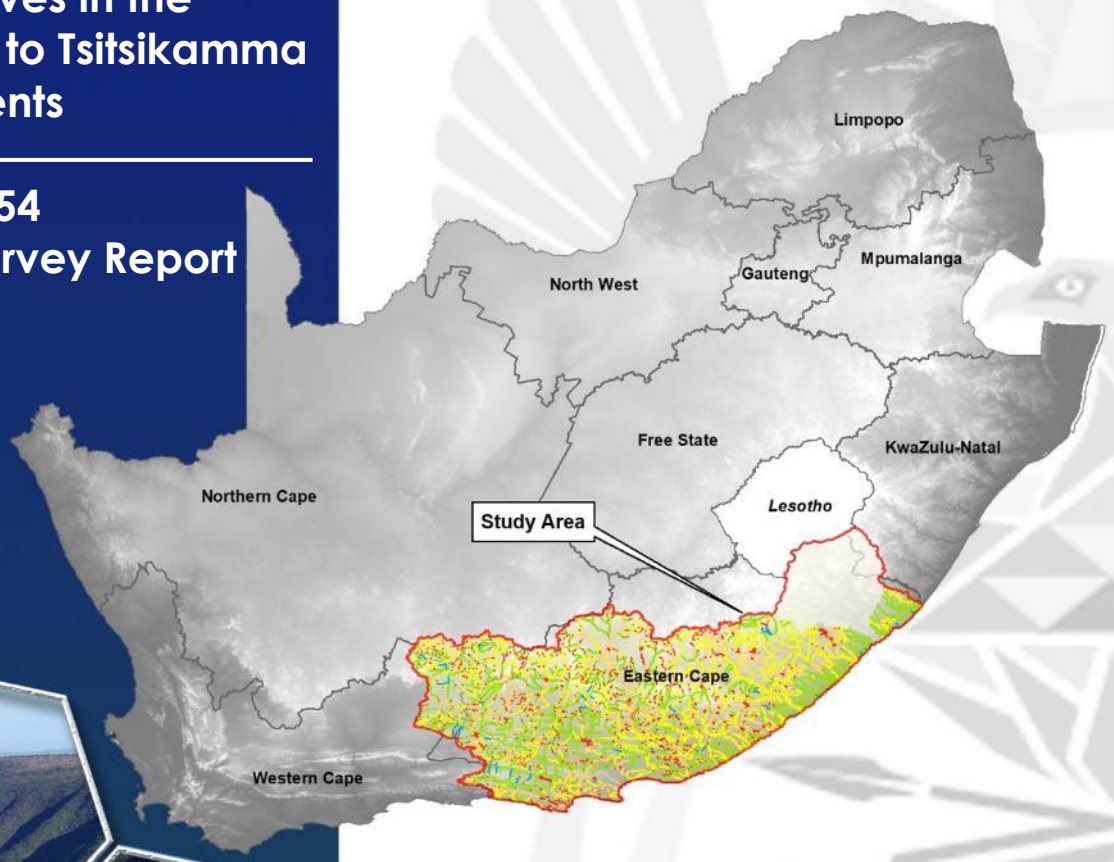
DEPARTMENT OF WATER AND SANITATION

Determination of Water Resource Classes, Reserve and the Resource Quality Objectives in the Keiskamma and Fish to Tsitsikamma Catchments

WP11354
Wetland Field Survey Report



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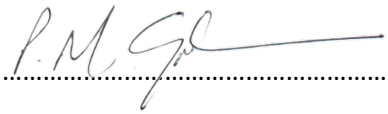

…… 28 September 2022

Dr Mark Graham *Date*

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Project Manager *Scientific Manager*

Approved for the Department of Water and Sanitation by:

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Director: Reserve Determination

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Bold type indicates this report

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Acronym	Definition
AFC	Amatole Forestry Company
BHN	Basic Human Needs
CD:WE	Chief Directorate: Water Ecosystems
DEDEAT	Department of Economic Development, Environmental Affairs and Tourism
DFFE	Department of Fisheries, Forestry and the Environment
DWS	Department of Water and Sanitation
EIS	Ecological Importance and Sensitivity
EWR	Ecological Water Requirements
HGM	Hydrogeomorphic
NFEPA	National Freshwater Ecosystem Priority Area
NWA	National Water Act
PES	Present Ecological State
RDM	Resource Directed Measures
RQOs	Resource Quality Objectives
RU	Resource Unit
WMA	Water Management Area
WRCS	Water Resource Classification System
WRU	Wetland Resource Unit

1. INTRODUCTION

1.1 Background

The National Water Act, 1998 (No. 36 of 1998) (NWA) is founded on the principle that National Government has overall responsibility for and authority over water resource management for the benefit of the public without affecting the functioning of water resource systems. To achieve this objective, Chapter 3 of the NWA provides for the protection of water resources through the implementation of Resource Directed Measures (RDM). These measures are protection-based and include Water Resource Classification, determination of the Reserve and setting the associated Resource Quality Objectives (RQOs). These measures collectively aim to ensure that a balance is reached between the need to protect and sustain water resources, while allowing economic development.

The provision of water required for the maintenance of the natural functionality of the ecosystem and provision of Basic Human Needs (BHN) is the only right to water in the National Water Act (No. 36 of 1998) (NWA). The other water users from a strategic use, who are second in line to other water users, are subject to formal gazetted General Authorization and water use authorization as per Section 21 of the NWA.

The Department of Water and Sanitation, through the Chief Directorate: Water Ecosystems Management (CD: WEM), has initiated a study for the determination of Water Resource Classes, Reserve and associated Resource Quality Objectives for the identified significant water resources in the Keiskamma and Fish to Tsitsikamma catchments. The water resource components included for this study are rivers, wetlands, groundwater and estuaries. The Reserve determination include both the water quantity and quality of the Ecological Water Requirements (EWR) and Basic Human Needs (BHN). This will ensure the availability of water required to protect aquatic systems and that the essential needs of individuals that are directly dependent on these water resources.

1.2 Purpose of this study

The Keiskamma and Fish to Tsitsikamma catchments within the Mzimvubu to Tsitsikamma Water Management Area (WMA7) are amongst many water stressed catchments in South Africa. These areas are important for conservation and have recognisable protected areas, natural heritage, cultural and historical sites that require protection. However, water use from surface as well as groundwater for agricultural and domestic purposes are high, especially in the more arid catchments, impacting on the availability of water resources for the protection of the aquatic ecosystems. Industrial practices and domestic water use are on the rise in some of these catchments, especially around the major towns and cities. Water transfers into the study area from adjacent WMAs and within the study area and numerous storage dams changes the flow patterns, impacting on the aquatic biota.

Thus, the main purpose of the study is to determine appropriate Water Resource Classes, the Reserve and associated RQOs for all significant water resources in the study area to facilitate sustainable use of the water resources while maintaining ecological integrity.

The aim is to:

- implement the Water Resource Classification System (WRCS) (Regulation 810, 2010) to determine the Water Resource Classes,
- follow the integrated framework (DWS, 2017),
- undertake the 7-step process to determine and set RQOs, and
- determine the Reserve for the water resources of the study area.

This will ultimately assist the DWS in the management of the water resources in the study area and making informed decisions regarding the authorisation of future water use and the magnitude of the impacts of proposed developments.

1.3 Purpose of this report

The purpose of this report is to document the wetland field survey of the selected wetland resource units (WRU) and provide feedback on the preliminary findings. Additionally, details on the capacity building aspect of the survey work will be detailed in this report.

2. METHODS

The following section provides an overview of the methodology adopted. It should be noted that this fieldwork report should be read in conjunction with the Resource Unit (RU) Report (DWS 2022), which highlights the selection process for the wetland RUs, and as such, the methodology associated with the selection process has not been repeated in this report.

2.1 Site visit

Two consolidated site visits were conducted from the 25th to the 29th of July and from the 15th – 19th of August to review the greater study area and the selected RUs within the study area (**Figure 2-1**). Additional site visits to the more remote sites were undertaken by members of the team on an *ad-hoc* basis to allow for the field verification of as many of the RUs as possible. The infield review of the RUs allowed for the condition of the wetlands to be reviewed following on from the desktop analysis of the systems.

Limitations

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

- Due to budgetary and time constraints, not all identified RUs were reviewed during the site visit. The RUs visited during the fieldwork, were selected based on the following criteria:
    - Catchment-related impacts;
    - Within-wetland impacts and the relative intactness of the wetland(s);
    - Proximity to a priority river;
    - The current demand for water within the catchment;
    - Proximity of the wetland(s) to priority water supply dams;
    - Whether the wetland is supplying significant and important ecosystem services to local users; and
    - Whether the wetland is a priority wetland according to the NFEPA/FEPA spatial dataset.
- Due to the limited time at each wetland, it was not always possible to see the entire wetland/wetland complex and some desktop-based assumptions have been made.
- Due to the limited time at each wetland, accurate delineation of the wetland boundary could not be undertaken. As such, the majority of the wetland mapping was undertaken utilising a combination of imagery, contour data and limited in-field verification. It should be noted that the RU extents reflected in the following sections represent the initial desktop mapping rather than the amended extents (informed by the field studies) that will used for the subsequent assessments.

2.2 Infield evaluation

A tiered approach was adopted for the review of the selected wetlands. This tiered approach was adopted by the team to prioritise the wetlands that could be visited during the trip and to define the level of assessment and engagement that was going to be undertaken at each visited wetland. **Table**

2-1 provides a summary of the two tiers of assessment that were adopted for the fieldwork. A total of 17 of the 27 wetland RU's were visited during the field survey.

Table 2-1 Tiered approach to the assessment of the wetland resource units identified in the Keiskamma and Fish to Tsitsikamma Catchments

Attributes	Tier 1	Tier 2
Intensity of field verification	Moderately low to moderate intensity, generally involving at least half a day of field verification in the RU	Low intensity - desktop and/or landscape based verification with at least two verification points – 1-2 hours
Level of engagement with landholders and stakeholders	Generally moderately low to moderate. Discussions generally held with at least one key informant, landowner and/or stakeholder	Generally, very low or entirely absent
Level of detail of the wetland descriptions	Generally moderate. In addition to HGM type/s and land-cover class/es, dominant vegetation types and predominant hydroperiod identified and, if possible, red-listed species dependent on the wetland and other key features relevant to management, notably burning and grazing regime.	Generally low but including at least confirmation of HGM type/s and land-cover class/es, from which the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the wetlands is determined by also referring to ancillary desktop-derived data.
Specificity and detail of the Resource Quality Objectives (RQOs)	More specific and containing more detail relating to the specific features of the wetlands, e.g. specific requirements of red-listed wetland-dependent species identified in the wetland/s	Relatively general and limited in detail

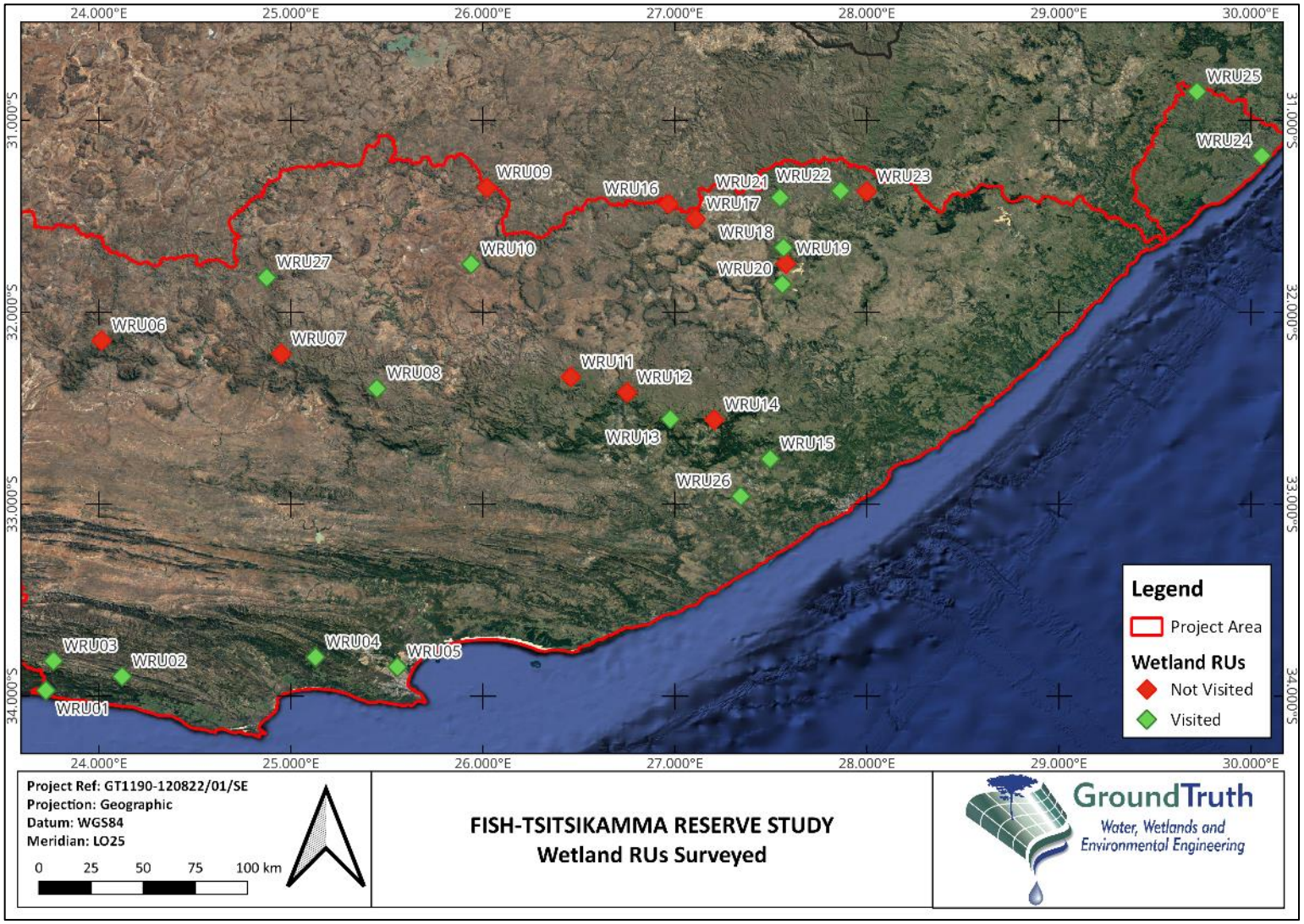

Figure 2-1 Overview of screened sites that were visited during the fieldtrip

3. FIELDWORK DETAILS

3.1 WRU01 – Tsitsikamma Plains Wetlands

Dates:	**Fieldwork Team:**
1st and 2nd March 2022	Donovan Kotze and Pumla Dlamini

Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU01 – Tier 2	33°58'11.87"S 23°43'28.43"E	The Tsitsikamma plains, centred around Storms River Village, has a naturally high extent of wetlands, which are predominantly valley bottom (channelled and unchannelled) with lateral seeps. Most of these wetlands fall within either plantation forestry land or private farmland focused on dairy production. In the dairy farmland, most of the wetlands have been largely converted to cultivated pastures, while in the forestry plantation areas, most wetlands are largely unplanted, but closely surrounded by pine plantations, for which the narrow wetlands have been most severely affected by the desiccating and shading edge-effects of the plantations, resulting in many of these wetlands now being dominated by opportunistic species such as bracken fern (*Pteridium aquilinum*). In contrast, some of the broader wetlands still contain extensive intact natural vegetation, which is characterized by restios (e.g. *Platycaulos callistachyus*), shrubs, notably the near-threatened Garden Route Conebush (*Leucadendrom conicum*) and the grass-like *Cliffortia graminae*, and sedges, notably *Carpha glomerata*. The wetland also supports a diversity of fauna, including the vulnerable dragonfly *Syncordulia venator*, and the vulnerable Grass Owl, *Tyto capensis*. The wetland ranges from temporarily saturated through seasonally- to permanently saturated, with some of the latter areas supporting organic soils, which appear more prevalent closer to the mountains, where groundwater input fed from the Table Mountain Group Sandstones is more likely. Where intact, the Tsitsikamma plains wetlands present a special case for landscape-level conservation by providing a corridor network that links the coastal strip and the mountains. While much of the mountains and an extended strip of the coastline are formally conserved within the Tsitsikamma National Park, the great majority of the plains is not.

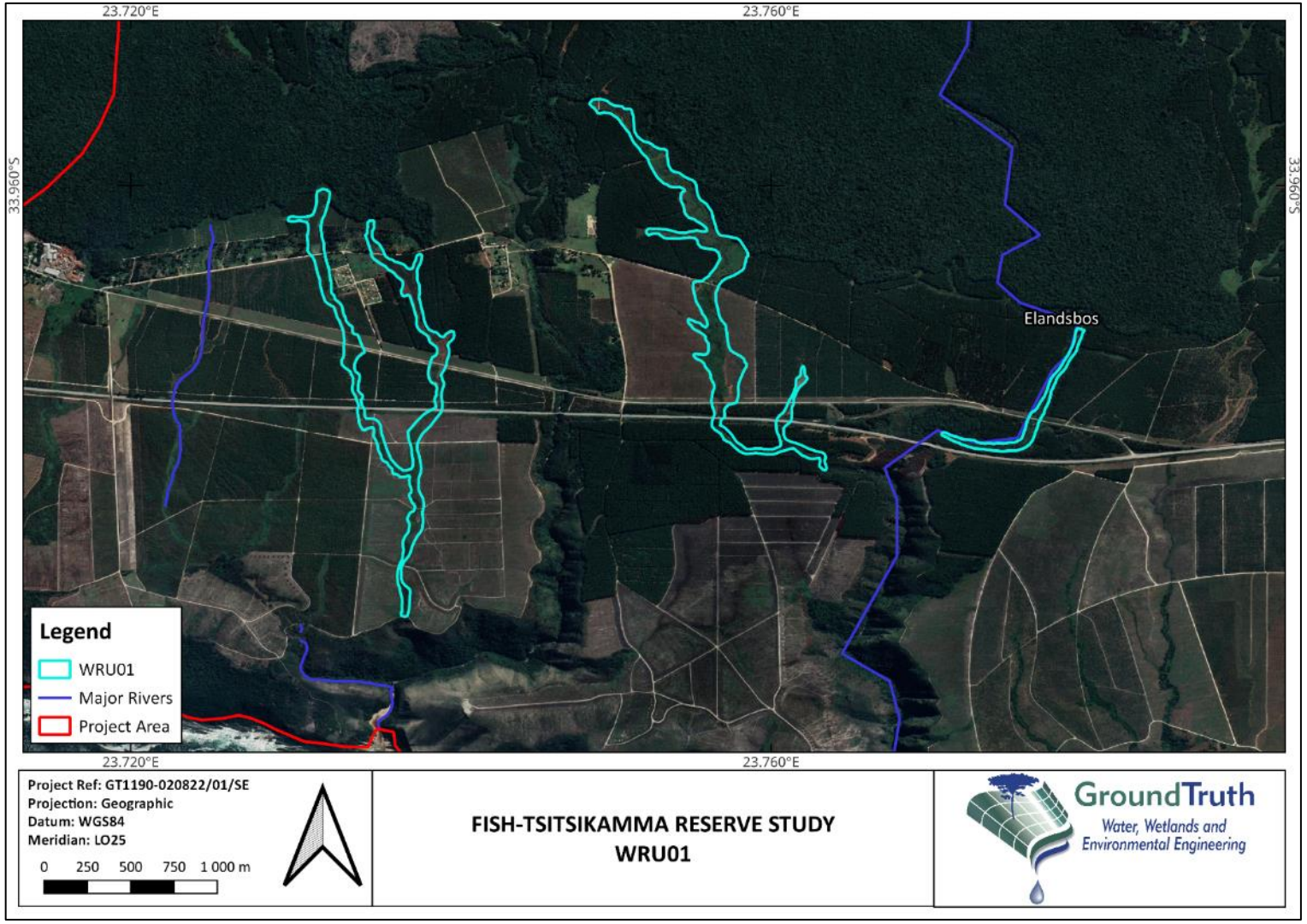

Figure 3-1 Overview of WRU01

Photo Log

Figure 3-2 **Channelled valley bottom dominated strongly by palmiet (*Prionium serratum*), especially in the central wettest portions, and moderately infested with invasive alien plants, especially on its margins.**

Figure 3-3 **An area of channelled valley bottom with a mix of restios (*Restio panicuata*), the grass-like shrub *Cliffortia graminae* and a margin now strongly dominated by the bracken fern (*Pteridium aquilinum*). Also, pine plantations can be seen extending very close to the wetland margin.**

Figure 3-4 **An unchanneled valley bottom with restios (*Platycaulos callistachyus*) and the near-threatened Garden Route Conebush (*Leucadendrom conicum*)**

Figure 3-5 **A hillslope seep wetland area near the Kareedouw pass, comprising a mix of restios (notably *Platycaulos callistachyus*) and shrubs (notably *Protea mundii* and *Berzelia intermedia*).**

Figure 3-6 **An historically disturbed and now infrequently burnt wetland area in poor ecological condition, which is dominated by bracken fern, with a few typical wetland species such as *Berzelia intermedia* as well as several *Halleria lucida* shrubs, a forest precursor species.**

Figure 3-7 **The edge of wetland lying close to a forest plantation, which has favoured the fern *Hypolepis sparsisora*, typically adapted to forest margin situations. Visible in the foreground, and further into the wetland, are typical wetland species *Carpha glomerata* and *Cliffortia graminae***

Figure 3-8 **A relatively broad valley bottom wetland, with the tall shrub *Berzelia intermedia* (see insert), which is a facultative wetland species, dominating the margin of the wetland adjacent to the tree plantations**

Figure 3-9 **Sphagnum moss growing in the wetland shown above in the core wettest area of the wetland, which has organic soils.**

3.2 WRU02 – Kromme Wetland

Dates:	**Fieldwork Team:**
29th July 2022	Donovan Kotze

Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU02 – Tier 2	33°53'47.52"S 24°07'16.30"E	The wetland, which falls within privately owned farmland, comprises predominantly channelled valley bottom and, to a lesser extent, a few sections of unchannelled valley bottom, extending along a 36 km length of the Kromme River east of Joubertina town. A series of relatively broad (>300 m wide) wetland basins are each connected by relatively narrow (<150 m wide) sections. Two of the basins are dominated by some of the largest intact areas in South Africa of palmiet (*Prionium serratum*) peatland wetland, nationally-recognized as threatened. The remaining five basins are characterized by a mosaic of indigenous shrub, restios, *Phragmites australis*, mixed grasses and palmiet. While one of these basins is entirely uncultivated, the other four basins have, to varying degrees, been converted to cultivated land. The wetland ranges from permanently saturated through to seasonally- to temporarily saturated, and is maintained by direct precipitation, inflows from its upstream catchment and lateral inflows, which include extensive subsurface water (both groundwater and interflow) from the surrounding sandstones and quartzites of the Nardouw Subgroup and Peninsula Formation, which move through preferential flow paths in the alluvial fans (Tanner et al. 2019). Four of the basins have been the focus of major wetland rehabilitation interventions by Working for Wetlands to halt major head-ward advancing erosion. There has also been considerable clearing by Working for Water of invasive alien plants along much of the length of the wetland. However, the extent of young black wattle trees (*Acacia mearnsii*) in the wetland has recently increased greatly, and the need for follow-up clearing is considerable given the potentially major impacts that these trees can have directly on the wetland and the volume of water available for downstream water users. The wetland has a high importance in terms of regulating ecosystem services, including trapping of sediment and regulating stream flows, which both make key contributions to water storage in the downstream Churchill Dam, which supplies the Gqeberha metropolitan area.

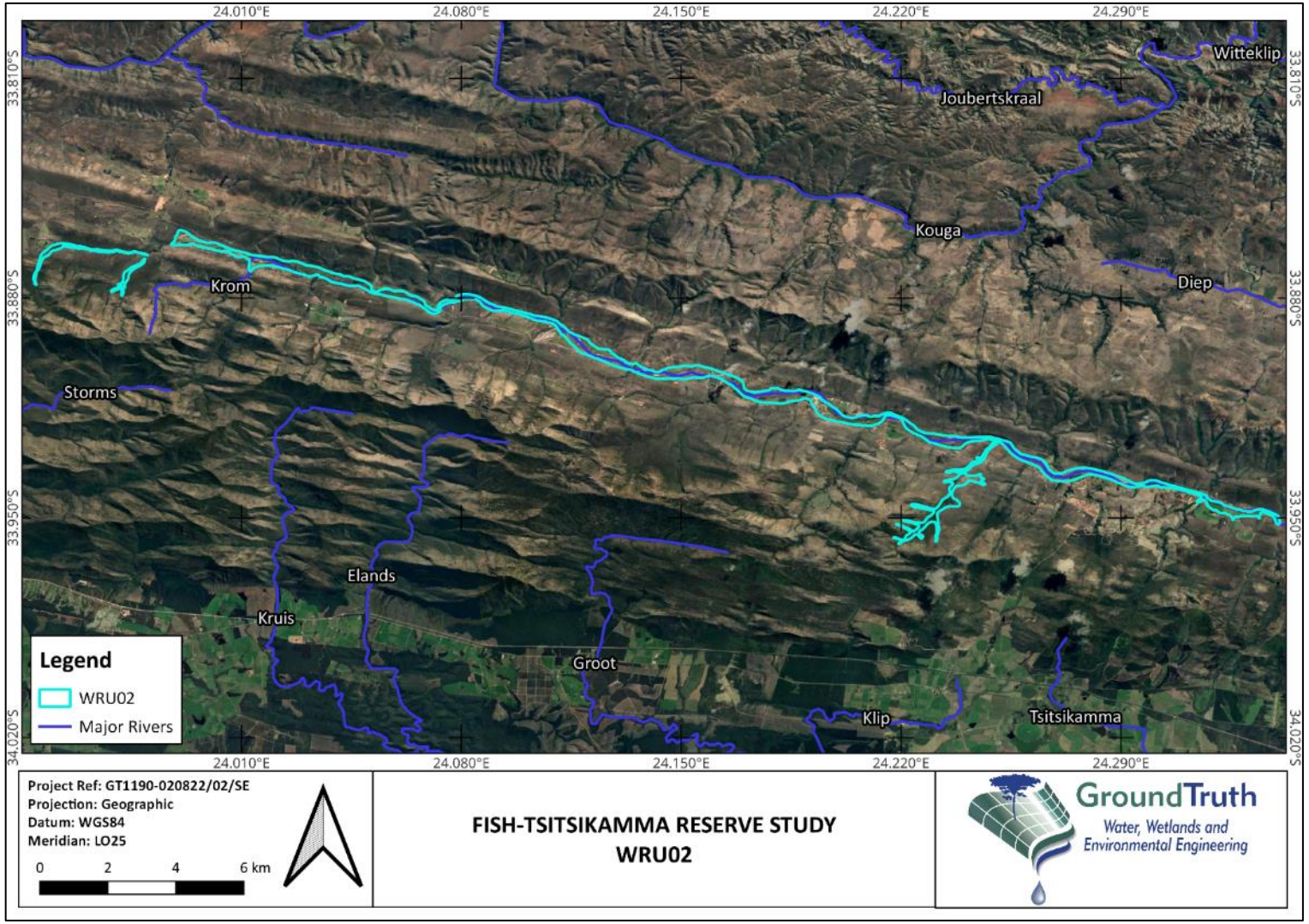

Figure 3-10 Overview of WRU02

Photo Log

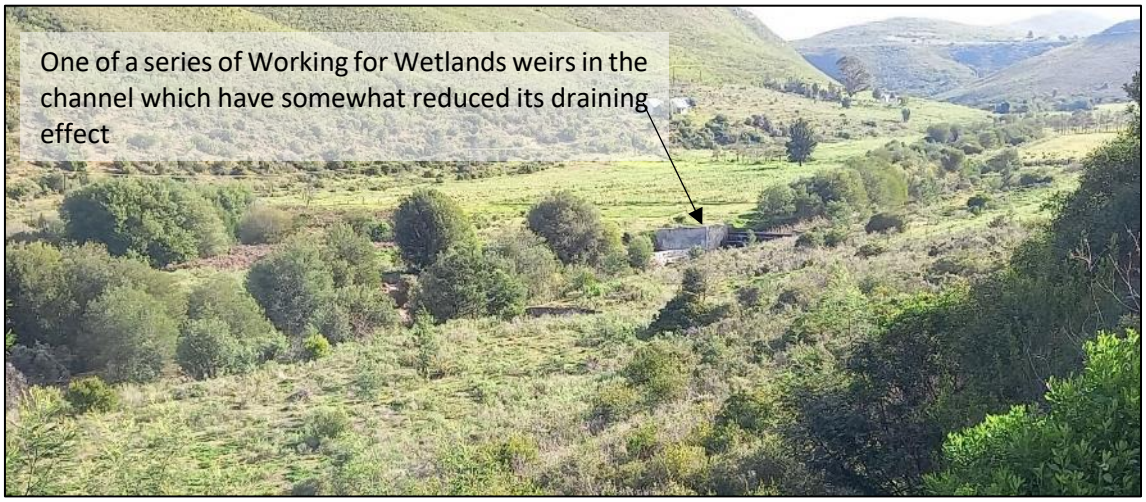

Figure 3-11 **The inflow portion of the wetland, highly transformed by agricultural development over most of its surface and with an excavated and incised central channel with invasive alien infestation along its entire length.**

Figure 3-12 **The upstream end of the Krugersland Basin portion of the wetland, with its largely-intact natural vegetation comprising restios (e.g. *Restio paniculata*) and shrubs (e.g. *Cliffortia strobolifera*) and scattered young black wattle (*Acacia mearnsii*) trees.**

Figure 3-13 **The main Krugersland Basin portion of the wetland, dominated by an extensive palmiet (*Prionium serratum*) area**

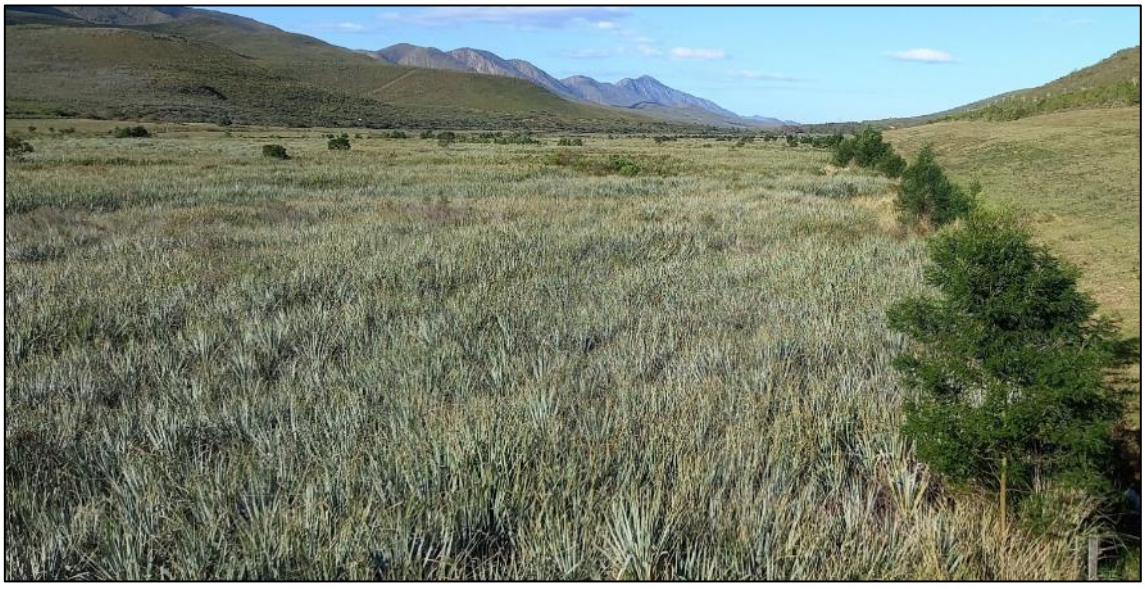

Figure 3-14 **The main Kompanjiesdrif Basin portion of the wetland, also dominated by extensive palmiet, and with scattered young black wattle trees, especially on the margins.**

Figure 3-15 **Two major rehabilitation weirs lying at the downstream end of the Kompanjiesdrif Basin, and which continue to prevent the headward advance of a major erosion gully threatening the basin's palmiet wetland. Also visible are localized dense infestations of young black wattles**

Figure 3-16 **The upper portions of the Hendrikskraal basin, including areas under orchards as well as under intact natural vegetation and historically-cultivated semi-natural vegetation, both with scattered black wattles.**

Figure 3-17 **The lower portions of the Hendrikskraal basin with largely natural vegetation (recently burnt) and a low infestation of invasive alien trees.**

Figure 3-18 **The middle portions of the Jagersbos basin comprising predominantly natural vegetation, but with cultivated pastures on the margins.**

Figure 3-19 **The lower portions of the Jagersbos basin, with extensive cultivation of dairy pastures and a central area of natural vegetation dominated mainly by *Phragmites australis* and with extensive black wattle infestation.**

Figure 3-20 **The upper portions of the Assegaaibosch basin with the shrub *Cliffortia strobolifera,* common reed (*Phragmites australis*) and palmiet, together with a high level of infestation of young *Eucalyptus sp*. and wattle trees**

Figure 3-21 **The mid portions of the Assegaaibosch basin comprising mainly indigenous vegetation, including common reed (*Phragmites australis*) the grass *Pennisetum macrourum*, the shrub *Cliffortia strobolifera* and palmiet, and with both scattered and localized dense infestations of young black wattle.**

Figure 3-22 **The lower portion of the Assegaaibosch basin (immediately upstream of the R62 bridge over the Kromme River) extensively infested with young black wattle.**

3.3 WRU03 – Krakeel Wetland

Dates:	**Fieldwork Team:**
28th February 2022	Donovan Kotze

Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU03 – Tier 1	33°48'56.51"S 23°45'49.03"E	The Krakeel wetland, located immediately west of Joubertina town in private farmland, consists of two main portions, the first associated with the Krakeel River and the second with the Wabooms River. Both are predominantly channelled valley bottoms, but it would appear that prior to human modification there were also areas of unchannelled valley bottom which have subsequently become channelized. The vegetation in the intact wetland comprises a mosaic of palmiet (*Prionium serratum*), common reed (*Phragmites australis*) and mixed shrub/restio/sedge/grass (including *Cliffortia strobolifera*, *Restio paniculata*, *Psoralia* spp., *Cyperus textilis* and *Pennisetum macrourum*). Invasive alien plants, particularly black wattle, occur extensively in the intact natural areas. The wetland ranges from permanently saturated through to seasonally to temporarily saturated, and appears to be maintained by direct precipitation, inflows from its upstream catchment and lateral inflows. Only 29% of the wetland remains under natural vegetation, and the predominant land use in the wetland and in the areas immediately surrounding the wetland are fruit orchards, together with several farm dams. The wetland has a high importance in terms of ecosystem services, not only in terms of provisioning services for water storage and areas for cultivation but also in terms of regulating services, particularly with respect to the remaining intact areas enhancing water quality which has been compromised by the high level of intensive agriculture in the wetland and its nearby catchment.

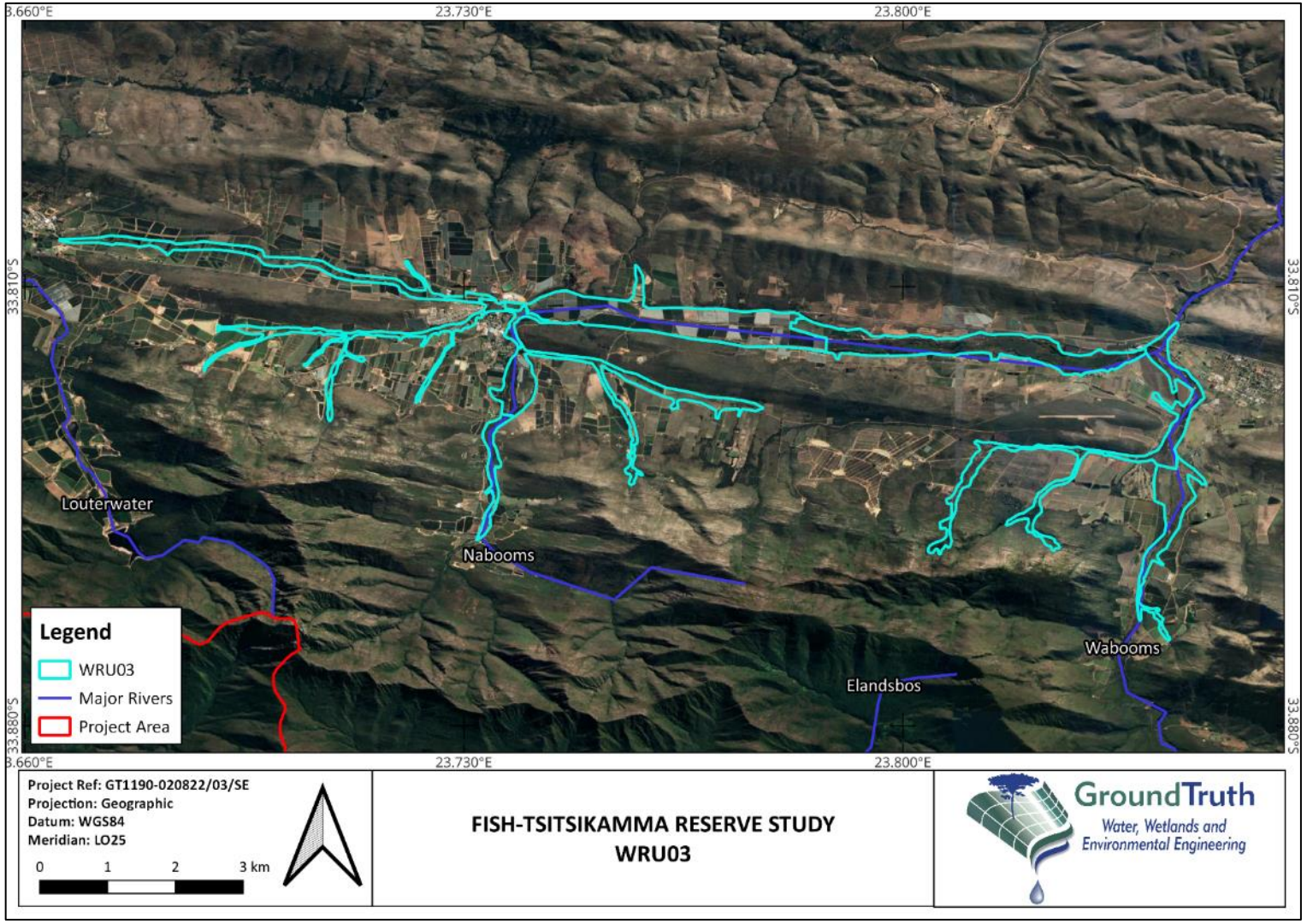

Figure 3-23 Overview of WRU03

Photo Log

Figure 3-24 **The wetland in the upper reaches of the Krakeel River (visible in the foreground) comprising a mosaic of orchards, dams and semi-natural wetland (with large clumps of the invasive alien Spanish reed, *Arundo donax*, while extensive orchards adjacent to the wetland can be seen in the middleground and an area of natural vegetation in the catchment infested with IAPs.**

Figure 3-25 **Mixed restio/sedge/grass/shrub vegetation in Krakeel portion of the wetland, with a clump of young black wattle trees visible to the extreme left**

Figure 3-26 **The Wabooms River with flanking palmiet (left) and mixed shrub/restio vegetation (right)**

Figure 3-27 **The transition between the central portion of the Krakeel wetland which is highly developed to orchards and the lower portion which is under natural and semi-natural vegetation with extensive invasive alien plant infestation, in particular black wattle. Also visible is a drainage furrow associated with the orchard development**

3.4 WRU04 – Longmore Wetland

Dates:	**Fieldwork Team:**
25th July 2022	Donovan Kotze and Pumla Dlamini

Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU04 – Tier 2	33°53'47.52"S 25°07'42.80"E	The wetland, which occupies much of the drainage network of the upper Bulk River catchment, comprises predominantly valley bottom wetland fed laterally by hillslope seeps. The vegetation is a diverse mix of shrubs (*Cliffortia graminae*, *Leucadendron conicum*, *Psoralia* spp. and the vlei boegoe, *Empleurum unicapsulare*), restios (*Elegia fistulosa* and *Platycaulos callistachyus*), sedges (*Carpha glomerata*), grass (*Miscanthus capensis*) and palmiet. Although much of the wetland's catchment has been planted to pine trees, the wetland vegetation is still close to natural and the extent of invasive alien plants is limited, although some of the minor tributary arms of the wetland lying in steep-sided valleys have localized infestations, as well as being subject to an expanding extent of the indigenous forest-pioneer tree the Keurboom (*Virgilia divaricata*). Together with the invasive alien trees, this species poses a threat to the wetland's native vegetation, as well as likely having higher transpiration rates than the native vegetation described above, and therefore reducing water outflows from the wetland. Some localized erosion in the wetland has been noted, including two headcuts in the main body of the wetland, but over the last few decades these have not actively advanced. Nevertheless, they remain a threat to the wetland. In particular, if the erosion headcut at the outflow of the lowermost valley bottom portion of the wetland were to advance it is likely to result in direct habitat loss and desiccation of the lateral wetland areas favoured by the Vanstadensberg honeybush tea *Cyclopia longifolia*, which is a critically endangered wetland species with an extremely restricted geographical distribution. In addition to the extremely high biodiversity importance of the wetland (owing to its condition, high diversity and threatened species) the wetland also makes an important contribution to streamflow regulation and limits sedimentation of the water supply dam located shortly downstream of the wetland's outlet.

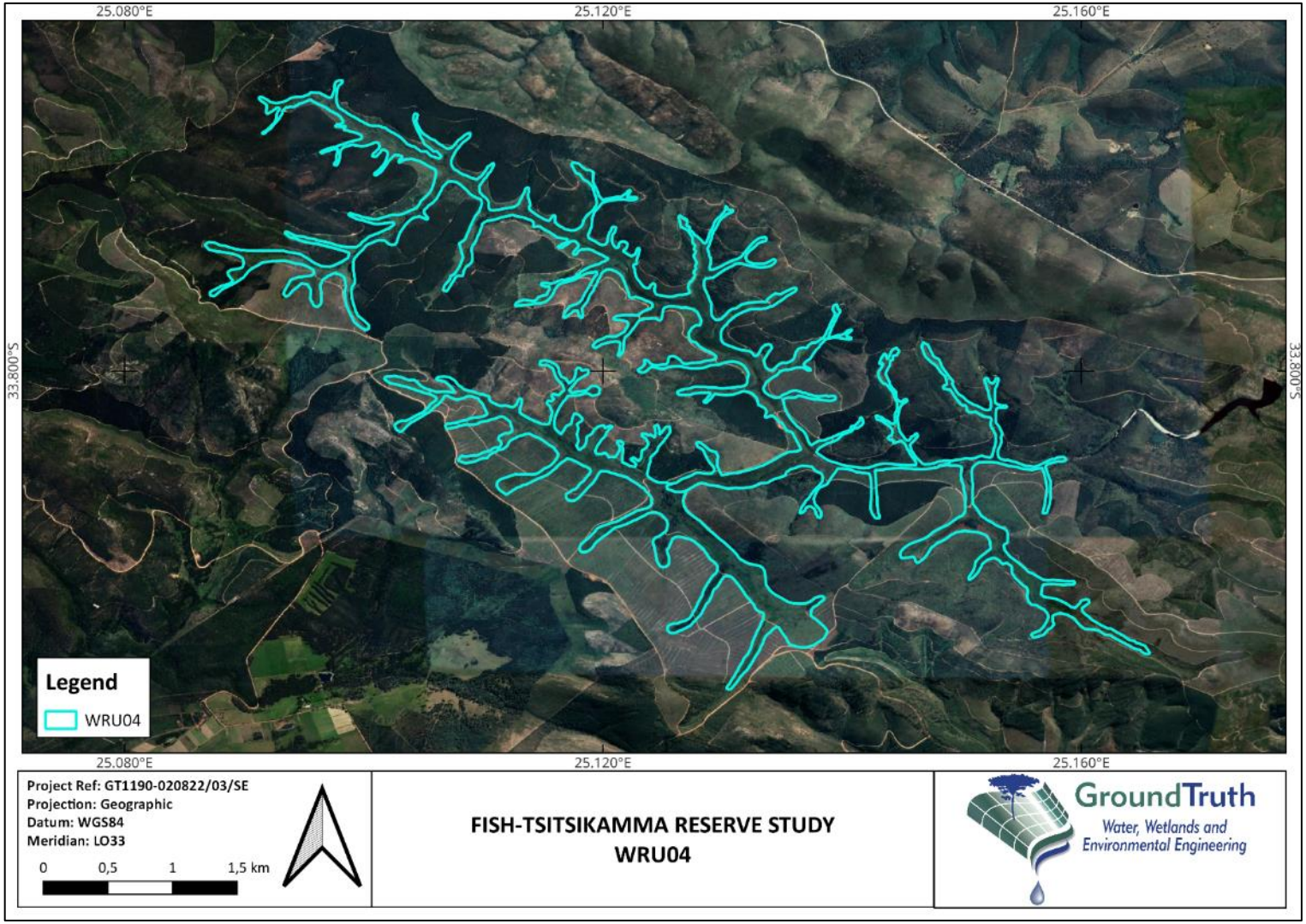

Figure 3-28 Overview of WRU04

Photo Log

Figure 3-29 **A valley bottom area with intact natural vegetation comprising a mix of restios (*Platycaulos callistachyus*), sedges (*Carpha glomerata*) and the grass-like shrub (*Cliffortia graminae*), and almost entirely free of invasive alien plants.**

Figure 3-30 **A hillslope seep area with intact natural vegetation comprising a diverse mix of shrubs (*Erica* spp., *Psoralia* spp. and the vlei boegoe, *Empleurum unicapsulare*), restios (*Elegia fistulosa*) and grass (*Miscanthus capensis*) and also almost entirely free of invasive alien plants.**

Figure 3-31 **A valley bottom wetland comprising intact natural vegetation with a low density of invasive alien plants and a relatively generous wetland buffer, which is mostly clear of invasive alien plants, especially to the right. The buffer was expanded greatly to its current position after the major fire of 2005 and when the tall pine trees in the buffer on the left are harvested they will not be replanted.**

Figure 3-32 **A narrow wetland area in a steep-sided valley. In the wetland buffer to the left are some mature pine trees (also visible in the previous photo) and in the wetland is a dense clump of the indigenous forest-pioneer tree the Keurboom (*Virgilia divaricata*), both of which escaped the 2017 fire. In the buffer to the right are scattered pine trees established after the 2017 fire.**

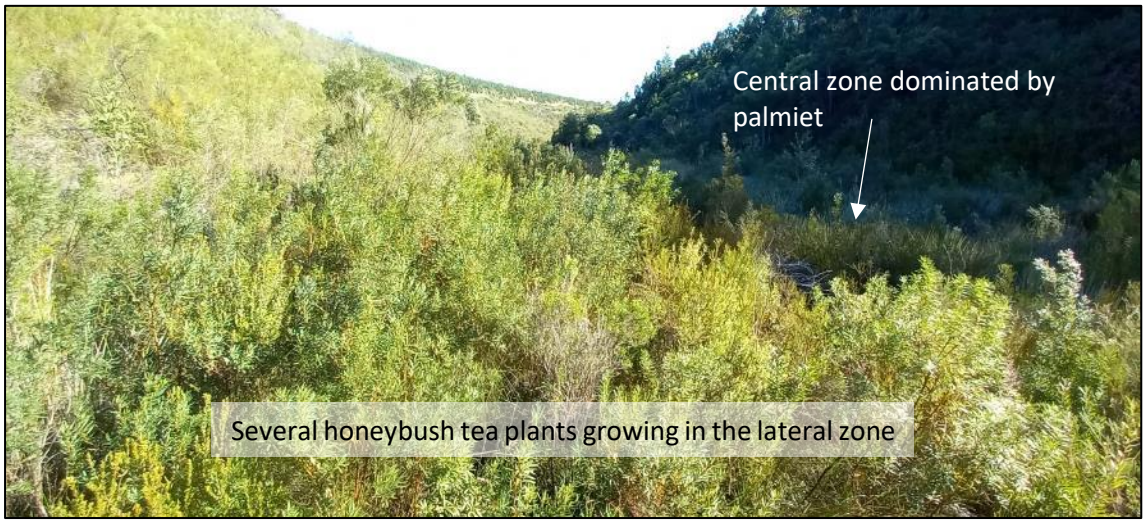

Figure 3-33 **The lowermost valley bottom portion of the wetland, with the wettest, central zone dominated by palmiet (*Prionium serratum*) and the margins supporting the largest known sub-population of the critically endangered Vanstadensberg honeybush tea, *Cyclopia longifolia***

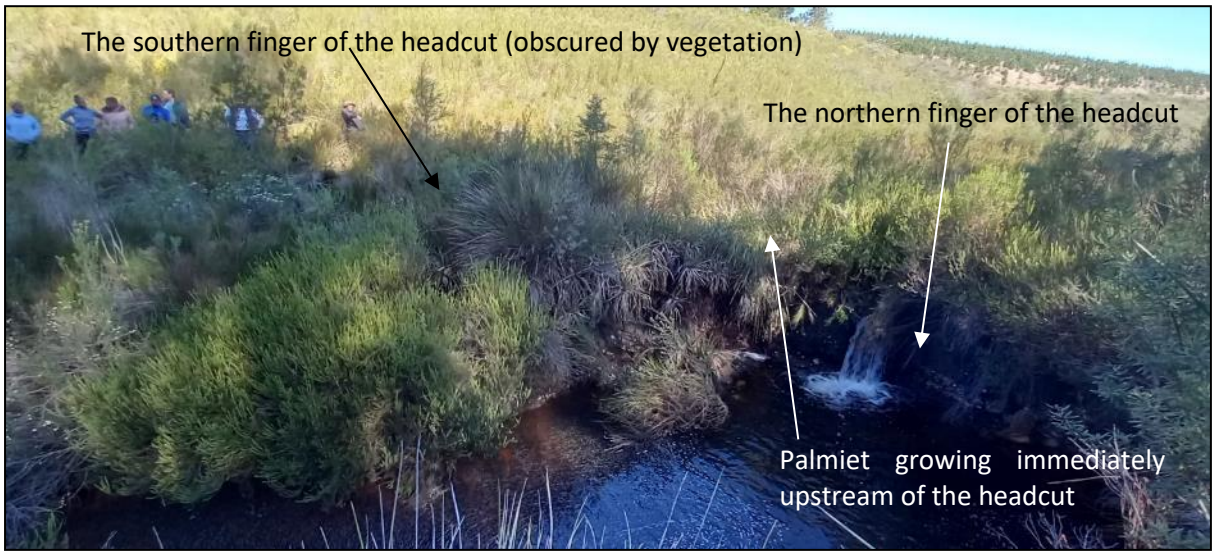

Figure 3-34 **A major erosion headcut (with two main fingers) at the outflow of the lowermost valley bottom portion of the wetland. The progressive upstream advance of the headcut is likely to result in much of the habitat and sediment in the central zone being lost and the greatly incised channel having a draining and desiccating effect on the lateral areas favoured by the Vanstadensberg honeybush tea.**

3.5 WRU05 – Chatty River Wetlands

Dates:	**Fieldwork Team:**
25th July 2022	Steven Ellery

Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU05 – Tier 2	33°50'49.95"S 25°07'42.80"E	WRU05 is comprised of a series of valley bottom and seepage wetlands – forming a large wetland complex nested within the developed areas of Bethelsdorp, Ibhayi, Booysen Park and Kwadwesi in the city of Gqerbeha. A large, channelled valley-bottom wetland (CVB 1) that is associated with the Chatty River is the first order stream within the wetland complex and flows in an easterly direction into a large salt evaporation pond before it enters into the Swartkops Estuary – a recently declared Ramsar site. This 375 ha channelled valley-bottom is the receiving system for the four additional valley-bottom wetlands that feed into the Chatty River Wetland. Overall, the catchments of these wetlands have been severely altered with the development of the Bethelsdorp, Ibhayi, Booysen Park and Kwadwesi settlements which have expanded from the coast in a north westerly direction toward Uitenhage. These developments have drastically increased the impermeable surfaces within the wetlands' catchments which has increased the overall runoff and runoff velocity entering these wetlands especially at stormwater discharge points up the length of each wetland. Only the two western arms of the wetland complex (CVB 4 & 5) still have some undeveloped areas associated with their fringes and significant portions of their catchments. In addition, many of the inflowing streams flowing into these wetlands have been canalised and convey high velocity flows into the HGM units, along with large volumes of litter and debris. The combination of a highly urbanised catchment, canalisation of many of the inflowing streams, and the regularly surcharging sewer systems have resulted in the incision and erosion of many of the channelled portions of all of the Chatty River Wetlands. The within wetland impacts to all wetlands include widespread accelerated channel incision and sediment deposition which is, in part, occurring as a result of the increasingly urbanised catchment. Channel incision was observed inside all of the wetland units, with some large headcut erosion features within CVB 2 and CVB 3. Furthermore, CVB 1 has been moderately impacted by significant areas of infilling associated with roads, dumping of construction rubble and the expansion of informal settlements into the wetland boundary. According to a resident in Ibhayi, many of the informal settlements within the wetland have recently been removed. It also appeared that a large portion of the channel within CVB 1 has been modified and canalised as well, possibly in an attempt to control water flows within the HGM unit to protect the encroaching developments. CVB 2 and CVB 6 wetlands have been severely affected by large scale sediment deposition as a result of the clearing of land for development

		within their catchments. Recent rains have mobilised that sediment into these wetlands, resulting in significant sediment deposits. At the time of the site visit, five surcharging sewer manholes were observed within CVB 3, and an additional two were observed, one each in CVB 2 and CVB 6. All sites were characterised predominantly by disturbance-tolerant plant species such as *Typha capensis, Phragmites australis, Juncus effuses, Cynodon dactylon, Pennisetum clandestinum, Cyperus textilis* and *Sarcocornia cf natalensis* (confined to CVB 1). Despite the evident anthropogenic pressure within each of the HGM units and their associated catchments, the low turbidity, the absence of a strong odour and the absence of evidence of detergents and chemicals at the toe of the wetland was encouraging – showing the extent to which this wetland is providing water quality enhancing ecosystem services.

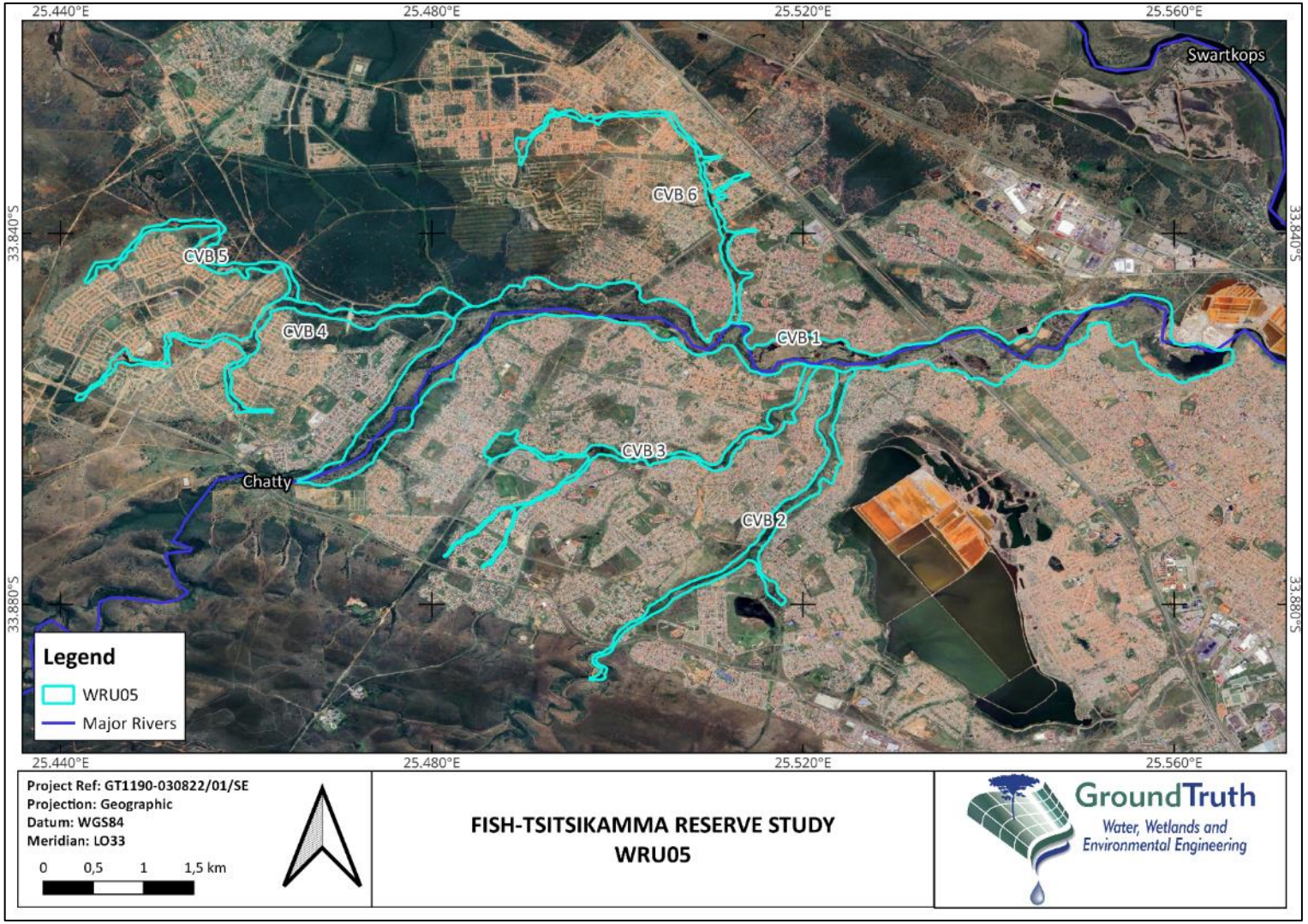

Figure 3-35 Overview of WRU05

Photo Log

Figure 3-36 **One of the many stormwater canals that conveys stormflows into the Chatty River Wetlands. Many of these canals have been totally blocked by the litter and debris, causing them to overtop into inhabited areas, potentially posing a health risk to those living nearby. In addition, the canalised stormwater conduits that are not blocked were observed to, in some cases, have resulted in erosion and scour of the downstream wetland.**

Figure 3-37 **Evidence of recent infilling of rubble used for construction in CVB 1. It was noted that a homestead structure had recently been built using some of the rubble pictured here.**

Figure 3-38 **Photograph captured from one of the bridges crossing the CVB 1 wetland – with evidence of large scale canalisation of the channel as indicated by the large bank on the right hand-side of the photograph.**

Figure 3-39 **A lateral erosion gully that has been created directly downstream of one of the stormwater drains inputting water into the CVB 1 wetland. It appeared to be moderately active, with a stand of *Pennesitum clandestinum* growing across the active face of the headcut.**

Figure 3-40 **A surcharging sewer manhole pictured centrally, and a newly incising channel pictured to the right located in CVB 3. The lateral tongues of the incising channel (heading towards the manhole) and the proximity of the point of incision to this surcharging manhole indicate that this manhole has been a large causal factor in the incision of this channel**

Figure 3-41 **Relatively clear and non-odourous water flowing through the toe of the wetland. In addition, this lower section of the system coincided with the most intact vegetation observed across the entire site.**

3.6 WRU08 – Grootvlei Complex

Dates:	**Fieldwork Team:**
4th March 2022	Donovan Kotze and Pumla Dlamini

Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU08 – Tier 1	32°23'48.29"S 25°26'51.37"E	The Grootvlei wetland complex, located south-west of Cradock on the eastern edge of the Sneeuberg Mountains in private farmland in the upper Groot Vis catchment, is an unusually large wetland for its wetland-scarce broader landscape. The bulk of the wetland comprises a floodplain but channelled and unchannelled valley bottom portions are also present. The hydroperiod appears predominantly temporarily saturated, and the floodplain also includes some elevated/better drained non-wetland areas. The vegetation comprises grasses (*Miscanthus capensis* and *Eragrostis* spp.) and the robust sedge *Pseudoschoenus inanus*, *Phragmites australis* and scattered trees/shrubs (*Vachellia karroo* and *Searsia* spp.). Although portions of the wetland are cultivated, the majority of the wetland comprises natural/semi-natural vegetation, but with localized infestations of alien trees, including poplars in particular, as well as *Eucalyptus sp*. and willows mainly along the stream channel. The wetland's high importance for biodiversity derives especially from the fact that this large wetland is still largely intact and that in much of the surrounding landscape, which is predominantly arid to semi-arid, wetlands are naturally scarce. Thus, in this landscape, any wetlands present provide important ecological refuges, especially during dry periods and in the face of predicted increasing temperatures and decreasing water availability. The primary direct use made of the wetland is for livestock grazing, for which the wetland is likely to be a key resource.

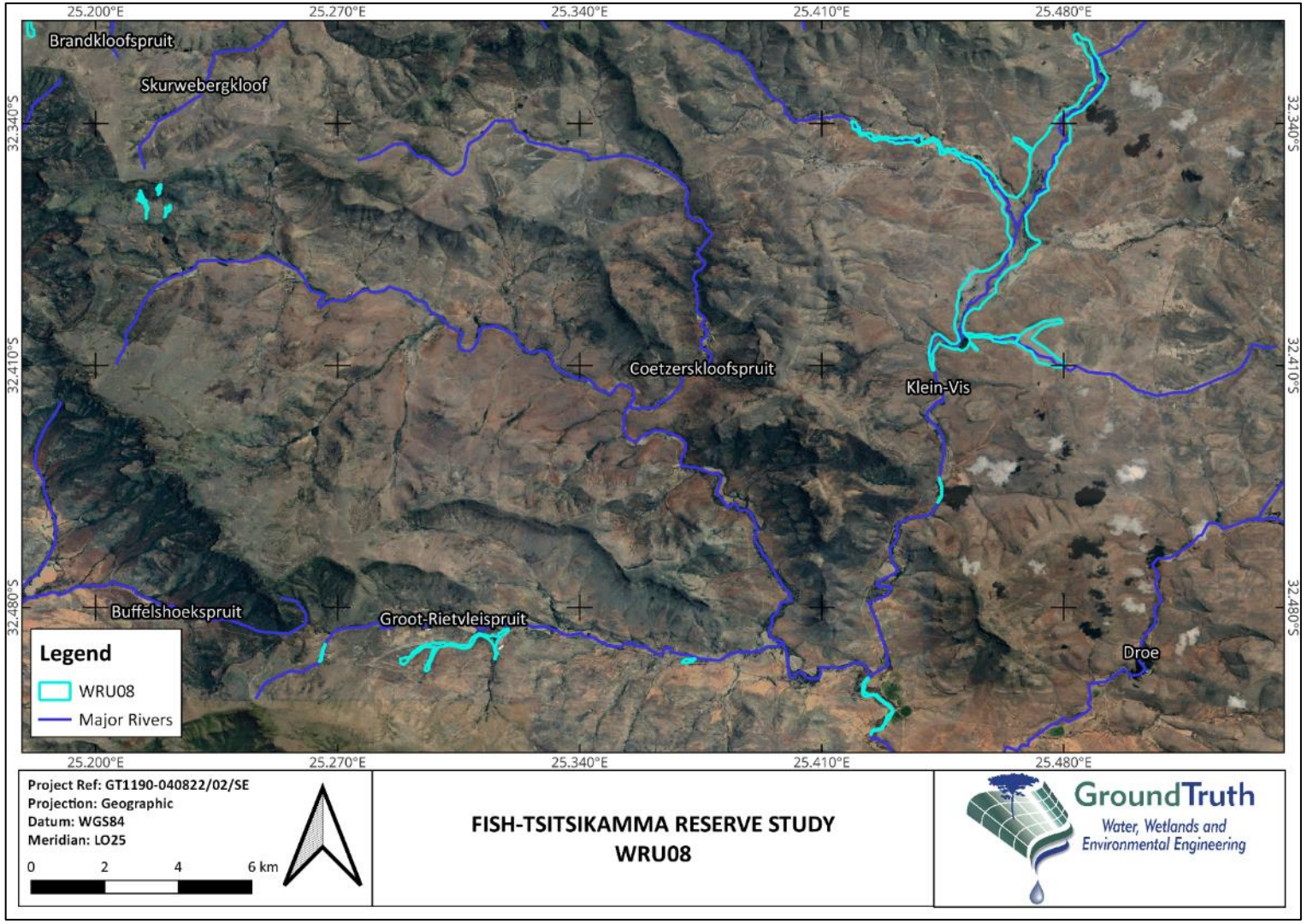

Figure 3-42 Overview of WRU08

Photo Log

Figure 3-43 **The upper portions of Grootvlei wetland, with extensive woody vegetation, including alien eucalypts, poplars and willows and the indigenous *Vachellia karroo*. The predominant herbaceous species is the indigenous common reed *Phragmites australis***

Figure 3-44 **An unchanelled valley bottom feeding the central portion of the wetland, with robust clumps of the grass *Miscanthus capensis.* Where the otherwise-gravel road crosses this wetland, it is concrete (as seen in the photo) suggesting at least periodic saturation in this wetland area.**

Figure 3-45 The central floodplain portion of the Grootvlei wetland, here dominated by the robust sedge *Pseudoschoenus inanus*.

Figure 3-46 The lower portions of the Grootvlei wetland

3.7 WRU10 – Dagbreek Wetland

Dates:	**Fieldwork Team:**
18th February 2020	Fiona Eggers

Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU10 – Tier 2	31°44'54.32"S 25°56'17.98"E	The Dagbreek wetland is located between the towns of Hofmeyr and Elandskop along the Vlekpoort River and along the western edge of the Bamboesberg mountain range. The greater wetland complex is predominantly located within private farmlands, with the headwaters of the system being predominantly state-owned land, which include the headwaters of the Vlekpoort River. Generally, the wetland habitat associated with the Vlekpoort River has formed as a result of the suite of weirs/dams constructed along the length of the system. The suite of interventions were implemented in the mid 1900's by the then Department of Agriculture to assist in a soil conservation programme. The objective of many of the interventions was to retain the soil within the landscape but also to initially provide a direct benefit to the landowners – water for irrigation purposes. Although measures to retain the soil within the landscape were implemented, these did not necessarily focus on the adjacent management practices, and continuous overgrazing continued and the associated tree and alien invasive species encroachment due to the loss of the original system's biophysical drivers. The general land use of the greater Dagbreek system is livestock farming, with very few areas of cultivation. The cultivated areas are for the provision of fodder for the livestock during the dry winter months and are not linked to food production. The wetland habitat along the Vlekpoort River is largely associated with the weirs/dams along the length of the river. With the continuous accumulation of sediment upstream of the interventions, many of the dams are now either very shallow or have become extended grazing areas with the accumulation of water during the wetter months and/or years. Generally, upstream of the major interventions the channel associated with the Vlekpoort River becomes less defined and the sediment plume extends for over 1.2km upstream of the interventions, with the interventions being in excess of 7m in height. The vegetation composition of these upstream systems is considered to be largely modified with either secondary grassland which is generally heavily grazed and/or alien invasive species e.g. *Populus* spp. By the very nature of the Nama-Karoo, thorn trees generally only grow in water courses due to the availability of water within the landscape. Although these systems are not considered to be true wetland habitat, they provide important ecosystem services within the landscape, including additional grazing lands and/or sources of water. Additionally, the interventions have ensured that there

		has not been a mass export of sediments out of the greater catchment area, which would have otherwise been the case and the gully associated with the Vlekpoort River would have most likely been much larger in extent with further loss of the adjacent landscape to erosion. Overall, the greater system has been classified as a D-class system and is considered to be largely modified, which can be attributed to the interventions within the river and the degraded state of the system's catchment. However, the maintenance and management of these interventions and associated systems are crucial in sustaining the habitat within the landscape and should one of the interventions fail, especially within the upper reaches, it can be assumed that the mass export of sediment may lead to the failure of the downstream interventions and as such loss of habitat within the landscape, and the formation of a large gully, similar to those present in the systems catchment. Additionally, all the mobilised sediment would accumulate in the Kommandodrif dam.

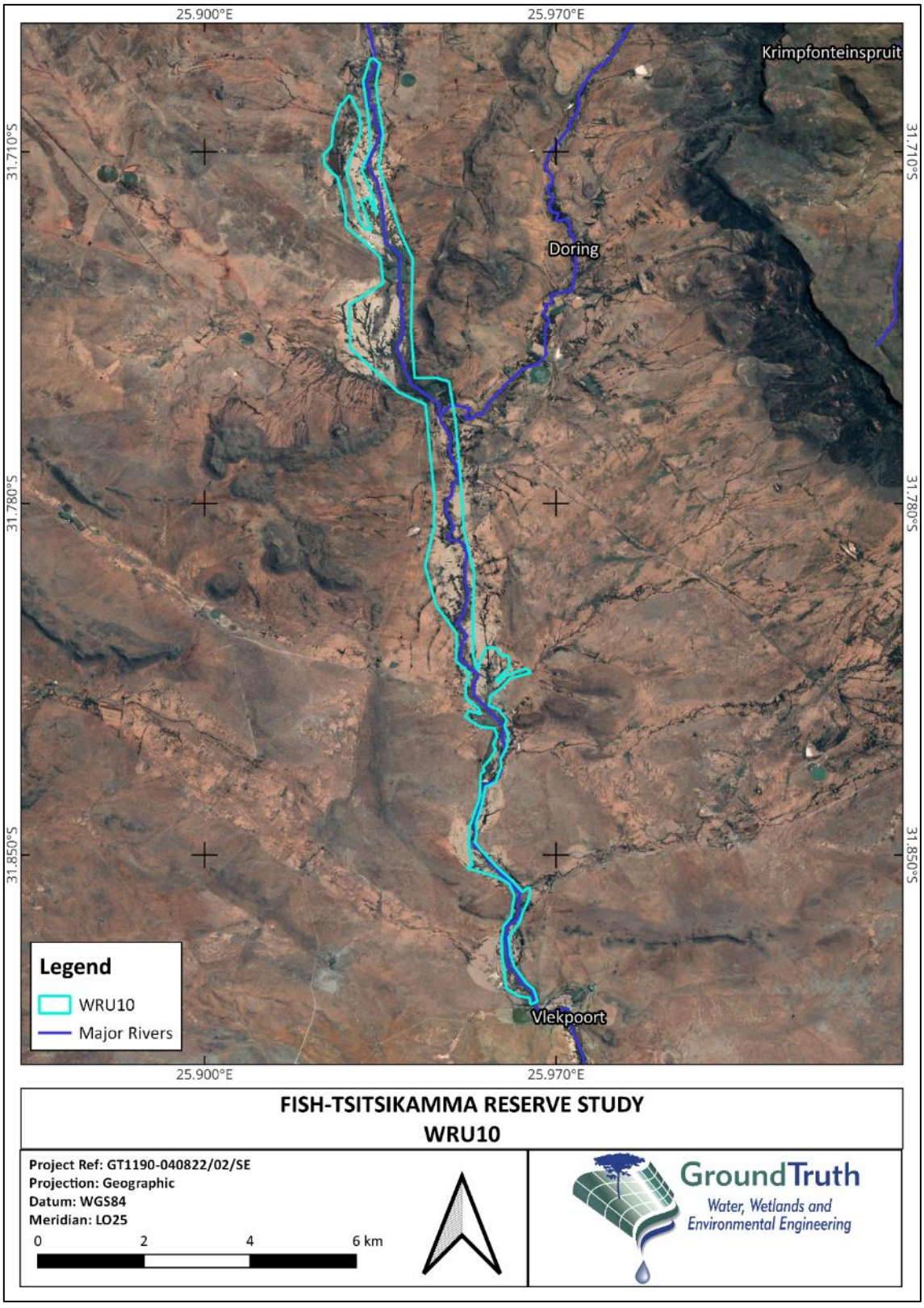

Figure 3-47 Overview of WRU10

Photo Log

Figure 3-48 Views of the sediment directly upstream of an intervention and the remaining pool of water

Figure 3-49 View of the accumulated sediment upstream of the weir and heavily grazed grassland

Figure 3-50 View of the erosion gully downstream of a weir

Figure 3-51 View of a buttress weir and the upstream grazing areas

3.8 WRU13 – Hogsback Wetland Complex

Dates:	**Fieldwork Team:**
27th & 28th July 2022	Donovan Kotze, Steven Ellery & Pumla Dlamini

Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU13 – Tier 1	32°33'22.51"S 26°58'33.89"E	The Hogsback wetland, located north of Hogsback town, falls within the headwaters of the Great Kei River in the Klipplaatrivier catchment, and is part of a much more extensive wetland "mega-cluster" extending along the Amathole mountains into neighbouring catchments, particularly to the west. The wetland includes extensive seeps feeding into channelled valley bottoms (generally steep minor tributaries), floodplains and unchannelled valley bottoms. Wetness ranges from temporary through seasonal to permanent saturation/flooding. Grasses (e.g. *Festuca caprina* and *Fingerhuthia sesleriiformis*) dominate the temporary areas and sedges (notably *Carex acutiformis*) and, to a lesser extent, *Juncus lomatophyllous* and *Phragmites australis*, dominate the permanent areas, while a sedge/grass mix is characteristic of the seasonal areas. In the floodplain, *Cliffortia linearifolia* shrubs are often locally abundant, especially along the stream channel. Small *Leucosidea sericea* trees are also present, and most abundant where the historical fire frequency appears to have been reduced. Although fairly limited in extent, anthropogenically-induced erosional incision occurs in a few localized sites in the wetland, and several of these already have Working for Wetlands erosion-control structures in place. The wetland falls within private farmland (livestock and cultivation) and timber plantations, which vary according to which wetland types are most impacted. In the farmland, several wetland areas in the major valley bottoms and floodplains have been historically drained and transformed to cultivated lands, but the minor valley bottoms and seeps, which tend to be steeper and located in higher-lying areas, are much less transformed. In contrast, in forestry areas, the major valley bottom wetlands, which are characteristically very broad, are largely intact, while many of the seeps and minor valley bottoms, which are characteristically narrow, are severely affected by the adjacent plantation's edge effects (shading, desiccation & promoted American bramble infestation). However, some of the still-intact seeps in forestry areas have generous buffers, limited plantations in their catchments and are ecologically well connected, notably those on the south-western slopes of Gaika's Kop.

		These provide potentially key ecological linkages for the critically endangered Amathole Toad (*Vandijkophrynus amatolicus*) which is restricted to the grasslands of the Amathole Mountains and favours hillslope seepage wetlands for breeding. Besides the very high biodiversity importance of the wetland, it is likely to also have a high importance for regulating services, e.g. in terms of carbon storage and regulating stream flows. By far the greatest direct use made of the wetland, both in farmland and plantation areas, is for livestock grazing.

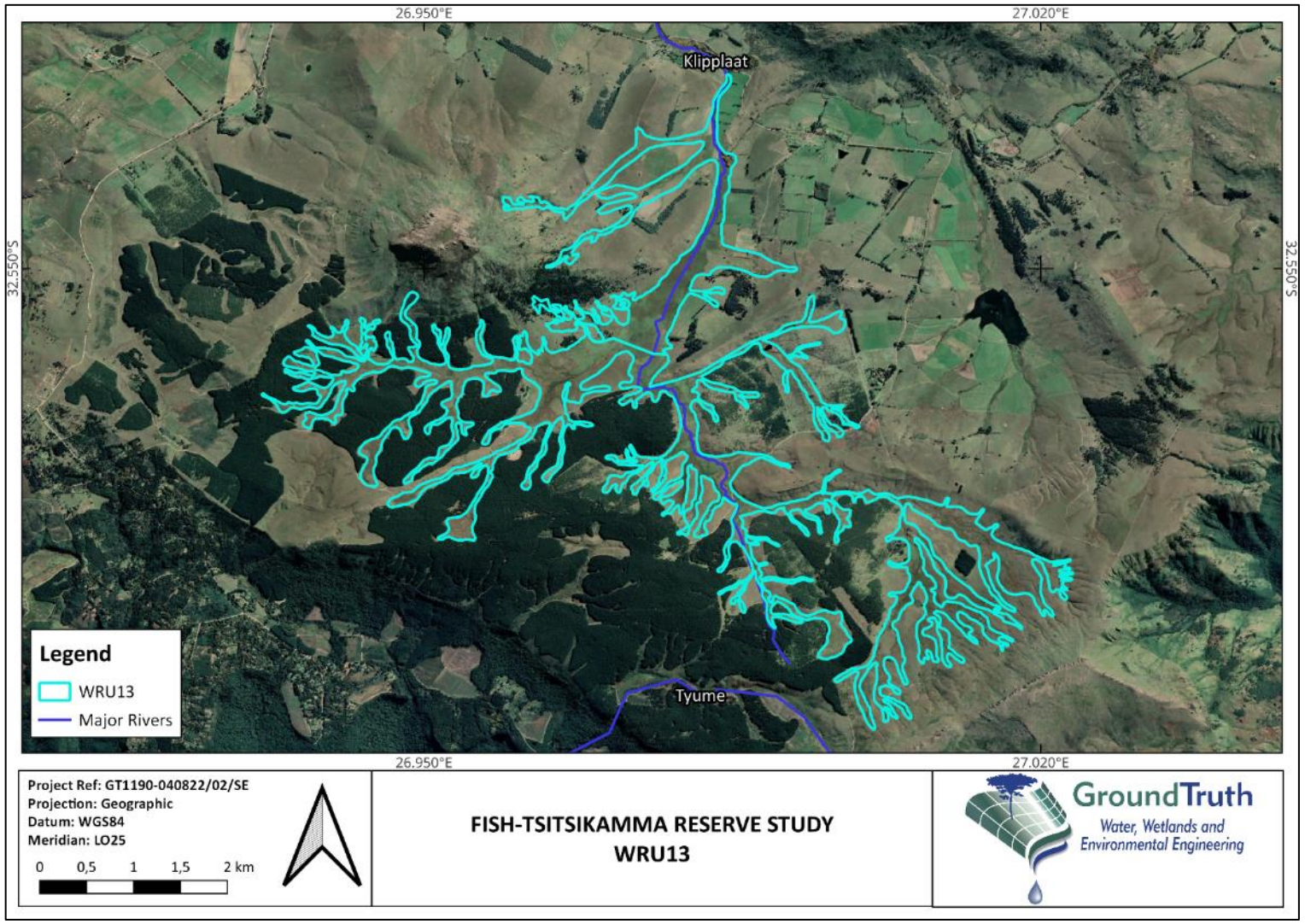

Figure 3-52 Overview of WRU13

Photo Log

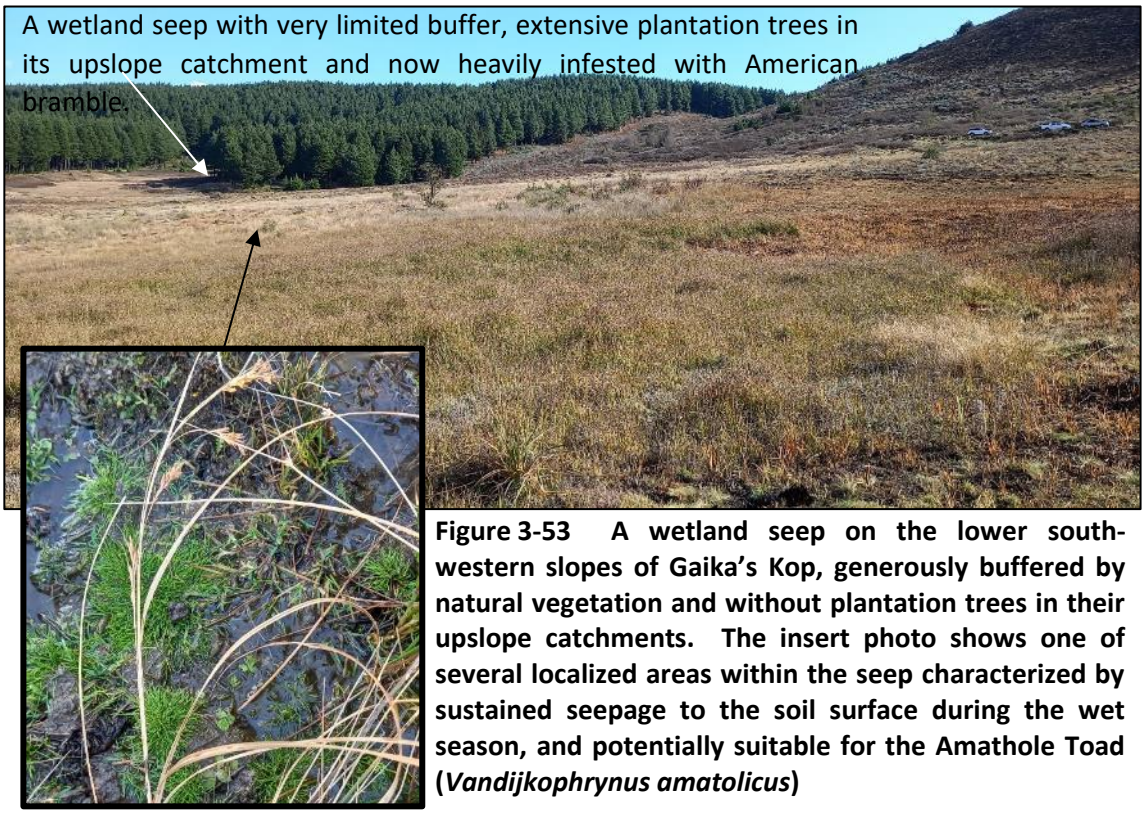

Figure 3-53 A wetland seep on the lower south-western slopes of Gaika's Kop, generously buffered by natural vegetation and without plantation trees in their upslope catchments. The insert photo shows one of several localized areas within the seep characterized by sustained seepage to the soil surface during the wet season, and potentially suitable for the Amathole Toad (*Vandijkophrynus amatolicus*)

Figure 3-54 A well-buffered wetland seep on the Gaika road, supporting a diversity of grasses (notably *Festuca caprina*) and sedge (e.g. *Pyreus* sp.) and with its wettest core dominated by the rush *Juncus puctorius*

Figure 3-55 **Left: A wetland seep heavily used by livestock. Right: One of Working for Wetlands rehabilitation interventions in a channelled valley bottom which was identified as incised**

Figure 3-56 **A wetland seep area with extensive *Leucosidea sericea* trees, which are favoured by an absence/infrequency of fires.**

Figure 3-57 A wetland seep area infested with American bramble

Figure 3-58 A floodplain wetland, showing the sinuous main stream channel and vigorous vegetation including the sedge *Carex acutiformis* and the short shrub *Clutia* sp.

Figure 3-59 A floodplain wetland with grasses, sedges and the shrub *Cliffortia linearifolia*

Figure 3-60 **The most extensive unchannelled valley bottom in the Hogsback area, dominated mainly by *Carex acutiformis* and seen here after a recent fire.**

Figure 3-61 **An unchannelled valley bottom with abundant *Carex acutiformis* and *Phragmites australis.***

3.9 WRU15 – eDrayini Floodplain

Dates:	**Fieldwork Team:**
27th July 2022	Donovan Kotze, Steven Ellery & Pumla Dlamini

Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU15 – Tier 2	32°45'48.70"S 27°29'43.95"E	The wetland, located north of Bisho in communal land, is a floodplain, with its upper portions comprising a western arm associated with the Kwagana River and an eastern arm associated the Incemerha River, and its lower portion continuing from the confluence of these two rivers and flowing in a southward direction towards Bisho. The floodplain is predominantly temporarily saturated, but also includes localized seasonally saturated areas, particularly near the margins of the wetland, which appear to be either fed by lateral hillslope seepage and/or by small influent tributaries flooding out onto the floodplain. Non-wetland areas are also present within the floodplain, particularly associated with levees and other raised areas generally near the main river channel. Bank overspill from this channel occurs infrequently, and the main inflows maintaining the wetland appear to be predominantly from lateral sources. The wetland's vegetation has been relatively transformed and is largely dominated by grass species favoured by human disturbance, e.g. *Eragrostis plana,* together with disturbance-tolerant sedges, e.g. *Cyperus pulcher*. Although historically about 60% of the floodplain was cultivated, in the last two decades this extent has been progressively declining to the current extent of <10% of the floodplain. The extent of *Vachellia karroo* and black wattle trees have increased greatly along the stream channels, and *V. karroo* has also become well established on some of the abandoned cultivated lands, especially in the upper western arm of the floodplain. Currently, by far the greatest direct use made of the wetland is for livestock grazing. In terms of regulating services, flood attenuation is probably most important, given the floodplain's location upstream of Bisho and the extensive spatial extent within the wetland available for flood storage.

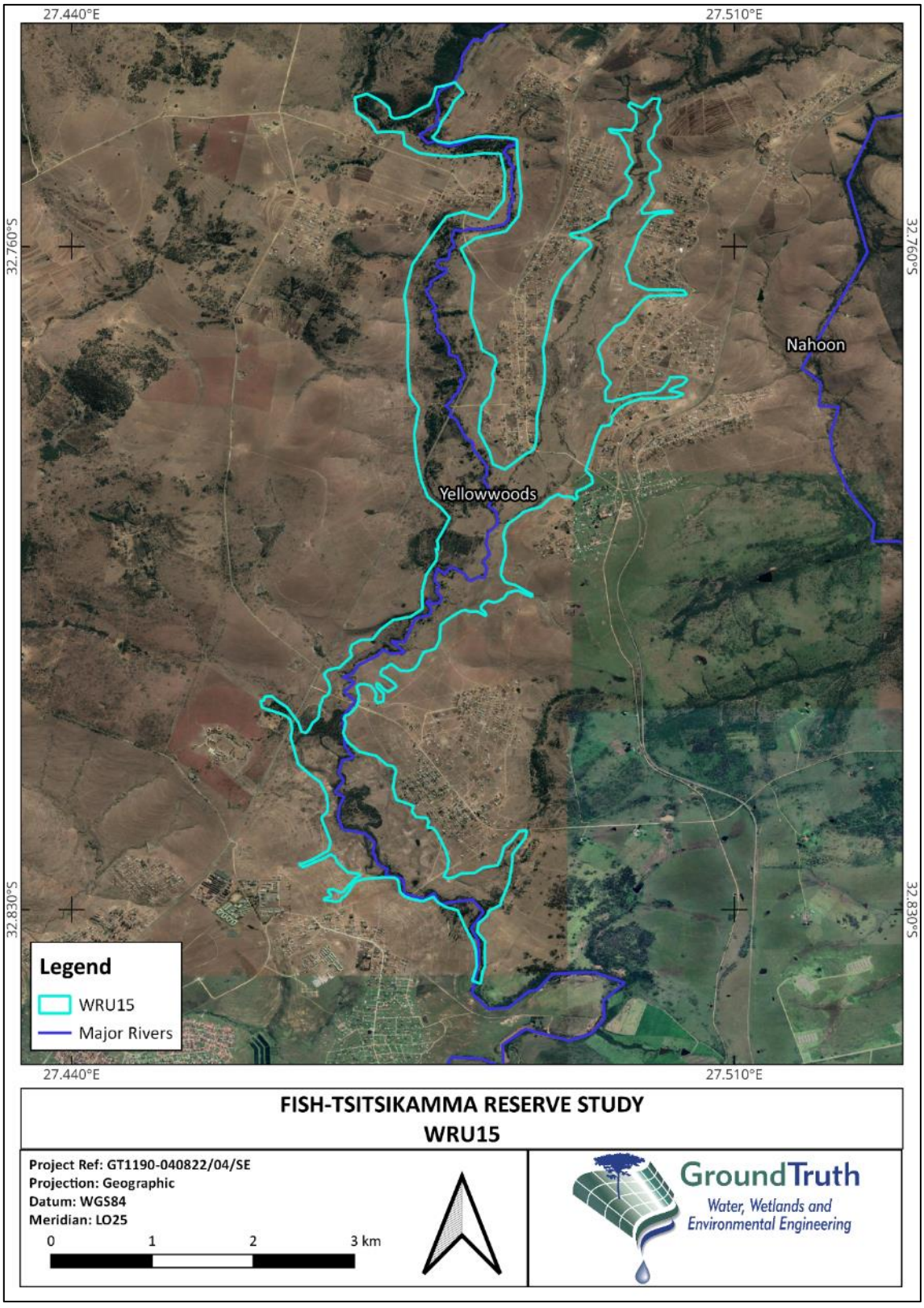

Figure 3-62 Overview of WRU15

Photo Log

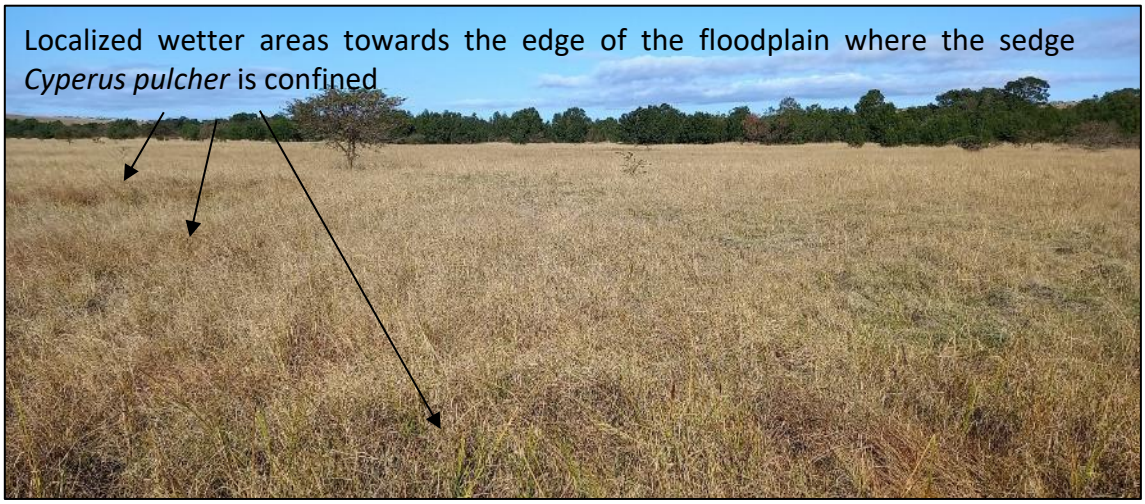

Figure 3-63 **A historically-cultivated area in the western arm of the upper floodplain, with black wattle (visible in the background) dominating the stream channel.**

Figure 3-64 **An historically-cultivated area in the eastern arm of the upper floodplain, with *Vachellia karroo* trees (visible in the background) dominating the stream channel.**

Figure 3-65 **One of the most extensive seasonally-saturated wetland areas in the floodplain, located in the eastern arm of the upper floodplain.**

Figure 3-66 **A minor headcut erosional feature currently subject to moderate levels of livestock trampling. Although currently the level of activity of the erosion is moderately low, it could potentially increase and threatens to advance into one of the naturally wettest portions of the wetland (shown in the previous photo) which, in turn, will likely have a significant draining effect on this area of the floodplain.**

Figure 3-67 **A shallow erosion gully lying downstream of the headcut shown in the previous photo. Note the well vegetated nature of the areas adajcent to the erosion.**

Figure 3-68 **A low-lying (possibly paleochannel) area in the lower iDrayini floodplain, dominated by the sedge *Eleocharis dregeana*, with *Cyperus pulcher* on the edge. The adjacent higher lying areas are characterized by *Eragrostis* spp. and other grasses favoured by disturbance, together with scattered young *Vachellia karroo* trees.**

Figure 3-69 **A temporarily-saturated area dominated by sedges near the margins of the lower iDrayini floodplain, which seems to be maintained by lateral inflows to the wetland**

3.10 WRU18 – Cala

Dates:	**Fieldwork Team:**
16th August 2022	Craig Cowden & Fiona Eggers

Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU18 – Tier 2	31°39'46.78"S 27°33'54.19"E	The Cala wetland complex comprises of a number of hillslope seepage wetlands which feed into a discontinuously channelled valley-bottom wetland. The wetlands are located in communal land upstream of the Lanqanci village and adjacent to the abandoned Cala state forests. The wetland complex feeds into the Tsomo River, which eventually drains into the Tsojana dam. As the wetland complex forms part of the headwaters of the small stream, the system is considered to be an important feature within the landscape and supplier of ecosystem goods and services. Although the Cala wetland complex is located on communal lands, the catchment of the wetland complex has not been extensively modified, unlike similar systems in the neighbouring catchments. The predominant catchment impacts include rotational cultivation, old-abandoned state plantations, clumps of black wattle, grazing and some houses. The seepage wetlands alongside the valley-bottom wetland are generally more heavily impacted than the valley-bottom, as these areas have allowed for the establishment of some fields as the wetness regime of these systems varies between temporary and seasonal wetness zones, whilst the valley-bottom system's wetness regime tends towards seasonal to permanently wet. Due to the level of wetness, the valley-bottom has generally been excluded from direct impacts. In addition, within the flatter portions of the seepage systems, evidence of historical plough lines and/or ridge and furrow agricultural practices are still visible however, the vegetative cover within these areas has suitably recovered and is considered to be representative in terms of surface roughness but contains some disturbance tolerant wetland species, such as *Arundinella nepalensis*. Two drains were identified within the system, aimed at improving the hydraulic efficiency of the system from an anthropogenic perspective. However, based on the vegetative cover alongside and within the drains and the level of wetness in the adjacent habitat, the drains are relatively ineffective.

		The fringe wetland habitat adjacent to the plantations, has adapted to the increased shade within this area, with the vegetation comprising mostly of *Juncus effusus*, versus the *Carex spp, Pycreus spp*, *Eleocharis dregeana* etc., which dominates the valley-bottom system. *J. effusus* is a disturbance tolerant species and has thus encroached along the wetland/plantation interface. A depression wetland was identified within the northern catchment area. The depression is perched quite high above the wetland habitat in the valley bottom and decants via a small drainage line into the downstream wetland. The depression is serving as a source of water for livestock and as such careful management of the system is essential. Additionally, the road which bisects the drainage line should be reconsidered, to ensure that it does not alter the hydrology of the system or introduce erosion. The entire Cala wetland complex is controlled by a geological control at the base of the system, from which point a small area of wetland habitat is associated with the stream before the descending into a steep riverine valley. Considering the location of the wetland and the integrity of the system in comparison to similar systems within the adjoining catchments, it is essential that the Cala WRU be considered to have a high importance in terms of both maintaining biodiversity and supplying important ecosystem services. The management of adjacent croplands and grazing areas will be an important consideration to ensure that the sediment loads into the system are managed.	

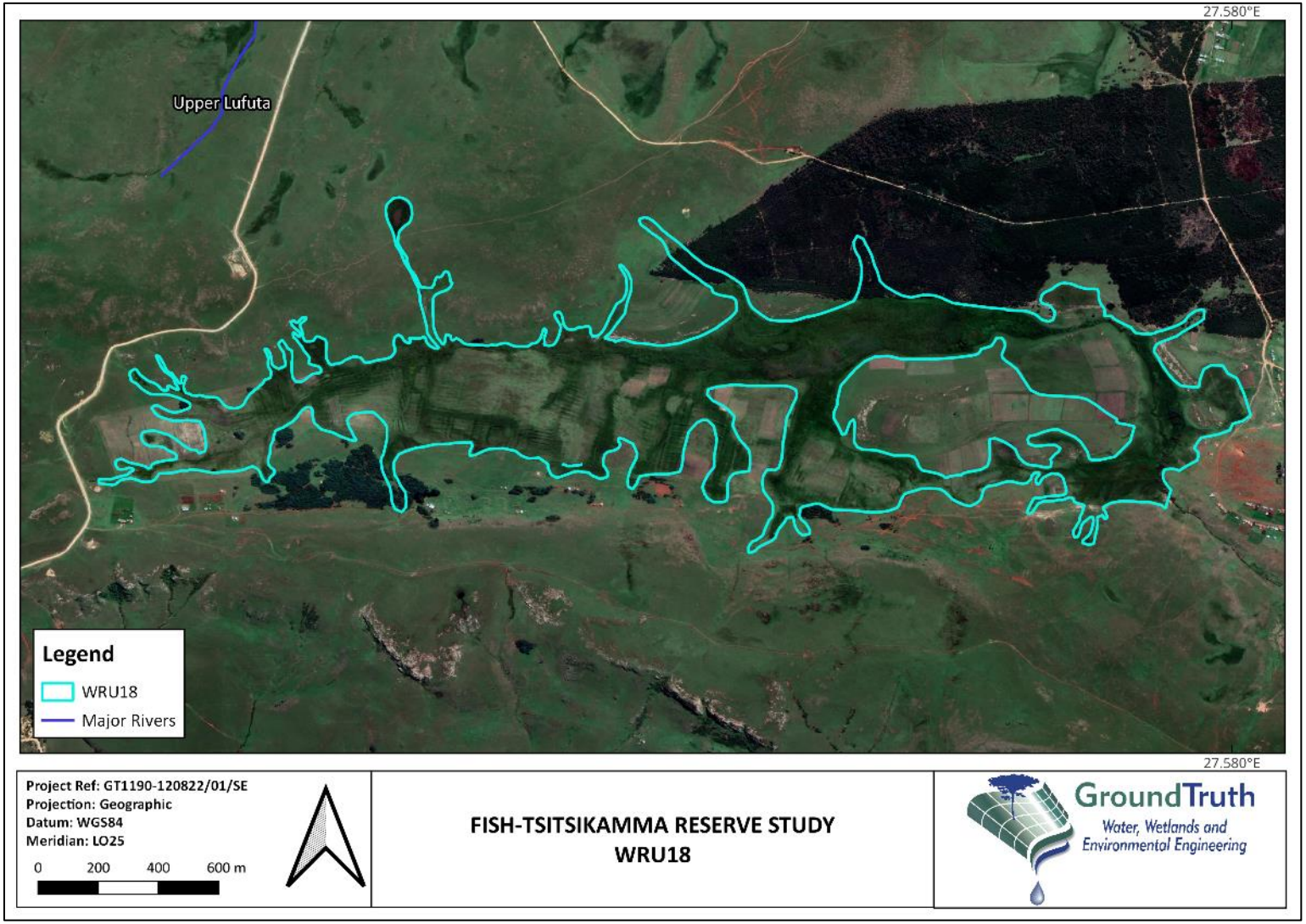

Figure 3-70 Overview of WRU18

Photo Log

Figure 3-71 View of the Cala wetland from the upper catchment area

Figure 3-72 View of the scrub wattle within a portion of the wetland's catchment

Figure 3-73 View of the depression wetland within the catchment of the system

Figure 3-74 View of the lowest portion of the valley-bottom wetland, which is characterised by permanent wetness.

3.11 WRU20 – Kulufini Wetland Complex

Dates:	**Fieldwork Team:**
7th August 2022	Steven Ellery

Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU20 – Tier 2	31°51'13.55"S 27°33'33.04"E	The Kulufini wetland complex is a large wetland complex comprised of a series of hillslope seepage wetlands that feed into a single valley-bottom wetland. These wetlands are located on communal land to the northwest of the Tsojana dam, into which the Kulufini wetland complex feeds – hence it was included in the field assessment. The Kulufini wetland complex is located in the headwaters of the small stream system that flows into the Tsojana dam and is therefore an important water supply area as well as an important supplier of ecosystem services. However, due to extensive grazing and the location of many of the seep wetlands on steep slopes with steep catchments, the majority of the seep wetlands and the entire valley-bottom wetland are characterised by extensive erosional features. All of the seep wetlands within the Kulufini wetland complex have been impacted by gully erosion, and large areas of these seep wetlands have been partially or entirely desiccated as a result of this erosion. Furthermore, the valley-bottom wetland has experienced extensive erosion and now has a channel that runs down the length of the entire wetland and is approximately 1.5-2.5m deep. Some intact valley-bottom wetland areas are still present adjacent to the eroded channel in the main valley-bottom wetland, although it was recognised that these intact wetland areas are maintained by lateral seepage inputs. Generally, the wetland is not able to provide many regulating or supporting ecosystem services as a result of the extensive erosion and the loss of sediment trapping and water retention ability within the wetland. However, the wetlands do provide an important grazing resource to the local community, especially during the dry season when other grazing areas have dried. The intact portions of the wetlands were predominantly characterised by *Fuirena pubescens* and *Sporobolus africanus*. Both of these species can tolerate disturbance and would not be observed in such high abundance in an undisturbed wetland.

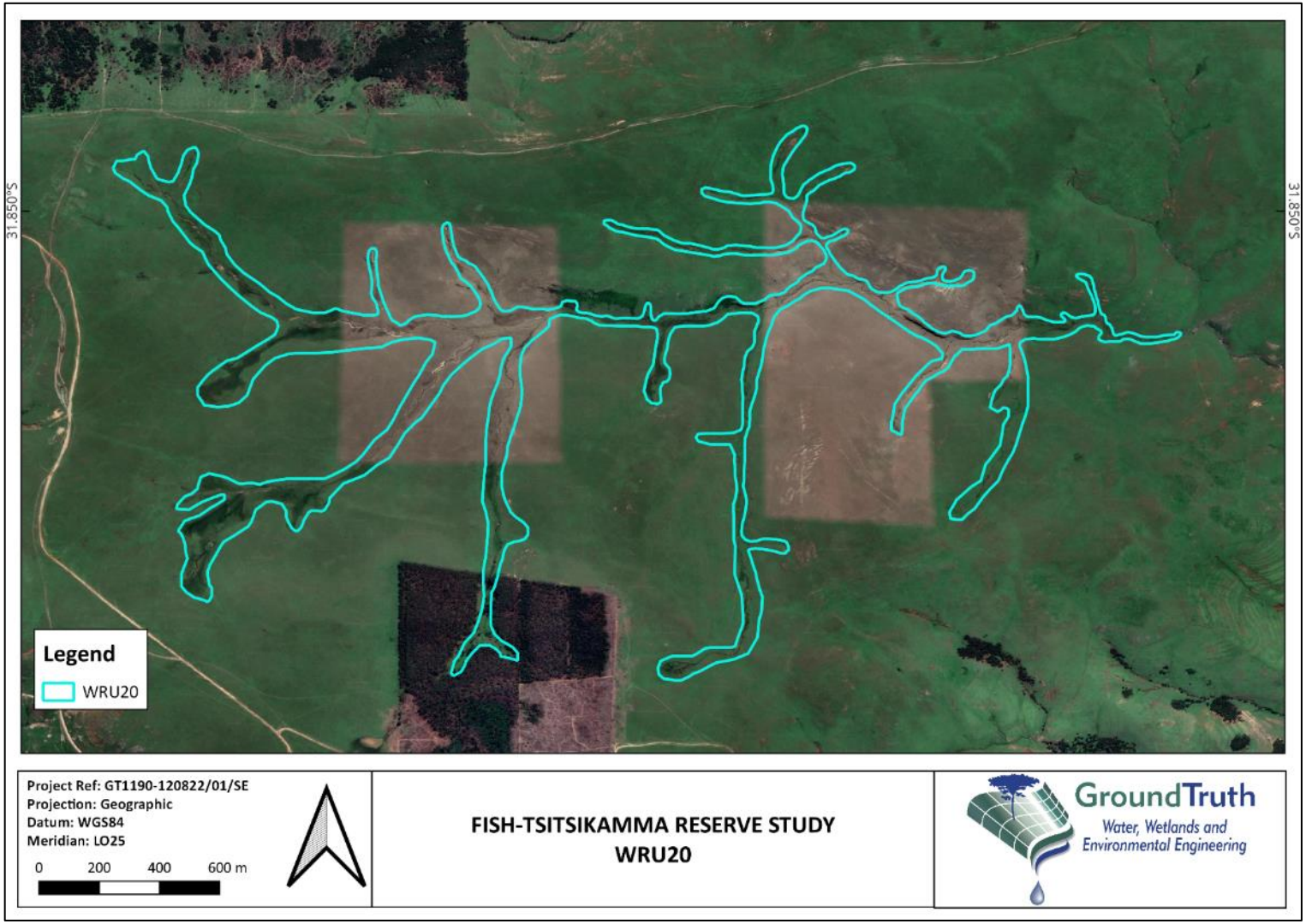

Figure 3-75 Overview of WRU20

Photo Log

Figure 3-76 **Evidence of trampling by cattle across one of the seeps. The cattle path coincides with a new headcut which is forming, possibly as a result of the cattle path which may channel water into the headcut.**

Figure 3-77 **A large gully within a seepage wetland, characterised by a large depositional feature in its centre which has been colonised by *Eragrostis planiculmis* and *Fuirena pubescens*.**

Figure 3-78 **Preferential flow path in one of the seep wetlands which has been extensively trampled by cattle that now use this feature to drink water.**

Figure 3-79 **Deeply incised channel in the valley-bottom wetland – predominantly eroded down onto bedrock. This channel sets the geomorphological base level for all the seep wetlands which feed into this wetland and explains much of the erosion observed within the seep wetlands.**

3.12 WRU21 – Mbokotwa Floodplain Wetland

Dates:	**Fieldwork Team:**
15th August 2022	Craig Cowden & Fiona Eggers

Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU21 – Tier 2	31°24'9.458"S 27°32'48.57"E	The Mbokotwa floodplain is located within the Ida precinct and flows through varying different types of land uses from commercial agricultural land use practices to subsistence farming. The system is a tributary to the Tsomo River which eventually flows into the Tsojana dam. The headwaters of the system originate from the nearby Geltschberg mountain range. The wetness regime of the system ranges from extensive temporary wetness zones to areas of seasonal to permanent zones of wetness (often associated with flood channels and depressions/oxbow lakes). Natural vegetation was largely limited to these seasonal/permanent wetness zones with the sedge *Cyperus fastigiatus* often found in the depressions. In many portions of the system, the wetland habitat alongside the flood channel is maintained by lateral inputs from the seepage areas, and not by the overtopping from the channel due to sections of the channel being substantially incised. The main impacts on the system are predominantly associated with in-system impacts and the commercial agricultural activities within the catchment. Large tracts of the wetland habitat have been modified through cultivation which includes areas of rye grass but also centre pivots pastures for the adjacent dairy. The commercial agricultural activities within the wetland habitat include an off-channel freshwater dam, slurry dams and their associated decants into the floodplain channel, and centre pivots. The off-channel dam is not receiving its water from the adjacent landscape but rather from an offtake channel from the main floodplain channel, which was implemented in 2019. Some of the old flood channels and oxbow lakes have been slightly modified with the construction of an earthen berms on the downstream side of these systems, to serve as sources of water for livestock. The characteristics of the floodplain are fundamentally different within the lower portions of the system. The changes in the system dynamics are largely associated with a road crossing. Downstream, the floodplain channel reverts back to a shallow channel thereby allowing for overbank topping. Much of the adjacent wetland habitat has been modified and is used as a source of fodder during the dry months. The channel is heavily infested with alien invasive trees, including *Populus spp* and *Acacia spp*. The catchment of this lower portion of the system has been cultivated and/or is utilised for grazing.

		Although there are a number of impacts within and adjacent to the system, the floodplain is considered to be an important system in terms of supplying ecosystem services associated with regulating services especially water quality enhancement – due to the discharge from the commercial farming activities. Furthermore, this system is part of the headwaters for the Tsojana dam, and as such, to increase the longevity of water supply dams, the upstream areas should be well managed.

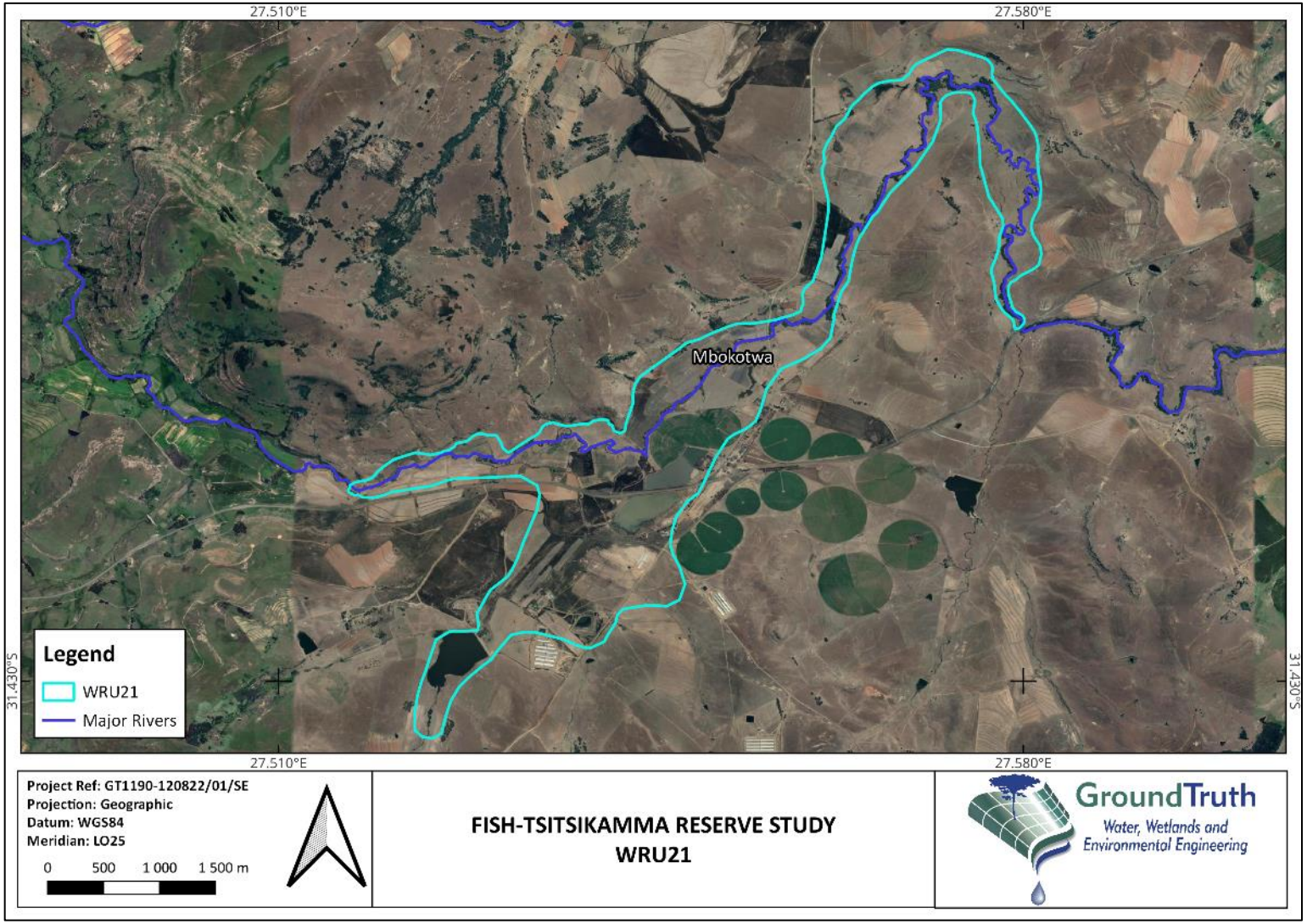

Figure 3-80 Overview of WRU21

Photo Log

Figure 3-81 **View of a portion of the floodplain and the small artificially impounded areas on the adjacent floodplain terrace, and agricultural activities**

Figure 3-82 **Incised river channel within the floodplain, with the discharge point from the waste ponds slightly upstream from this point.**

Figure 3-83 **View of the flows along the diversion channel supplying the off-channel dam.**

Figure 3-84 **Debris below a large road culvert across the incised portion of the floodplain.**

Figure 3-85 Artificially impounded area in the lower portion of the floodplain which is serving as a source of water for the livestock

Figure 3-86 Grazing lands within the lower portion of the floodplain system

3.13 WRU22 – Elliot Floodplain Wetland Complex

Dates:	**Fieldwork Team:**
4th-5th March & 16-17th August 2022	Donovan Kotze, Pumla Dlamini, Craig Cowden & Fiona Eggers

Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU22 – Tier 1	31°24'9.458"S 27°32'48.57"E	The Elliot wetland, which passes through Elliot town itself, includes one of the largest floodplains in the overall study area, and if taken together with all the tributary arms connected to the floodplain, could well be the largest wetland complex in the entire study area. In addition to its core floodplain, the wetland includes channelled valley bottoms and unchannelled valley bottoms, all fed by influent wetland seeps. Wetness ranges from temporary through to seasonal to permanent saturation/flooding, and the floodplain wetland area appears to be maintained by a combination of bank overspill from the main channel (mostly in the downstream portions) and by lateral inflows. Grasses (e.g. *Themeda triandra* and *Eragrostis* spp.) dominate the temporary areas and sedges (e.g. *Carex acutiformis* and *Cyperus fastigiatus*) and *Phragmites australis* the permanent areas, while a sedge/grass mix is characteristic of the seasonal areas. Although large portions of the floodplain have been developed (with some of these protected from flooding by constructed berms) much is still intact and an active floodplain. Similarly, while some of the tributary arms have been extensively developed to cultivated lands and farm dams, other tributary wetland areas remain largely under natural vegetation. Invasive alien plant infestation levels are moderately low across much of the wetland, but localized dense infestations of silver wattle (*Acacia dealbata*) occur in some of the north-eastern tributary arms and scattered *Salix babylonica* and *Salix fragilis* trees occur along much the length of the Slang River flowing through the floodplain. The wetland supports breeding Crowned Crane as well as hosting large numbers of foraging Crowned Cranes. In a field visit to the floodplain in March 2022, a pair of Crowned Cranes were observed with an unfledged chick adjacent to the permanently-flooded back marsh area, together with a flock of 63 Crowned Cranes in an area lower in the floodplain which was shallowly flooded. Owing to its importance for cranes and the fact that floodplains are a highly impacted wetland type generally, the site has a high biodiversity importance. The site also has a high ecosystem services importance, both in terms of provisioning services for livestock grazing, water supply and areas for cultivation, as well as in terms of regulating services, particularly with

		respect to flood attenuation and the enhancement of water quality compromised by Elliot's wastewater treatment works which discharges into the floodplain and from runoff from adjacent urban areas and intensive agricultural production, notably a livestock feedlot and abattoir immediately adjacent to the floodplain. Most of Elliot town lies close to the floodplain and some of the town extends into the floodplain itself and into several of the wetland tributary arms feeding the floodplain, thus highlighting the great need for effective ecological planning and management of the greater floodplain wetland complex.

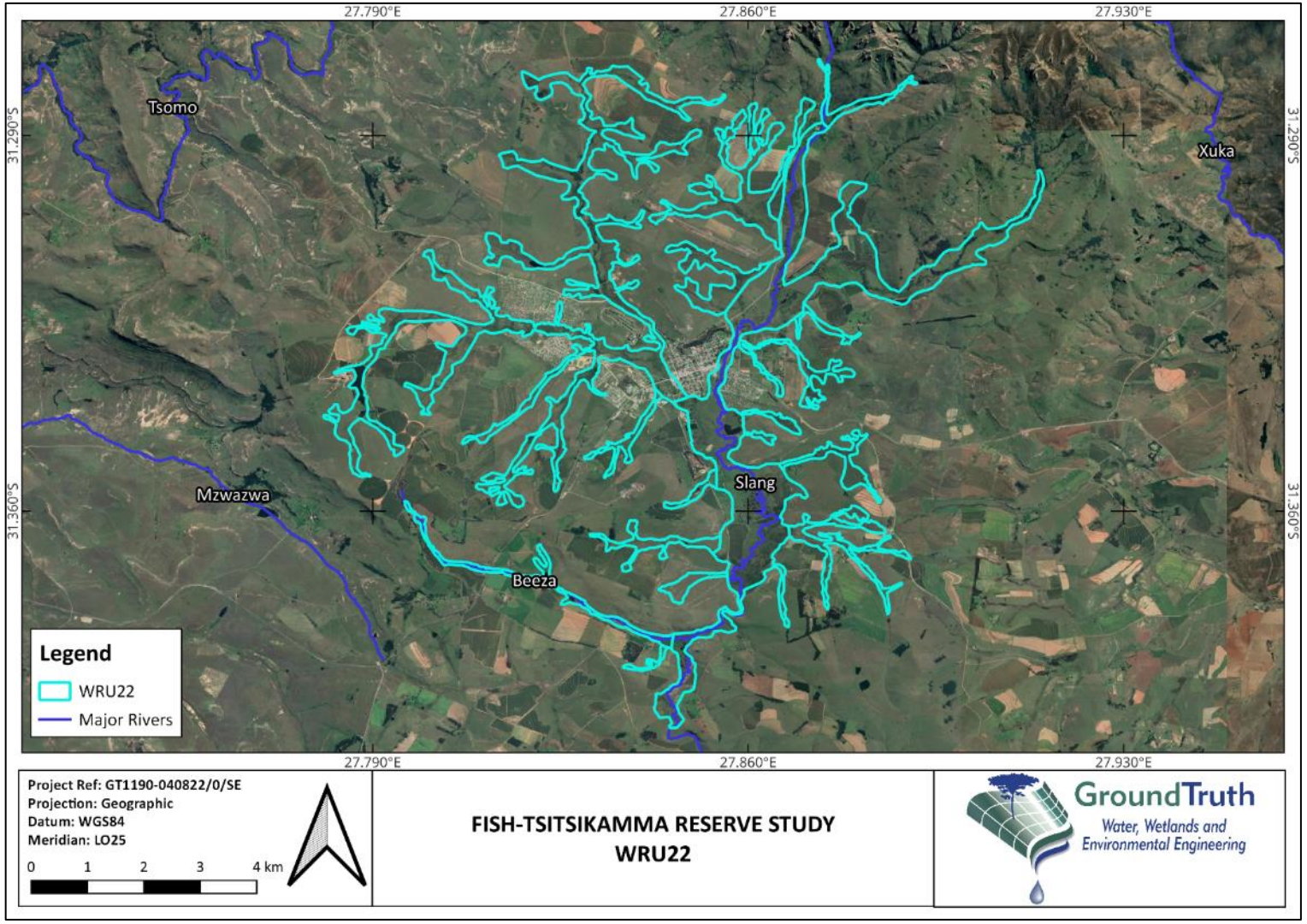

Figure 3-87 Overview of WRU22

Photo Log

Figure 3-88 **View of one of the tributaries flowing into the floodplain. This portion of the system has a series of dams to assist with the commercial agricultural practices which include crop cultivation and livestock grazing**

Figure 3-89 **View of an intact portion of the channelled valley-bottom wetland associated with the floodplain wetland**

Figure 3-90 **Solid waste and die back of wetland vegetation due to sewage contamination**

Figure 3-91 **View of die back of vegetation due to the accumulation of sewage within the wetland as a result of the surchraging sewerage infrastructure**

Figure 3-92 Surcharging manhole with the sewage being directed towards the wetland

Figure 3-93 Downstream portion of the floodplain, which is directly upstream of the geological control. This portion of the wetland resembles the most intact portion of the system and is also home to breeding cranes

Figure 3-94 **Incised floodplain channel (in the background), which has been restricted in its movements due to a geological control along its northern boundary and a flood protection berm along its southern boundary.**

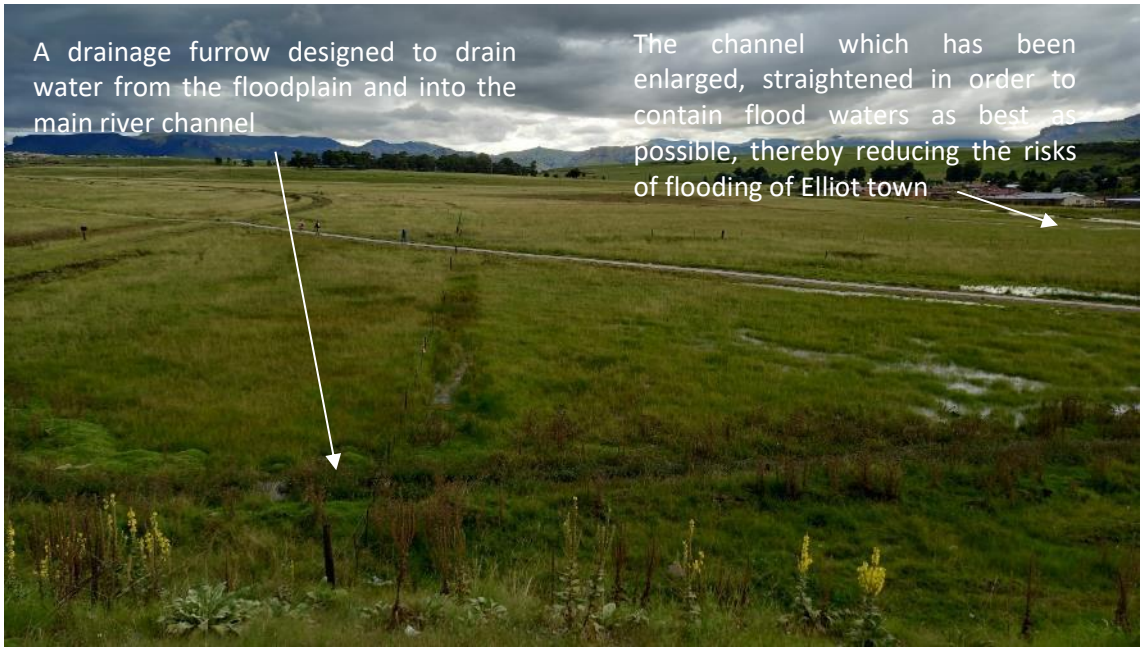

Figure 3-95 **The lowermost portions of the main western wetland arm feeding the Elliot floodplain**

Figure 3-96 **Flood-prone houses lying adjacent to the enlarged and straightened channel shown in the previous photo.**

Figure 3-97 **A low-lying flood-prone area of Elliot town located within the wetland complex.**

Figure 3-98 **The Slang River at the inflow to the upper portions of the Elliot floodplain, showing the vegetation dominated by kikuyu (*Pennistem clandestinum*) an alien pasture grass species.**

Figure 3-99 **Some of the upper portions of the Elliot floodplain, with the indigenous shrub *Leucosidea sericea* and predominantly indigenous pioneer grasses, including *Eragrostis* and *Sporobolus* spp.**

Figure 3-100 **Some of the upper portion of the Elliot floodplain, with the higher-lying areas dominated by grasses and the lower-lying areas by sedges.**

Figure 3-101 **The central portions of the Elliot floodplain, which contain some planted pastures as well as the most extensive areas still remaining under natural vegetation. The trees growing along the main river channel are alien willow tree species *Salix babylonica* and *Salix fragilis*, and a flooded oxbow lake can be seen in the third photo.**

Figure 3-102 **The lower portions of the Elliot floodplain which have largely been drained and converted to planted pastures except for a few low-lying oxbow lakes, which still support indigenous vegetation such as the sedge *Cyperus fastigiatus.***

Figure 3-103 **Hillslope seep wetland feeding one of the main valley bottom tributary arms of the Elliot floodplain, characterized by the short sedge *Fuirena pubescence* and grasses typically associated with good condition veld such *Tristachya leucothrix* and *Themeda triandra*.**

3.14 WRU24 – Sikombe and Xolobeni Wetland Complexes

Dates: 19th August 2022		**Fieldwork Team:** Craig Cowden & Fiona Eggers
Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU24 – Tier 1/2	31°11'6.716"S 30°03'18.58"E	The Sikombe wetlands are a complex of palmiet (*Prionium serratum*) wetlands along the Sikombe River. The complex comprises of valley-bottom and seepage palmiet-dominated wetlands. Upstream of a geological control and downstream of a confluence of two major tributaries and topographically defined between two hillslopes. The Xolobeni wetland complex also comprises of a suite of hydrogeomorphic units and decants into the Kwanyana River. This system is also defined at the base by a geological control. The vegetation of these systems is predominantly dominated by palmiet, with the drier patches seeing the establishment of woody species such as *Syzygium* spp . The tributaries are heavily eroded systems, which in some instances is attributed to the encroachment of alien invasive species, such as *Eucalyptus* spp, and *Acacia mearnsii*; into the headwaters of these systems. Of the two systems, the Xolobeni is more heavily infested with alien invasive species, and further includes the establishment of woodlots within the upper portions of the system. For the Sikombe wetland complex, the erosion of the upstream tributaries has likely been a continuous (possibly natural) process based on the degree of alluvial mounds within the wetland. The most recent rainfall of April 2022 has seen a large amount of sediment being mobilised and deposited within the upper reaches of the wetland habitat. The process of scour/erosion and sedimentation within the system has resulted in the formation of obviously over-steepened areas within the system. This over-steepening in the lower portion of the wetland has resulted in the formation of a headcut erosional feature, however, the headcut is onto bedrock and well-vegetated with palmiet, and as such the risk of aggressive advancement of the erosion is limited. It is anticipated that the headcut will slowly migrate upstream and will allow for a new stable state of the system to develop. The process of scour/erosion and sedimentation is considered to be a natural cycle within these systems. Downstream of the headcut along the open channel banks, a number of orchid species were identified, contributing to the uniqueness of the system. Erosional features were also identified within the Xolobeni wetland complex. However, the erosion of the system coincides with anthropogenic disturbances linked to the installation of a water supply pipeline across the system. The water supply

		pipeline and the associated pump station are considered to be critically important to the adjacent community who rely on the water for basic human needs. The placement of the pipeline across the wetland however, coincides with an over-steepened portion of the system, which has triggered erosion in the system which is threatening both the integrity of the wetland and the supply of water to the adjacent communities. Both the Sikombe and Xolobeni wetland complexes should be considered to be important systems within the landscape, although for differing reasons. The Sikombe complex is considered to be relatively intact and as such should be maintained as such within the landscape, as it is considered to be providing a high level of regulating and supporting services to the adjacent community members. The Xolobeni complex is considered to be moderately degraded with the possibility of becoming severely degraded if suitable mitigation interventions are not implemented. The wetland is an important system particularly as a supply of potable water to the adjacent communities. Should the erosion within the system not be stabilised, it is likely the communities will lose their source of potable water. The management of the catchment and in-system impacts, such as brick making and the adjacent crop lands/woodlots, must be carefully considered to protect the systems from further degradation.

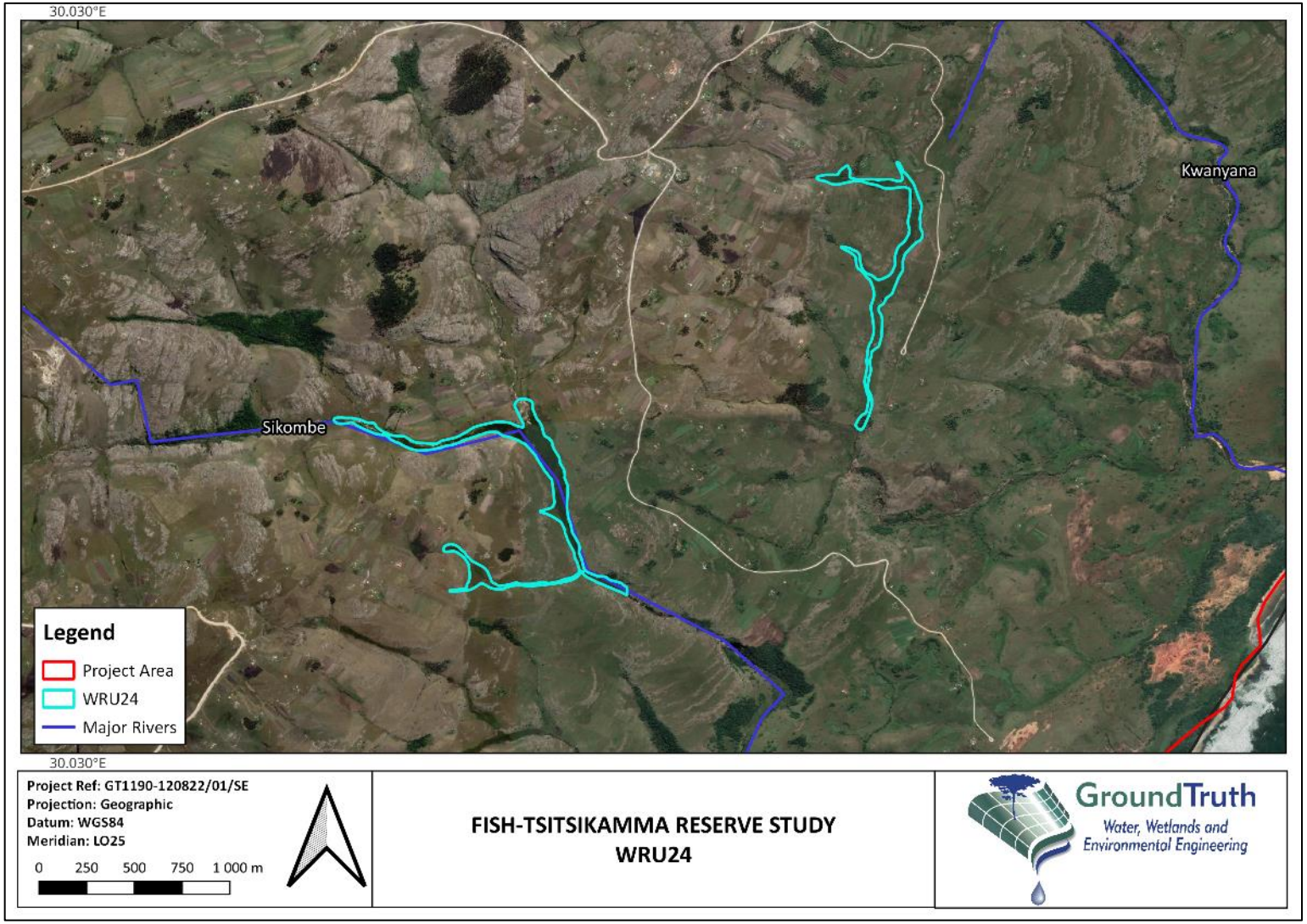

Figure 3-104 Overview of WRU24

Photo Log

Figure 3-105 Sikombe wetland: View of the upstream habitat of one of the major tributaries, which has been recently burnt

Figure 3-106 Sikombe wetland: View of the Palmiet wetland and the establishment of some woody species within the drier portions of the system

Figure 3-107 Sikombe wetland: Rotational madumbe/taro crop field adjacent to the valley bottom wetland in the seepage zones.

Figure 3-108 Sikombe wetland: Headcut erosion within the lower portion of the system.

Figure 3-109 Sikombe wetland: View of the geological control at the base of the palmiet wetland

Figure 3-110 Sikombe wetland: Palmiet wetland below the geological control

Figure 3-111 Xolobeni wetland: View of the upstream portion of the palmiet wetland and the woodlots within the wetland habitat

Figure 3-112 Xolobeni wetland: cultivation within the temporary zones of wetness associated with the seepage zones adjacnet to the vallye bottom wetland habitat

Figure 3-113 Xolobeni wetland: View of some of the catchment impacts, and the channel which has eroded onto bedrock (lighter areas)

Figure 3-114 Xolobeni wetland: Headcut erosion upstream of the water abstraction point

Figure 3-115 **Xolobeni wetland: Eroded palmiet wetland upstream of the water supply pipeline crossing point. Portions of the pipeline has been encased in concrete, however the channel has bypassed the concrete and has exposed portions of the pipeline**

3.15 WRU25 – Ludeke Halt Wetland

Dates:	**Fieldwork Team:**
18th August 2022	Craig Cowden & Fiona Eggers

Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU25 – Tier 2	30°50'58.96"S 29°43'06.23"E	The Ludeke Halt wetland complex is one of the tributaries of the Nqabeni River and comprises of hillslope seepage and channelled valley-bottom wetlands. The Ludeke Halt wetland is within communal land, with the catchment impacts varying between the various complexes. The catchment impacts vary between being dominated by houses, to catchments with very limited houses within the upper reaches of the catchment. In the catchment areas which are more heavily populated, the wetland habitat is generally more heavily impacted. The impacts include cultivation within the wetland and catchment area, grazing, sand/clay harvesting for brick making, and erosional features. The vegetation within the seasonal/permanent wetness zones is dominated by *Cyperus latifolius*, with the adjacent temporary wetness areas characterised by hygrophilous grassland areas. These intact temporary zones of wetness are generally more heavily utilised for grazing. The sub-catchments associated with the lesser populated areas are considered to be relatively intact with limited impacts mainly associated with grazing. The channelled valley-bottom habitat downstream of the R61, is the most severely impacted portion of the wetland complex. The tributary associated with this portion of the wetland has been entirely eroded, which has led to a large deposition of sediments within the valley-bottom and is assumed to have initiated the erosion further upstream in the main valley. An upstream dam has breached, which is assumed to have contributed to the erosion and incision of the main channel. The channel is approximately 2-3m below ground level. Alongside the channel a natural levee has formed, isolating some of the inputs from the adjacent seepage areas from the impacts of the channel and thus, these areas are considered to be relatively functional in comparison to the remining portions of the valley-bottom wetland habitat. Even though portions of the wetland complex are considered to be severely degraded, large portions of the upstream areas are still considered to be intact. Those systems, which have been slightly degraded, should ideally be identified as a priority for sensitive management to secure the level of ecosystem functioning.

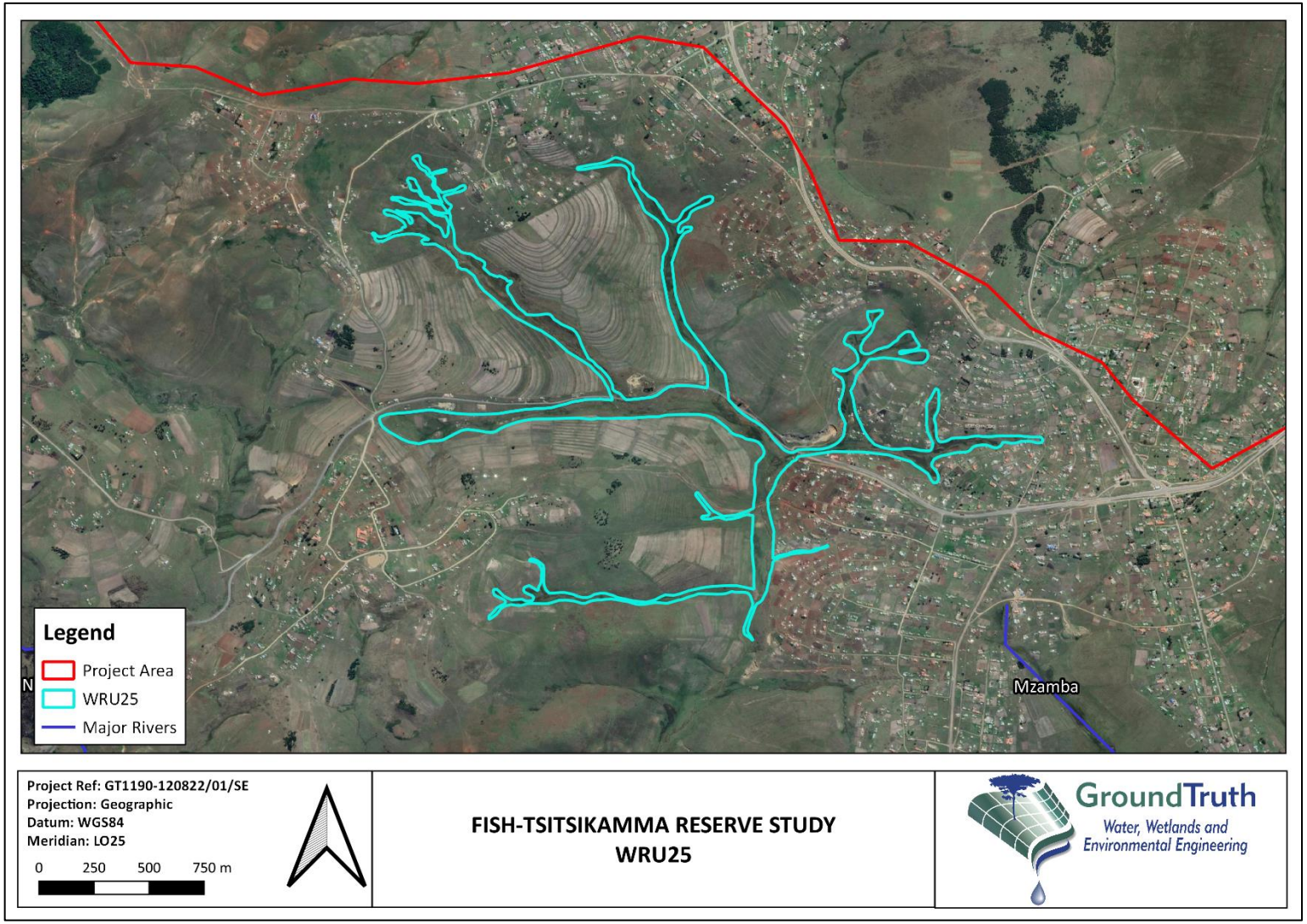

Figure 3-116 Overview of WRU25

Photo Log

Figure 3-117 **Eroded main channel with the seepage wetland maintained on the adjacent valley bottom terrace. The seepage wetland is entirely independent of the valley-bottom sysytem and is still considered to provide some ecosystem services within the modified landscape**

Figure 3-118 **An old flood channel associated with the valley-bottom wetland. A drain has been excavated from this pool of water towards the main channel, assisting with the desiccation of this feature and thereby, making the adjacent habitat more easily accessible for grazing purposes**

Figure 3-119 Seepage wetland adjacent to the valley-bottom wetland, however, erosional feastures are present upstream thereof, threatening the integrity of the seepage wetland

Figure 3-120 Incised channel associated with the main valley-bottom wetland.

Figure 3-121 **Breached dam wall within the valley-bottom wetland. The breach is most likely as a result of the advancing headcut erosional feature.**

Figure 3-122 **Evidence of brick making along the main portion of the Ludeke Halt wetland.**

Figure 3-123 **This tributary is more heavily impacted than some of the adjacent tribuatries. The density of houses and anthropogenic impacts on the wetlands are greater than the areas of the wetland. The seepage wetlands have in some instances been transformed to croplands. Additional impacts include grazing by livestock and over utilisation of the system resulting in the formation of headcut erosional features.**

Figure 3-124 **This tributary of the Ludeke Halt wetland is considered to be relatively intact with limited catchment and in-system impacts. The major impact on the system is associated with grazing by livestock, however, the limited number of livestock seen in the catchment area were not posing a threat to the seepage and valley-bottom wetland habitat**

Figure 3-125 **A tributary of the Ludeke Halt wetland, which has been encroached into by agricultural fields. Soils are also being harvested for brick making. Within the downstream portion of the tribuatry there is evidence of an old drain, which served as a cut-off drain along the edge of the system**

Figure 3-126 **View of the road culvert associated with the R61 which has led to the formation of a small headcut erosional feature upstream of the culvert. The headcut has not progressed too far due to the shallow bedrock layer within the system**

3.16 WRU26 – KwaMasele Wetlands

Dates:	**Fieldwork Team:**
26th July 2022	Donovan Kotze, Steven Ellery & Pumla Dlamini

Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU26 – Tier 1	32°57'29.08"S 27°20'32.16"E	KwaMasele wetland, located in a headwaters position south-west of Qonce town on communal land, comprises extensive hillslope seeps feeding valley bottom wetland areas. Much of the hillslope portions of the wetland occur within the hollows of Kommetjievlakte terrain, which is a unique landscape feature marked by repeated small ridges/mounds and depressions that give the landscape a rippled appearance and which are largely confined to an area between Qonce and Pirie Forest. In the KwaMasele wetland, this adds to the hydrological and habitat diversity of the overall wetland, which is predominantly temporarily saturated. It appears that the valley bottom areas were historically mainly unchannelled but advancing gully erosion has resulted in >50% of it now being channelled. Active erosion is continuing (exacerbated by heavy livestock trampling pressure) and threatens to erode through much of the remaining unchannelled area. Further adding to the risks of major erosion (and associated sediment release) is that the earthen dam wall in the wetland is in danger of overtopping, and ultimately breaching, where localized cattle trampling, etc. have reduced its height close to the dam's full supply level. While some of the original vegetation has been lost to cultivation and the dam in the wetland, most of the wetland remains as natural/semi-natural used for livestock grazing. The wetland has been subject to sustained high grazing pressure (although currently the upper portion of the wetland, which is fenced off, appears to be grazed more leniently). The wetland is now dominated by grass species favoured by high grazing pressure, notably *Eragrostis plana,* but the wetter areas (some of which are contained in the kommetjies) support predominantly short-growing sedges such as *Fuirena pubescens* and *Eleocharis dregeana*, together with hydric grass species such as *Eragrostis planiculmis*. The vulnerable species *Arctotis debensis* occurs on some of the Kommetjie ridges in and adjacent to the wetland. The high biodiversity value of the KwaMasele wetland derives especially from the wetland representing a significant area of Kommetjievlakte terrain, which, despite its uniqueness, is not formally conserved anywhere within its range.

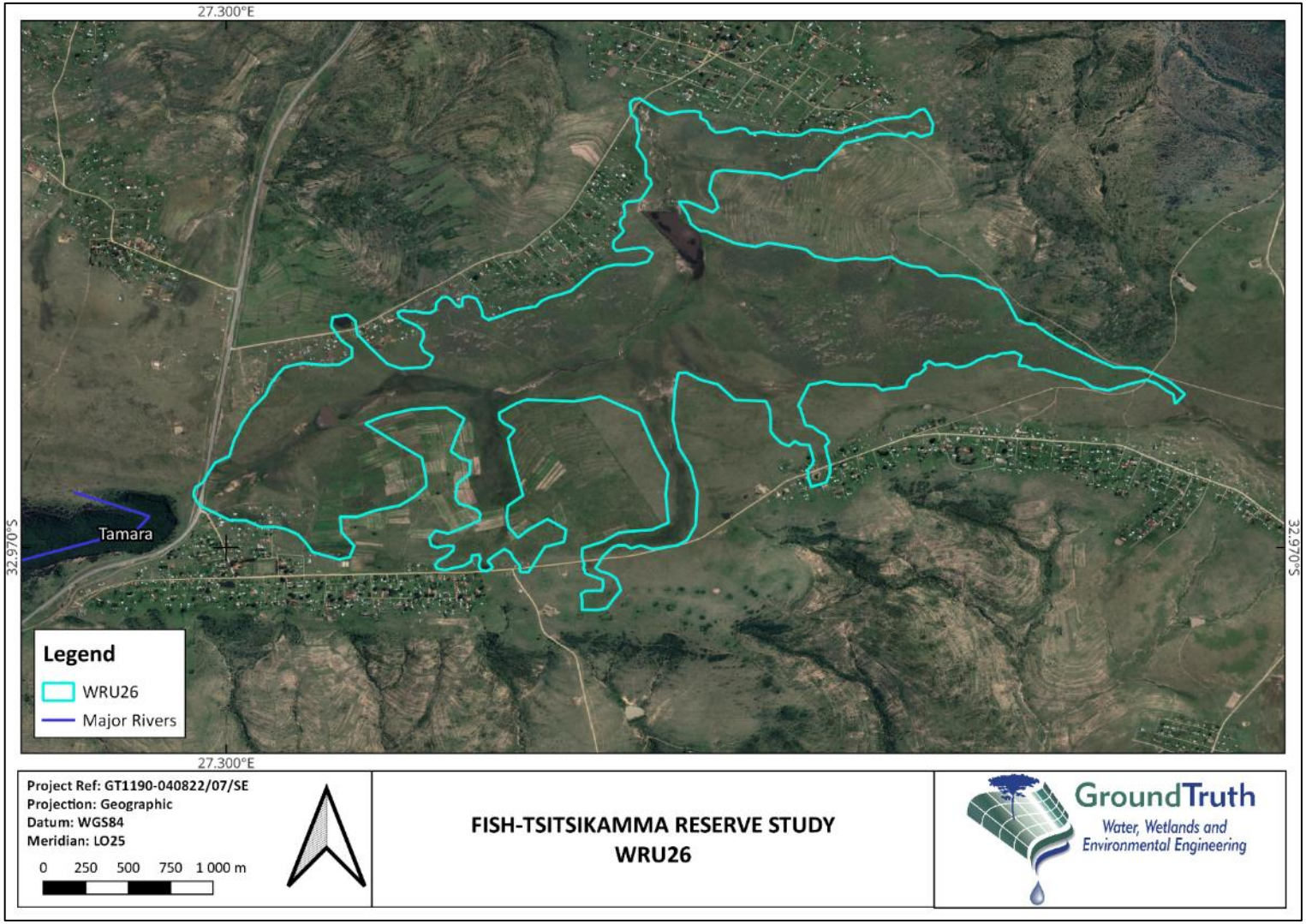

Figure 3-127 Overview of WRU26

Photo Log

Figure 3-128 **A hillslope seep dominated by the sedge *Fuirena pubescence* near the western inflow to the wetland, located in an area which is fenced off and, recently at least, appears to have been more leniently grazed than the central and eastern portions of the wetland.**

Figure 3-129 ***Arctotis debensis* growing in a kommetjievlakte area of the wetland amongst abundant earthworm casts. This is a vulnerable species known from only eight locations in a limited geographical area between Qonce and Perie Forest, and which appears well adapted to the extensive earthworm-mediated soil turnover characteristic of Kommetjievlakte (Dold et al. 2021)**

Figure 3-130 **The primary headcut at the head of the main gully (see the following four photos) which has advanced through an extensive area of unchannelled valley bottom and threatens a further large area of unchanelled valley bottom upstream. An active cattle path immediately upstream of the headcut can be seen, which is likely weakening the area under immediate threat of erosion.**

Figure 3-131 **The primary livestock crossing point through the main erosion gully in the wetland, subject to intense localized trampling.**

Figure 3-132 **The main erosion gully in the wetland (downstream of the headcut shown in the previous photo) with (a.) located shortly downstream with incomplete vegetation cover and (b.) somewhat further downstream where vegetation cover is generally higher and more sediment has accumulated than above but a cattle path has provided a focal point for localized incision and remobilization of some of the deposited sediment**

Figure 3-133 **The mid portions of the main erosion gully characterized by vigorous vegetation growth and the accumulation of sediment, indicating gully recovery is occurring here.**

Figure 3-134 **Three different locations where the hillslope component of KwaMasele wetland extends into adjacent Kommetjievlakte terrain, with (a.) on a midslope and the wetland areas confined to only a few of the deepest hollows such as that shown in the foreground; (b.) also on a footslope and wetland areas present in most of the hollows; and (c.) located at the transition between the hillslope and valley bottom.**

3.17 WRU27 – Jagpoort Wetland

Dates:	**Fieldwork Team:**
22nd March 2022	Donovan Kotze

Site Name & Level of Survey	**Site Coordinates**	**Comments / brief description**
WRU27 – Tier 2	32°57'29.08"S 27°20'32.16"E	The Jagpoort wetland, located south-west of Middelburg in the Loodsberg mountain foothills, comprises predominantly a channelled valley bottom associated with the Ventershoek River. Influent seeps occur where the valley bottom lies closest to south-facing Loodsberg mountains. The hydroperiod appears predominantly temporarily saturated. The vegetation is characterized by the sedge *Pseudoschoenus inanus* and mixed grasses as well as with *Phragmites australis* and shrubs (*Vachellia karroo*, *Searsia* spp. and *Leucosidea sericea*). Although moderately extensive areas of the central and lower valley bottom are cultivated and localized areas are infested with dense poplar stands, >60% of the wetland still comprises natural/semi-natural vegetation. However, much of the upper valley bottom areas, which appear to be inherently sensitive to erosion, are impacted by severe gully and rill erosion, and several erosion-control interventions are present in the wetland, likely constructed several decades ago through Department of Agriculture's soil conservation initiative. As for the Grootvlei, this wetland is considered to have a high importance in terms of maintaining biodiversity and as an agricultural resource, in particular because wetlands are generally scarce in the surrounding arid to semi-arid landscape. However, it is important to note that the overall Loodsberg area is a very unexplored area in terms of wetlands and it is suspected that with further investigation, representative wetlands in better ecological condition than the selected wetland may potentially be found.

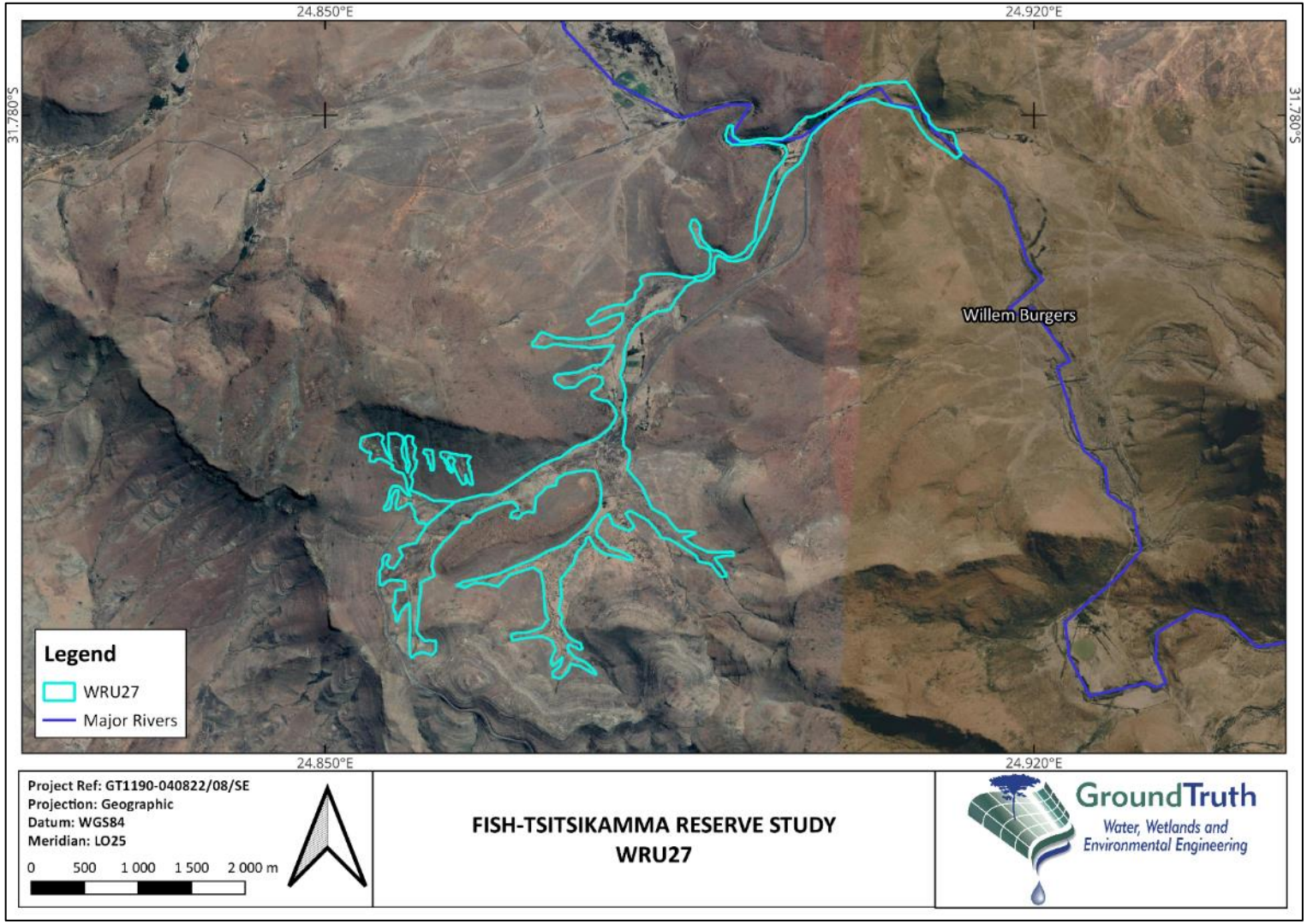

Figure 3-135 Overview of WRU27

Photo Log

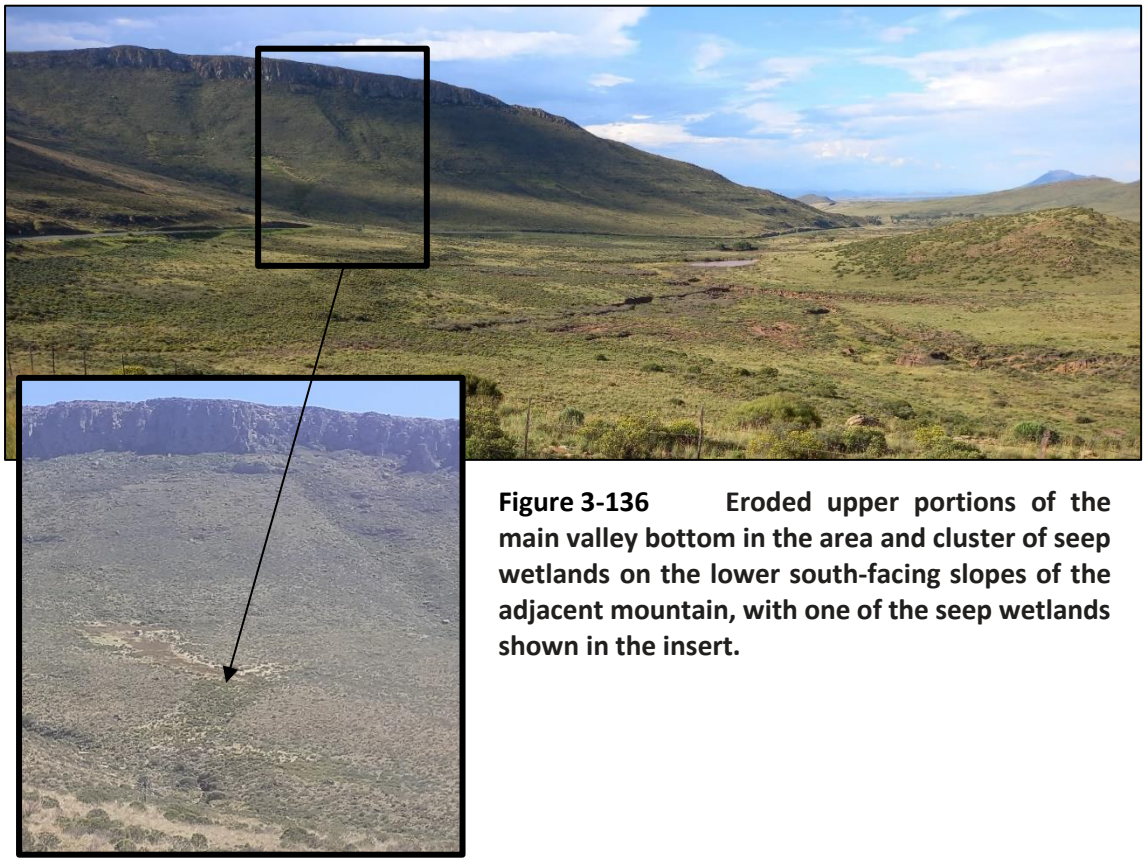

Figure 3-136 **Eroded upper portions of the main valley bottom in the area and cluster of seep wetlands on the lower south-facing slopes of the adjacent mountain, with one of the seep wetlands shown in the insert.**

Figure 3-137 **The lower portions of the valley bottom wetland, still largely intact and dominated by the sedge *Pseudoschoenus inanus* as well as with localized shrub-dominated and *Phragmites australis*-dominated areas.**

Figure 3-138 **An erosion-control concrete weir in a small valley bottom in the Loodsberg foothills, likely constructed several decades ago through Department of Agriculture's soil conservation initiative.**

Figure 3-139 **A soil berm associated with the weir shown above and which has been recently maintained. Also visible are *Salix babylonica* growing along the stream channel.**

Figure 3-140 **An historically-cultivated valley-bottom wetland in the Loodsberg foothills, characterized by pioneer grasses and shrubs and clumps of *Pseudoschoenus inanus* sedges.**

4. CAPACITY BUILDING

An important component of the wetland resource unit survey was to share expert knowledge and wetland survey methodologies with members of the Department of Water and Sanitation (both regional and national departments), members of the Eastern Cape Department of Economic Development, Environmental Affairs and Tourism (DEDEAT) and as well as members from the Department of Forestry, Fisheries and the Environment (DFFE) and forestry management staff and students with MTO and Amathole Forestry Company (AFC) (**Table 4-1**).

Due to the remoteness of some of the sites, not everyone from the governmental departments were able to attend all days of the fieldtrip, but the DWS officials joined the survey team at most of the WRUs. The learning that did occur at the WRUs that were visited together was valuable and detailed - where time allowed. The survey team shared several wetland delineation tips and tricks with the DWS officials using soils, vegetation and landscape position to quickly be able to tell if one is standing within or without the wetland boundary. In addition, at most of the sites the survey team shared information and guidance on scoring the Present Ecological State (PES) of the vegetation, with some opportunity provided for participants to individually score and then compare and discuss their scores with those assigned by the survey team. At one of the sites the survey team also completed the WET-Health (MacFarlane et al. 2020) assessment tool field datasheet with the DWS officials, which forms the primary form of data capture for these WRU surveys (see Appendix 1). Furthermore, general discussions were had about groundwater/surface water interactions in depression and seep wetlands, different hydroperiods of wetlands across the study area, defining HGM units, vegetation classification in wetlands, soil chemistry in wetlands and the different assessment techniques that will be used for the wetland component of the reserve study.

Overall, the enthusiasm and willingness to learn and ask questions made for a positive learning experience for all involved. In addition, DWS officials reported both improved capacity for understanding wetland functioning and for undertaking specific wetland-related tasks, notably reviewing environmental reports dealing with wetlands.

Table 4-1 Details of the individuals who received capacity building with at least one of the survey teams

Title	First Name	Surname	Department
Mr	Lwando	Dayimani	DWS: RP
Mr	Ncamile	Dweni	DWS: RP
Mr	Musa	Nyambi	DWS: RP
Ms	Nqabisa	Gwentswe	DWS: RP
Mr	Siyabonga	Ngcobo	DWS: RP
Ms	Zanele	Nyamende	DWS: RP

Mr	Lawrence	Mulangaphuma	DWS: HQ
Mr	Henry	Maluleke	DWS: HQ
Mr	Yongama	Mbanyeza	DEDEAT
Ms	Khanyisa	Mpisane	DEDEAT
Mr	Eric	Qonye	DEDEAT
Ms	Sinazo	Songca	DEDEAT
Ms	Margaret	Lowies	DFFE
Ms	Andani	Ndou	MTO (forester)
Mr	Buhlobo	Grootboom	MTO (forester)
Ms	Elizabeth	Mathebula	MTO (student)
Ms	Enathi	Puza	MTO (student)
Ms	Delani	Shongwe	MTO (student)
Ms	Karen	Kirkman	MTO (environmental advisor)
Mr	Desmond	Pilasa	AFC (student)

5. REFERENCES

DWS, 2022. Determination of Water Resource Classes, Reserve and RQOs in the Keiskamma and Fish to Tsitsikamma catchment: Status quo and delineation of Integrated Units of Analysis Report. *Draft - Version 01.* Report No: WEM/WMA7/00/CON/RDM/0322.

DWS, 2017. Development of Procedures to Operationalise Resource Directed Measures. Main Report. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd. Report no RDM/WE/00/CON/ORDM/0117.