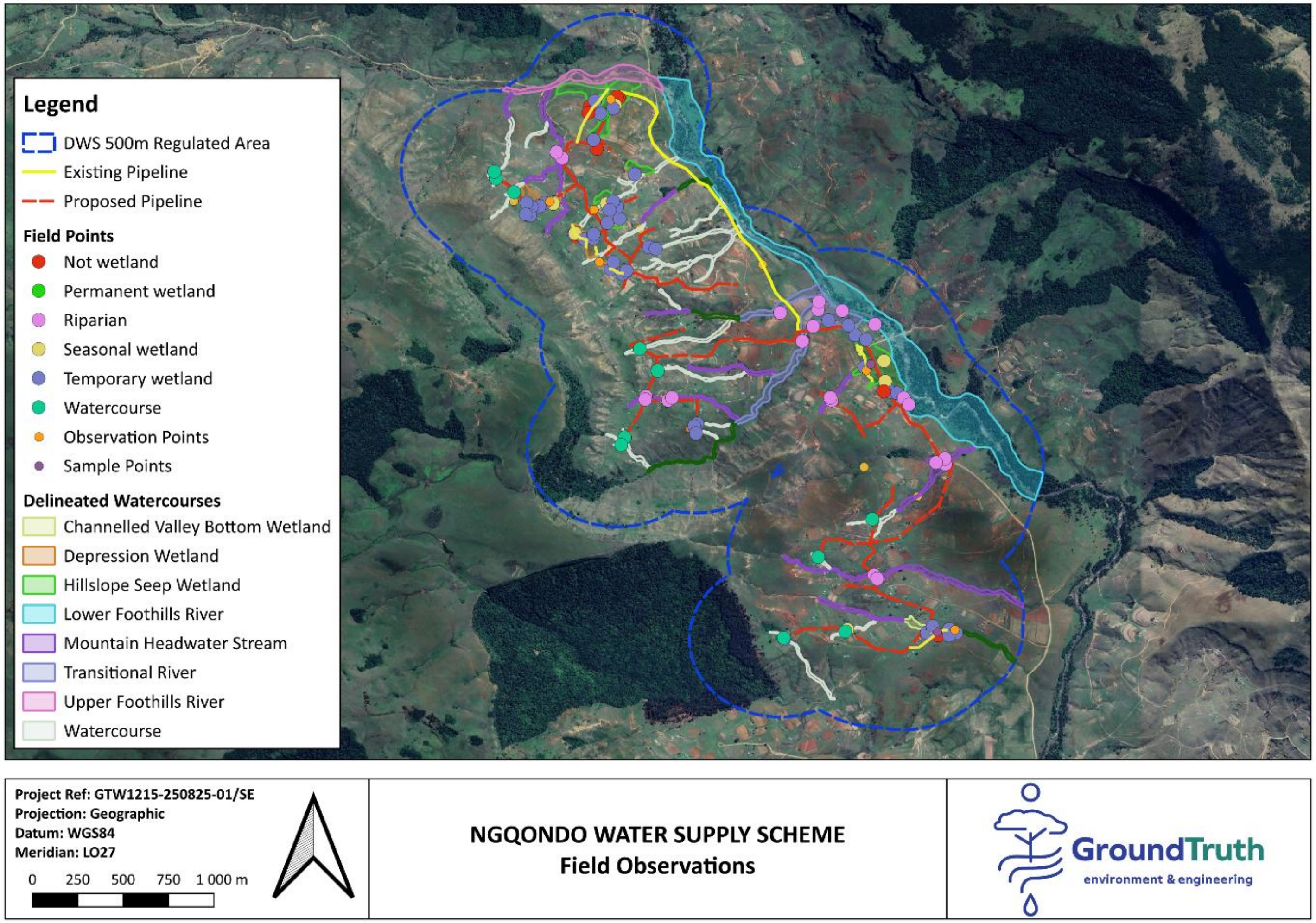
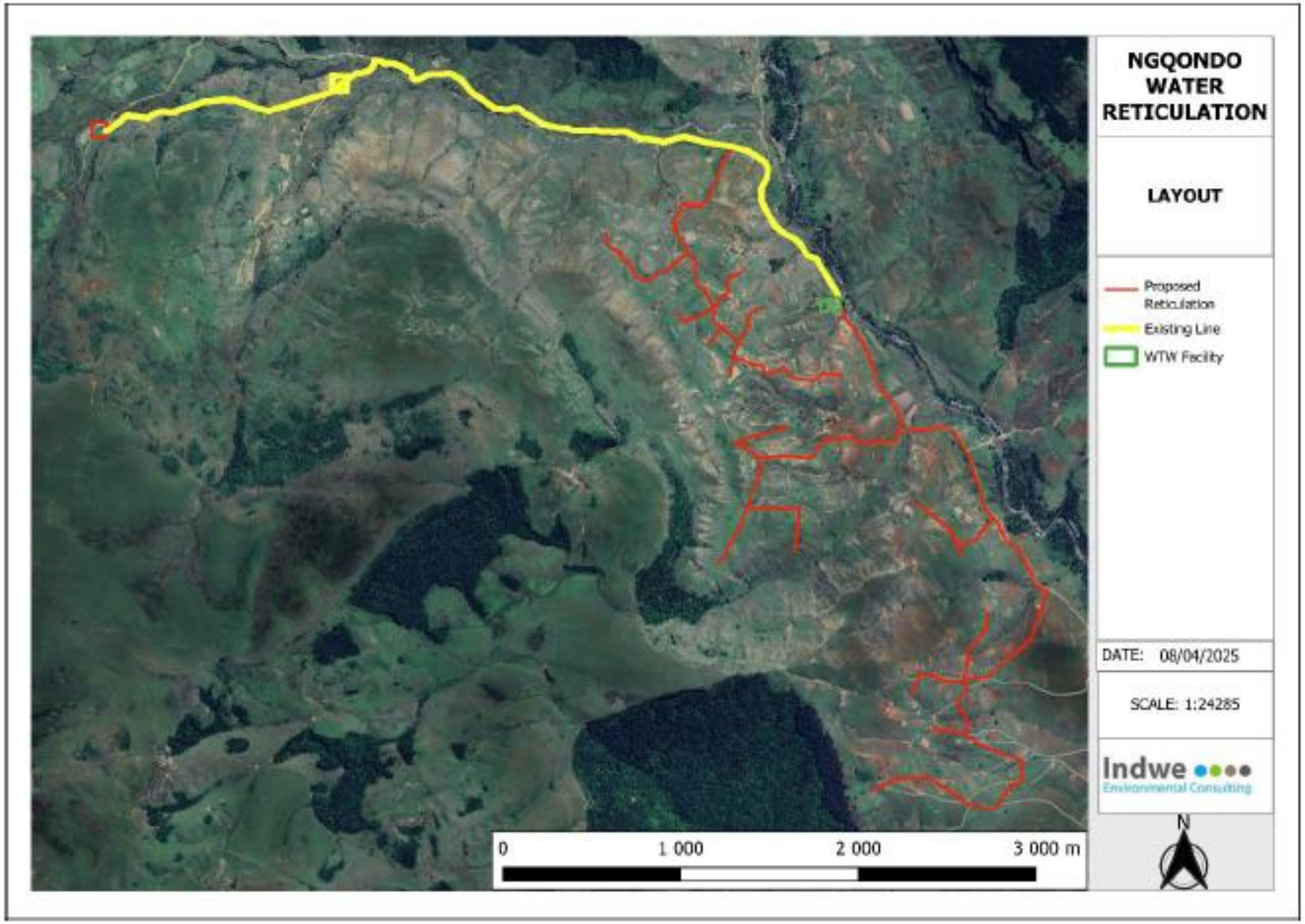
12. APPENDICES

Appendix 1: Field observations and field points



Appendix 2: Proposed development layout as provided by the client.



Appendix 3: A generic risk assessment matrix used to score risks associated with Section 21c and i.

Phase	Activity	Impact	Potentially affected watercourses			Intensity of Impact on Resource Quality					Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)
			Name/s	PES	Ecological Importance	Abiotic Habitat (Drivers)			Biota (Responses)							
						Hydrology	Water Quality	Geomorph	Vegetation	Fauna						
CONSTRUCTION	<1>	<1a>									0			0	none	#VALUE!
		<1b>									0			0	none	#VALUE!
		<1c>									0			0	none	#VALUE!
	<2>	<2a>									0			0	none	#VALUE!
		<2b>									0			0	none	#VALUE!
		<2c>									0			0	none	#VALUE!
	<3>	<3a>									0			0	none	#VALUE!
		<3b>									0			0	none	#VALUE!
		<3c>									0			0	none	#VALUE!
OPERATIONAL	<1>	<1a>									0			0	none	#VALUE!
		<1b>									0			0	none	#VALUE!
		<1c>									0			0	none	#VALUE!
	<2>	<2a>									0			0	none	#VALUE!
		<2b>									0			0	none	#VALUE!
		<2c>									0			0	none	#VALUE!
	<3>	<3a>									0			0	none	#VALUE!
		<3b>									0			0	none	#VALUE!
		<3c>									0			0	none	#VALUE!

Appendix 4: A generic impact assessment spreadsheet used to score potential impacts to inform the environmental impact assessment process.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1																
2	**Construction Phase**															
3	**Impact and Status**			**Consequence**					**Risk Scoring**		**Cumulative Impact Scoring**					
4	**No.**	**Impact description**	**Status**	**Intensity**	**Extent**	**Duration**	**Reversibility**	**Consequence**	**Probability**	**Environmental Significance Rating**	**Public response**	**Cumulative Impact**	**Irreplaceable loss of resources**	**Priority**	**Prioritisation Factor**	**Cumulative Impact Significance**
5	**Realistic 'Poor' Mitigation Scenario**															
6	C1	1. Water contamination from the operation and washing of machinery in the catchments of the aquatic ecosystems.	-1	2	2	1	2	-1.75	3	5.25	1	1	1	3	1	5.25
7	C2	2. Siltation in the aquatic ecosystems due to vegetation clearing and earthworks that will be undertaken in the catchments of the aquatic ecosystems.	-1	3	2	2	3	-2.5	5	12.5	1	1	1	3	1	12.5
8	C3	3. Spread of invasive alien plants into the aquatic ecosystems as a result of the disturbance during construction.	-1	3	3	3	3	-3	5	15	1	2	2	5	1.5	22.5
9	C4	4. Direct loss of wetland habitat due to excavation and install	-1	3	2	3	2	-2.5	5	12.5	1	1	1	3	1	12.5
12								0		0				0		#VALUE!
13	**Realistic 'Good' Mitigation Scenario**															
14	C1	1. Water contamination from the operation and washing of machinery in the catchments of the aquatic ecosystems.	-1	2	2	1	2	-1.75	1	1.75	1	1	1	3	1	1.75
15	C2	2. Siltation in the aquatic ecosystems due to vegetation clearing and extensive earthworks that will be undertaken in the catchments of the aquatic ecosystems.	-1	2	2	2	2	-2	2	4	1	1	1	3	1	4
16	C3	3. Spread of invasive alien plants into the aquatic ecosystems as a result of the disturbance during construction.	-1	2	1	1	2	-1.5	2	3	1	2	1	4	1.5	4.5
21	C4	4. Direct loss of wetland habitat due to excavation and install	-1	1	1	1	1	-1	5	5	1	1	1	3	1	5
27																
28																

Appendix 5: CV of specialist

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Curriculum Vitae – Steven Ellery

Personal Details:

Name:	Steven Ellery
Profession:	Wetland Specialist
Date of Birth:	01 October 1993
Marital Status:	Single
Nationality:	South African

Key Qualifications:

Involvement in a variety of projects over eight years ranging from:

- Wetland rehabilitation implementation support as an ecologist;
- Compliance related projects requiring sound knowledge and understanding of The National Water Act and The National Environmental Management Act;
- Wetland and riparian rehabilitation planning;
- Unmanned Aerial Vehicle (UAV) surveys and photography;
- IFC/IUCN compliant environmental and social impact assessment reporting;
- Nature based solution and ecological infrastructure conceptualisation and design
- Organisation and teaching of wetland and aquatic related courses;
- Citizen science water resource monitoring training;
- Monitoring and evaluating wetland rehabilitation interventions;
- Compilation of monitoring reports;
- Created wetland design and implementation for wastewater treatment purposes;
- Infield delineation of wetland and riparian habitats;
- Desktop mapping and identification of freshwater ecosystems;
- Assessing impacts on wetland ecosystems and calculating functional equivalents for offset/mitigation requirements;
- Remote sensing and imagery generation tools (Maps Made Easy, DroneDeploy, DJIFly, AgiSoft)
- Geographic Information Systems (QGIS, GRASS, MobileMapper, R); and
- Working in Microsoft Project (Word, Excel, Powerpoint, Outlook etc.)

Education and Training:

- 2015 B.Sc. Triple Major (Anthropology, Botany and Environmental Science) – Rhodes University
- 2016 B.Sc. Double Honours (Botany and Environmental Science) – Rhodes University
- 2017 Tools for Wetland Assessment Course – Hosted by Fred Ellery at Rhodes University

- 2018 M.Sc. in Geography specialising in geomorphology and geochemistry – Rhodes University
- 2019 Soils Classification and Land Potential Course at Cedara College of Agriculture
- 2022 Remote Pilots License (RPL) Training – Cortac
- 2024 Remote Pilots License (RPL) Training - HeliCam

Professional Memberships:

- Member – Society of Wetland Scientists
- Member – South African Wetland Society (Board Member 2022-2025)
- Professional Natural Scientist (Pr.Sci.Nat) in Ecological Science – The South African Council for Natural Scientific Professions (Reg. No. 132408)

Experience Record:

2018 to present: GroundTruth – Water, Wetlands and Environmental Engineering Consultants.

Wetland specialist with input into various projects including wetland delineation and assessment, vegetation monitoring, wetland rehabilitation planning and wetland rehabilitation monitoring and evaluation.

2012 to 2016: Rhodes University

Research assistant on multiple research projects where roles included infield data collection, data processing, data analysis and report writing.

Countries Worked in:

South Africa, Mozambique, Lesotho, Nigeria

Examples of Recent and Current Projects:

- Wetland ecologist on the rehabilitation implementation support team at Exxaro Belfast, responsible for bi-monthly progress reports, onsite ecological support and ensuring the wetland rehabilitation was carried out according to the rehabilitation plan
- Project lead and primary wetlander on the Mondi Wetlands project, carrying out long term wetland monitoring and making management recommendations for improved wetland management across Mondi landholdings
- Wetland ecologist on the Total Energies scoping study in Palma, Mozambique, responsible for the compilation of a long-term wetland monitoring and management plan
- Wetland ecologist on the rehabilitation implementation support team at Exxaro Grootegeluk, responsible for bi-monthly progress reports, onsite ecological support, UAV monitoring and ensuring the wetland creation was carried out according to the creation plan
- Wetland ecologist and GIS specialist on the United Nations Office for Project Services (UNOPS) flood alleviation and climate adaptation project in the Zambezi, Limpopo and Bons Sinias estuaries.
- Primary wetlander on the Working for Wetlands Strategic Plan for the province of KwaZulu-Natal
- Project manager, facilitator and presenter on the SAQA accredited Tools for Wetland Assessment Short Course hosted by GroundTruth, Rhodes University, Water Research Commission and Verdant Environmental
- Primary wetlander in KZN for the South African National Biodiversity Institute's Ecological Infrastructure for Water Security field validation project, responsible for the writing, refinement and testing of a new rapid wetland assessment technique and for field validating modelled wetland condition data

- Project manager and primary wetlander on the uMngeni-uThukela Water Baynespruit and iXopo wetland rehabilitation planning projects, responsible for the creation and compilation of wetland rehabilitation plans and long term monitoring and maintenance plans
- Project manager and primary wetland ecologist responsible for the remapping and infield verification of all freshwater ecosystems across Mondi's 255 000ha landholdings
- Project manager, facilitator and presenter on the SACANASP accredited Introduction to Wetland Assessment Short Course hosted by GroundTruth
- Project lead on the Fulbright Specialist Exchange with North Dakota State University and UKZN with a focus on creating a model to predict the pollutant assimilation capacity of natural in-situ wetlands
- Facilitator and presenter at the AfriAlliance Ubuntu Action Group: Upscaling of Citizen Science Tools for Network and Capacity Building in SADC at the AFRESH II workshop
- Wetland ecologist responsible for compiling the wetland reports and the novel 'integration' methodology for the Upper Orange Reserve Study for the Department of Water and Sanitation
- Wetland ecologist partially responsible for compiling the wetland reports and the novel 'integration' methodology for the Fish/Keiskamma-Tsitsikamma Reserve Study for the Department of Water and Sanitation
- Delineation, assessment and rehabilitation planning for Exxaro Grootegeluk wetland offset study
- Wetland ecologist responsible for managing the Free State Working for Wetlands rehabilitation planning projects for the 2020-2022 rehabilitation cycle.
- Wetland ecologist responsible for compiling the iSimangaliso Working for Wetlands rehabilitation plan for the 2014-2019 rehabilitation cycle.
- Delineation, assessment, created wetland design and rehabilitation planning for Mountain Valley created wetland project

Volunteer Work:

- South African Wetland Society trustee (2022-current) – Head of the Communications and Information portfolio, responsible for the initiation and running of the new SAWS Webinar series that started in 2023, maintenance of the SAWS website and the initiation and running of the SAWS blog page.
- Friends of Beacon Hill trustee (2021-current) – responsible for bi-annual UAV monitoring of the grassland and leading alien invasive clearing parties.
- Co-founder of the Hilton Rail Trail organisation and parent NPC (2022-current) – Board member on the Earth and Art NPC, project lead and head strategist on the Hilton Rail Trail project, responsible for leading a team of 11 to implement alien plant clearing, indigenous tree planting and trail creation/maintenance along the Rail Trail.
- Co-supervising a Masters student at UKZN working on completing a feasibility study for the use of UAV technology for wetland monitoring and management
- Co-supervising a Honours student at UKZN working on the pollutant assimilation capacity of rehabilitated wetlands in KwaZulu-Natal
- Mentor to three young wetland professionals (currently) – with a history of mentorship over the last two years

Publications and Presentations:

- Ellery S, Ellery WN, Tsikos H, Dunlevey J. 2024. Depression wetland formation by redoc-driven iron and silica cycling. *Wetlands Ecology and Management* 32, 191-206. https://doi.org/10.1007/s11273-023-09968-7
- Ellery S. 2017 The geochemical origin and evolution of depression wetlands on the African Erosion Surface. Presentation at the National Wetland Indaba in Port Edward, KwaZulu-Natal, South Africa.
- Ellery S. 2018 The geochemical origin and evolution of depression wetlands on the African Erosion Surface. Presentation at the Society of Wetland Scientists Annual Meeting in Denver, Colorado, United States of America.
- Ellery S, Harvey T, Cowden C, Pike T, Dale T. 2022. Wetland rehabilitation as a collaborative, adaptive and iterative process. Presentation at the National Wetlands Indaba in Golden Gate, Free State, South Africa.
- Ellery S, Harvey T, Cowden C, Pike T, Dale T. 2023. Wetland rehabilitation as a collaborative, adaptive and iterative process. Presentation at the Society of Wetland Scientists Annual Meeting in Spokane, Washington, United States of America.
- Eggers F, Ellery S, Cowden C, Pike T. 2023. Re-creating non-perennial pans in semi-arid conditions using substrate from intact pans. Presentation at the Society of Wetland Scientists Annual Meeting in Spokane, Washington, United States of America.