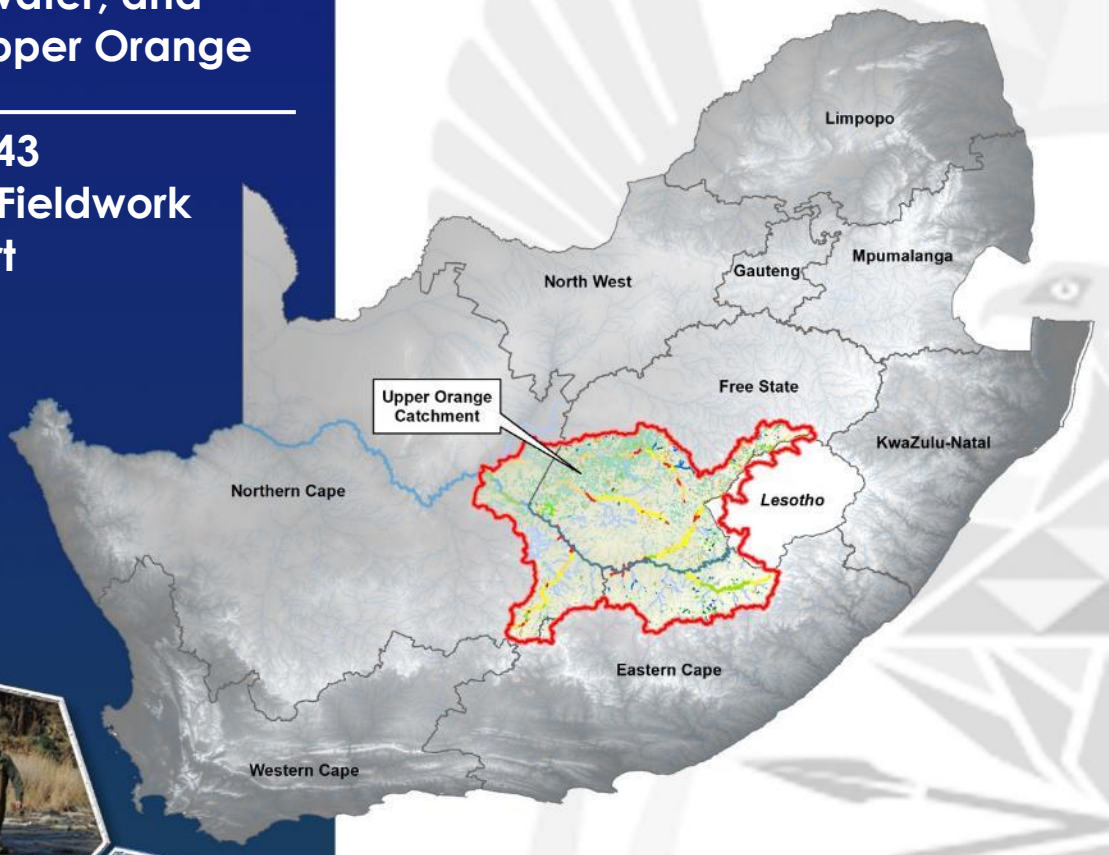
DEPARTMENT OF WATER AND SANITATION

A High Confidence Reserve Determination Study for Surface Water, Groundwater, and Wetlands in the Upper Orange

WP11343
Final Wetland Fieldwork Report



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Prepared by:

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Director, GroundTruth

DEPARTMENT OF WATER AND SANITATION

Chief Directorate: Water Ecosystems Management

Approved for DWS by:

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Ndivhuwo Netshiendeulu (Project Manager) *Kwazikwakhe Majola (Scientific Manager)*

Date: …….. *Date:* ……..

……

Director: Yakeen Atwaru *Date*

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Reports as part of this project:

Bold type indicates this report

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LIST OF ACRONYMS

Acronym	Definition
BHN	Basic Human Need
CD:WE	Chief Directorate: Water Ecosystems
DWS	Department of Water and Sanitation
EIS	Ecological Importance and Sensitivity
EWR	Ecological Water Requirements
HGM	Hydrogeomorphic
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

The National Water Act (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 seriously 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). As part of the RDM, a Reserve must be determined for a significant water resource, as a means to ensure a desired level of protection.

The Reserve (quantity and quality) is defined in terms of the Ecological Water Requirements (EWR), ensuring the water required to protect aquatic systems (water quality, habitat, and biota) of the water resource are provided for; and Basic Human Needs (BHN), ensuring that the essential needs of individuals served by the water resource in question are provided for. 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 Chief Directorate: Water Ecosystems (CD: WEM) of the Department of Water and Sanitation (DWS) is tasked with the responsibility of co-ordinating all Reserve Determination studies in terms of the Water Resource Classification System (WRCS). These studies include the surface water (rivers, wetlands and estuaries) and groundwater components of water resources. The Reserve has priority over other water use in terms of the NWA, and should be determined before license applications are processed, particularly in stressed and over utilised catchments.

Consequently, the CD: WEM have identified the need to determine the Reserve for the Upper Orange catchment (rivers, wetlands and groundwater) forming part of the Orange Water Management Area (WMA6) in accordance with the WRCS. This report serves as a summary of the wetland fieldwork component of the study.

2. METHODOLOGY

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

A site visit was conducted from the 10th to the 14th of April to review the greater study area and the selected RUs within the study area (**Figure 2-1**). 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.

2.1.1 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 downstream users; and
    - Whether the wetland is a priority wetland according to the NFEPA/FEPA spatial dataset.
- Due to site access constraints associated with landowner permission and the poor road conditions across the study area, some of the RUs which were supposed to have been reviewed during the fieldwork were not.
- 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.

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 three tiers of assessment that were adopted for the fieldwork.

Table 2-1 Tiered approach to the assessment of the wetland resource units identified in the Upper Orange Catchment

Attributes	Tier 1	Tier 2	Tier 3
Intensity of field verification	Very low intensity - desktop based verification and/or landscape-based verification from easily accessible road – 15-30mins	Low intensity - desktop and/or landscape based verification with at least two verification points – 1-2 hours	Moderately low to moderate intensity, generally involving at least half a day of field verification in the RU
Level of engagement with landholders and stakeholders	Entirely absent	Generally, very low or entirely absent	Generally moderately low to moderate. Discussions generally held with at least one key informant, landowner and/or stakeholder
Level of detail of the wetland descriptions	Generally, very low, but including confirmation of hydrogeomorphic (HGM) unit type at the point of reference and any land-cover classes visible from viewing point.	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.	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.
Specificity and detail of the Resource Quality Objectives (RQOs)	Relatively general and limited in detail	Relatively general and limited in detail	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

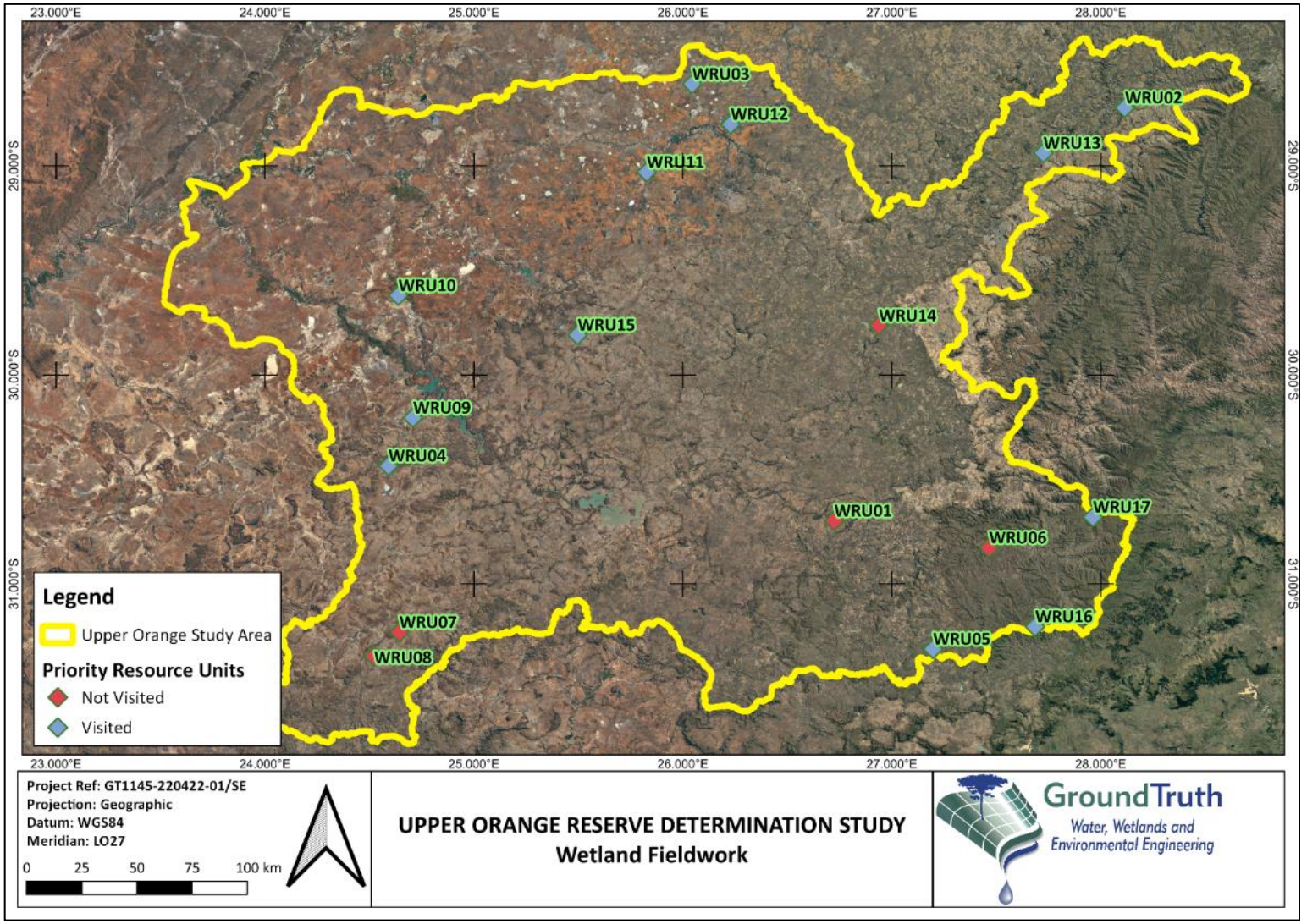


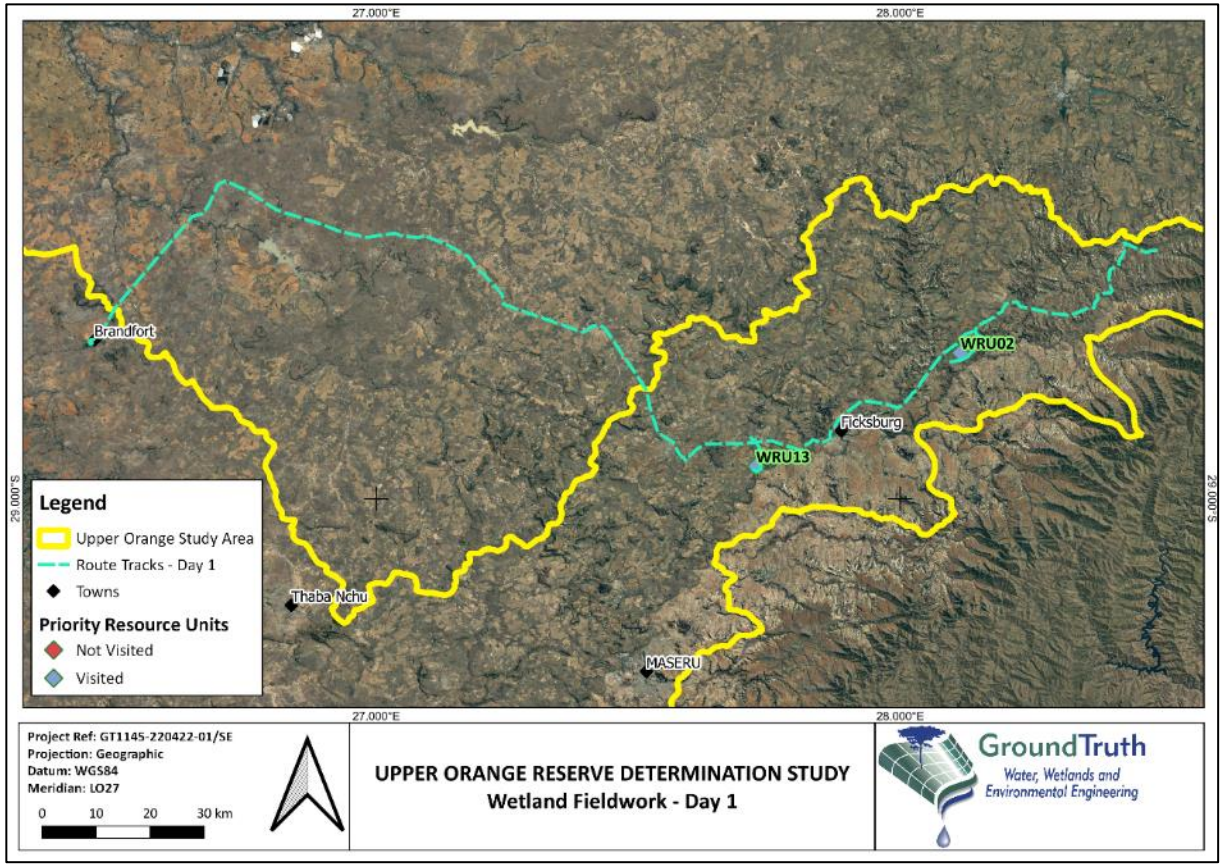
Figure 2-1 Overview of screened sites that were visited during the fieldtrip

3. FIELDWORK DETAILS

3.1 Day 1

Dates:	**Fieldwork Team:**
10th April	Craig Cowden and Steven Ellery

Fieldwork route:



Survey Sites:

Site Name	Site Coordinates		Level of Survey	Comments / brief description
	Latitude	Latitude		
WRU02	28°43'48.03"S	28°06'49.33"E	Tier 2	WRU02 is a large floodplain wetland approximately 260ha in size and is located to the south of the R26 road between Fouriesburg and Ficksburg. The wetland flows in a southerly direction and feeds into the Mohokare River (also known as the Caledon River) from the north (**Figure 3-1**). The Brandwater River flows through the floodplain wetland, and due to the incision of the Mohokare River, the Brandwater River too has incised, and no longer appears to overtop its banks to feed the floodplain wetland. However, multiple seepage wetlands and small tributaries of the WRU02 wetland are maintaining wetland habitat along the broad valley-bottom. The wetland is utilised for grazing, hay production and maize cultivation.
WRU13	28°55'59.70"S	27°43'14.61"E	Tier 2	WRU13 is a large wetland complex approximately 275ha in size and is similarly located between the R26 road and the Mohokare River and is located on the Rantsho River. The wetland is located to the west of Ficksburg and is directly adjacent to the Peka Bridge Border Post between South Africa and Lesotho. The floodplain wetland has three distinct sections that are separated by a very confined section of valley (**Figure 3-2**). The northern lobe of the wetland is bisected by the R26 road – the section of wetland upstream of the R26 is utilised for hay production and grazing while the section downstream of the R26 appears only to be utilised for grazing. The channel in the northern section is moderately sinuous and does not appear to be overly incised hence the retention of floodplain features in the valley-bottom. The northern lobe becomes confined and loses its floodplain characteristics as the valley narrows. The valley then loses confinement again and floodplain features appear again. Approximately 2km downstream of this flood out, the channel loses confinement as well and the wetland becomes an unchannelled valley-bottom wetland. A small, stable channel has formed between the unchannelled valley-bottom wetland and the Mohokare River. Land uses in this southern section of the wetland include grazing, hay production, water supply (a small off-channel dam) and cultivation. Runoff from a chicken run was noted entering the unchannelled valley-bottom wetland.

3.1.1 WRU Maps

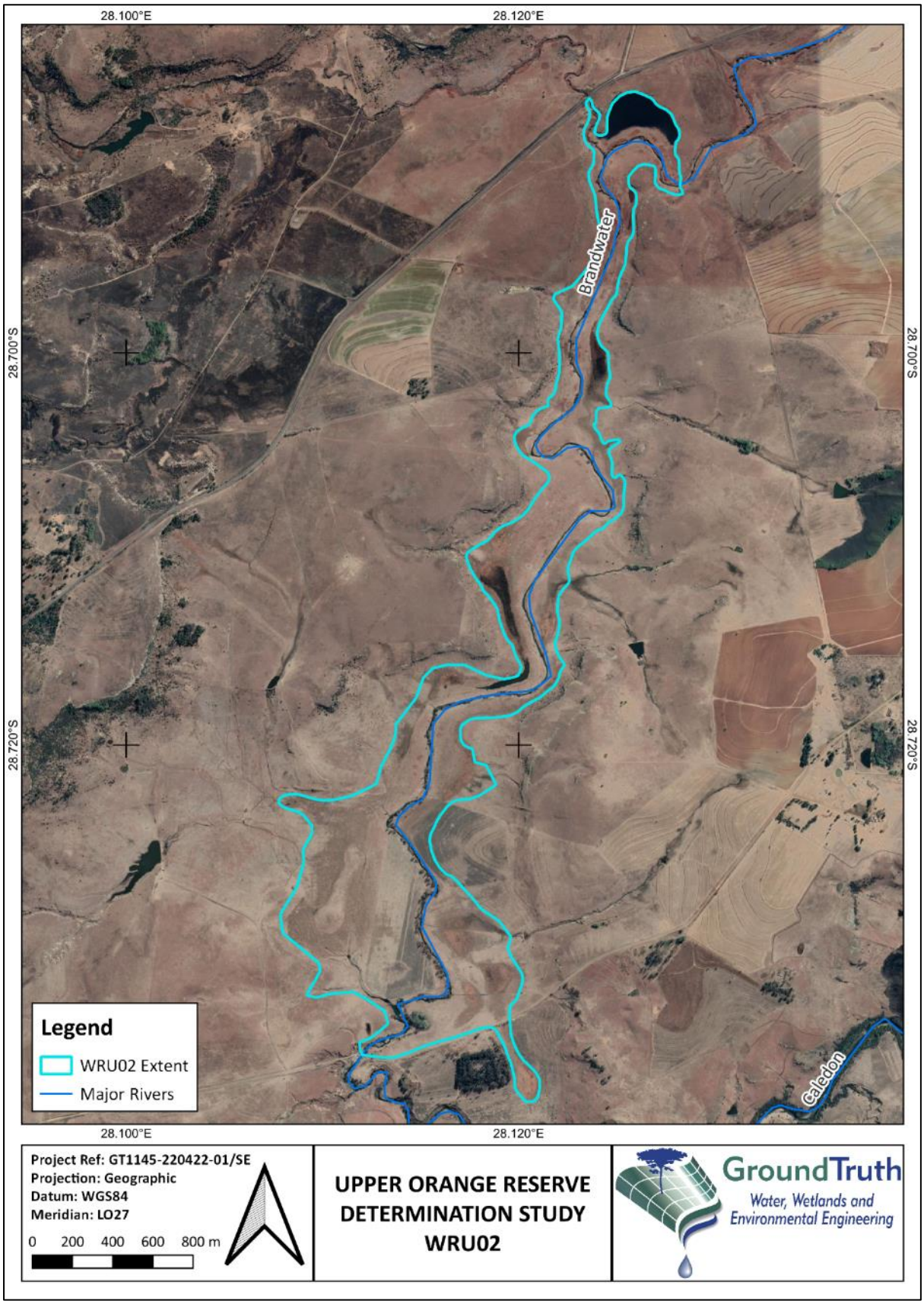


Figure 3-1 Overview of WRU02

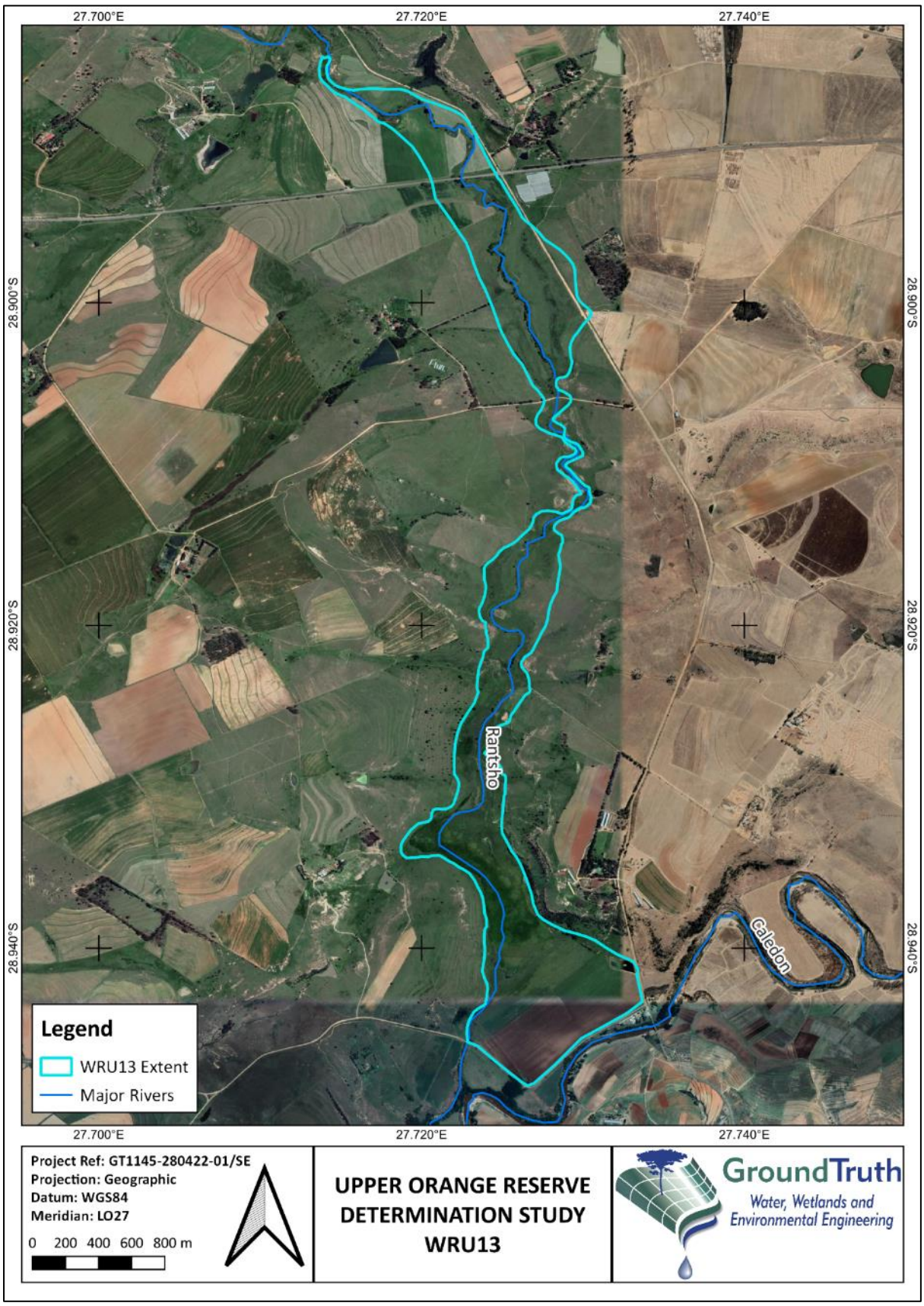


Figure 3-2 Overview of WRU13

3.1.2 Photo log

Site Name: WRU02

Top Left: Deeply incised and widened channel of the Brandwater River as it flows out of the southern portion of the WRU02 wetland.

Top Right: Floodplain features still maintained by lateral processes as indicated by darker patches of vegetation in the central and right-hand side of the photograph.

Bottom: Oxbow lake located in the northern portion of the floodplain wetland.

Site Name: WRU13

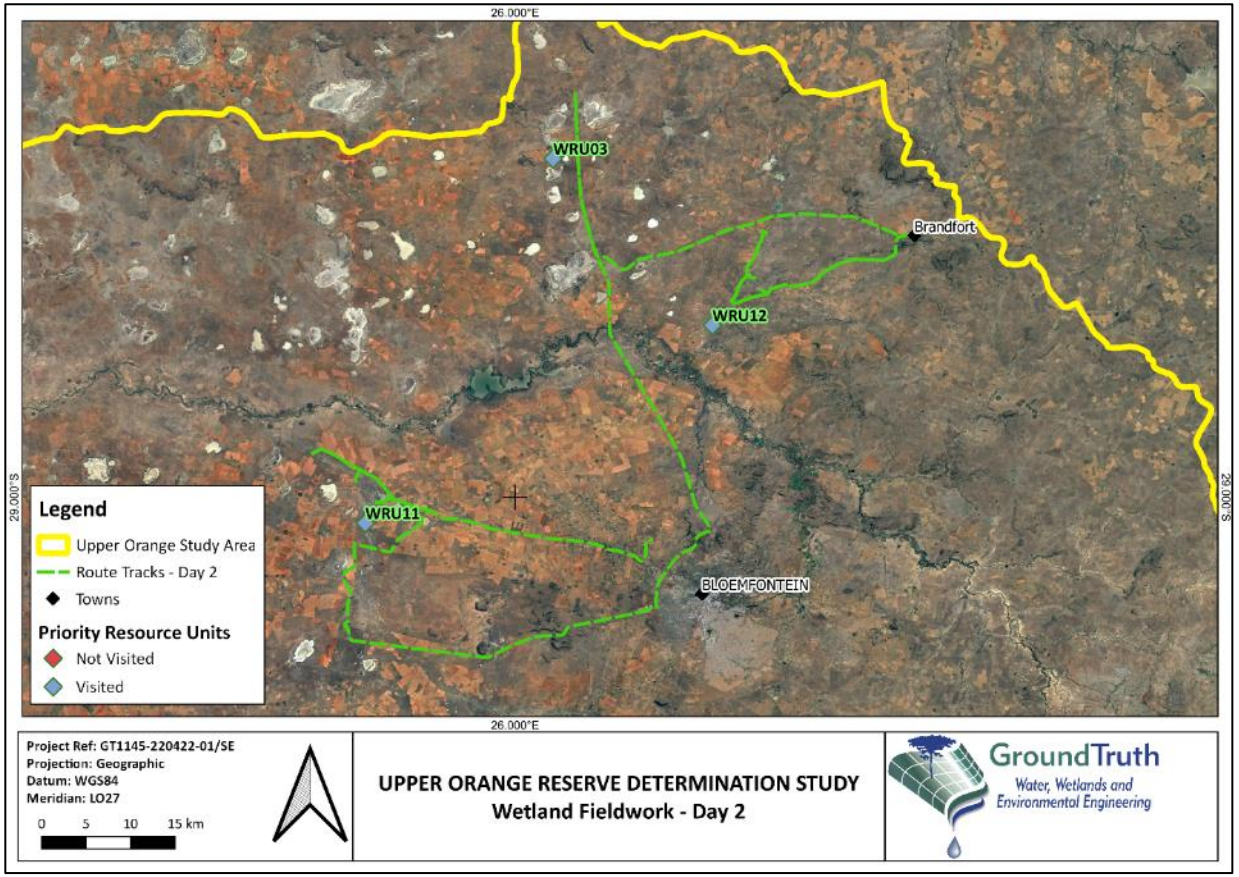
Left: Middle section of the floodplain wetland before it loses confinement. Dark patches adjacent to the channel indicate wetland vegetation and lateral seep processes that support wetland habitat.

Right: Picture taken from the toe of the wetland looking upstream. Green fields in the foreground are cultivated and green band in the middle of the picture is the extensive unchannelled valley-bottom and reedbed.

3.2 Day 2

Dates:	**Fieldwork Team:**
11th April	Craig Cowden and Steven Ellery

Fieldwork route:



Survey Sites:

Site Name	Site Coordinates		Level of Survey	Comments / brief description
	Latitude	Latitude		
WRU12	28°42'36.67"S	26°17'42.21"E	Tier 3	WRU12 is a large wetland complex that includes a large wetland flat and a discontinuously channelled valley-bottom wetland (**Figure 3-3**). The entire complex is approximately 1700ha in size and has a very gentle gradient. The northern (upstream) section of the wetland is characterised by an extremely flat wetland with shallow soils and a mix of seasonal and permanent zones of wetland. Small preferential flow paths were observed within the wetland flat that are generally characterised by permanent wetland, with the majority of the surrounding areas characterised by seasonal wetness. This wetland was included as a RU because the bottom half of the wetland receives flows from Brandfort via the Keeromspruit River which, according to local informants, has been receiving raw sewage from a dysfunctional wastewater treatment works in Brandfort. The bottom half of the wetland is characterised by greater relief and a more well defined valley line – hence the formation of a discontinuously valley-bottom wetland. The wetland is predominantly used for grazing and a number of water supply dams have been constructed along the Aardooringspruit.
WRU03	28°44'19.82"S	26°03'50.64"E	Tier 1	WRU03 is a large depression wetland complex consisting of a total of 27 depression wetlands that range in size from 6ha to 1'800ha (**Figure 3-4**). The largest of these wetlands is known as Soutpan and is an active salt mine as the name suggests. A number of the other depression wetlands have also been impacted by mining activities, while the majority of the wetlands appear to be in relatively good health. These depression wetlands are generally characterised by seasonal wetness and associated seasonal wetland vegetation that typically consist of a mosaic of grass and sedge species. These depression wetlands provide very important nesting and feeding habitat for aquatic birds in the region.
WRU11	28°59'52.00"S	25°50'03.80"E	Tier 3	WRU11 is another large wetland complex consisting of a number of depression wetlands, a discontinuously channelled valley-bottom and a channelled valley-bottom wetland (**Figure 3-5**). The mainstem valley-bottom wetland is approximately 2800ha in size with the depression wetlands scattered alongside this valley-bottom wetland. The valley-bottom wetland is located around the Kaalspruit River, which joins the Modder River downstream

				of the wetland resource unit (WRU). The catchments of this WRU is dominated by agriculture – predominantly maize and sunflower cultivation. The catchment land use has had a significant impact on a number of the depression wetlands in the RU through extensive sedimentation and possible nutrient loading from fertilizers used in the surrounding agricultural areas. The mainstem wetland is predominantly utilised for grazing and has impacts associated with channel incision in the lower portion of the WRU. A large dam exists in the upstream section of the mainstem wetland which is also having a significant impact on the hydrological connectivity of this wetland.	

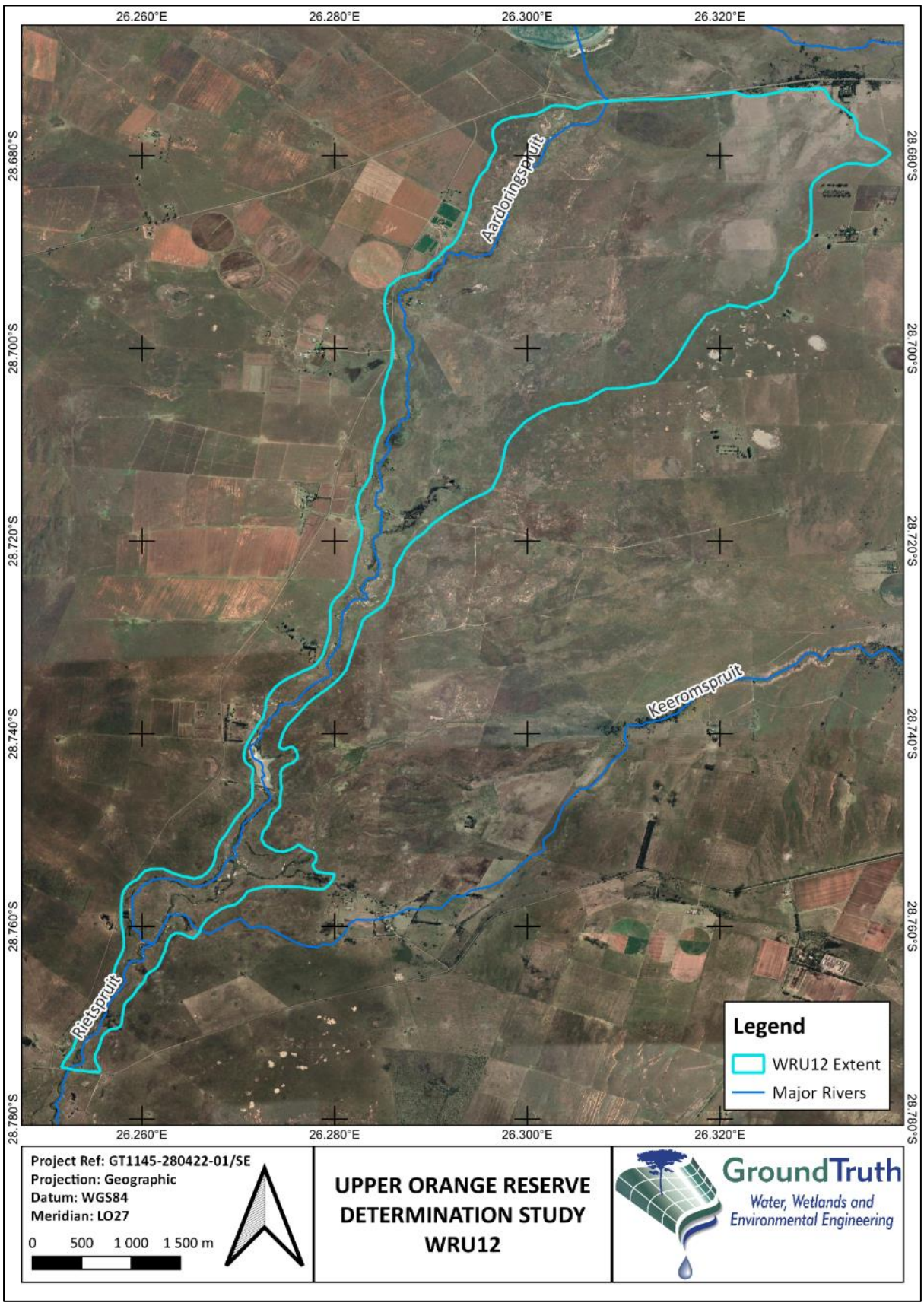


Figure 3-3 Overview of WRU12

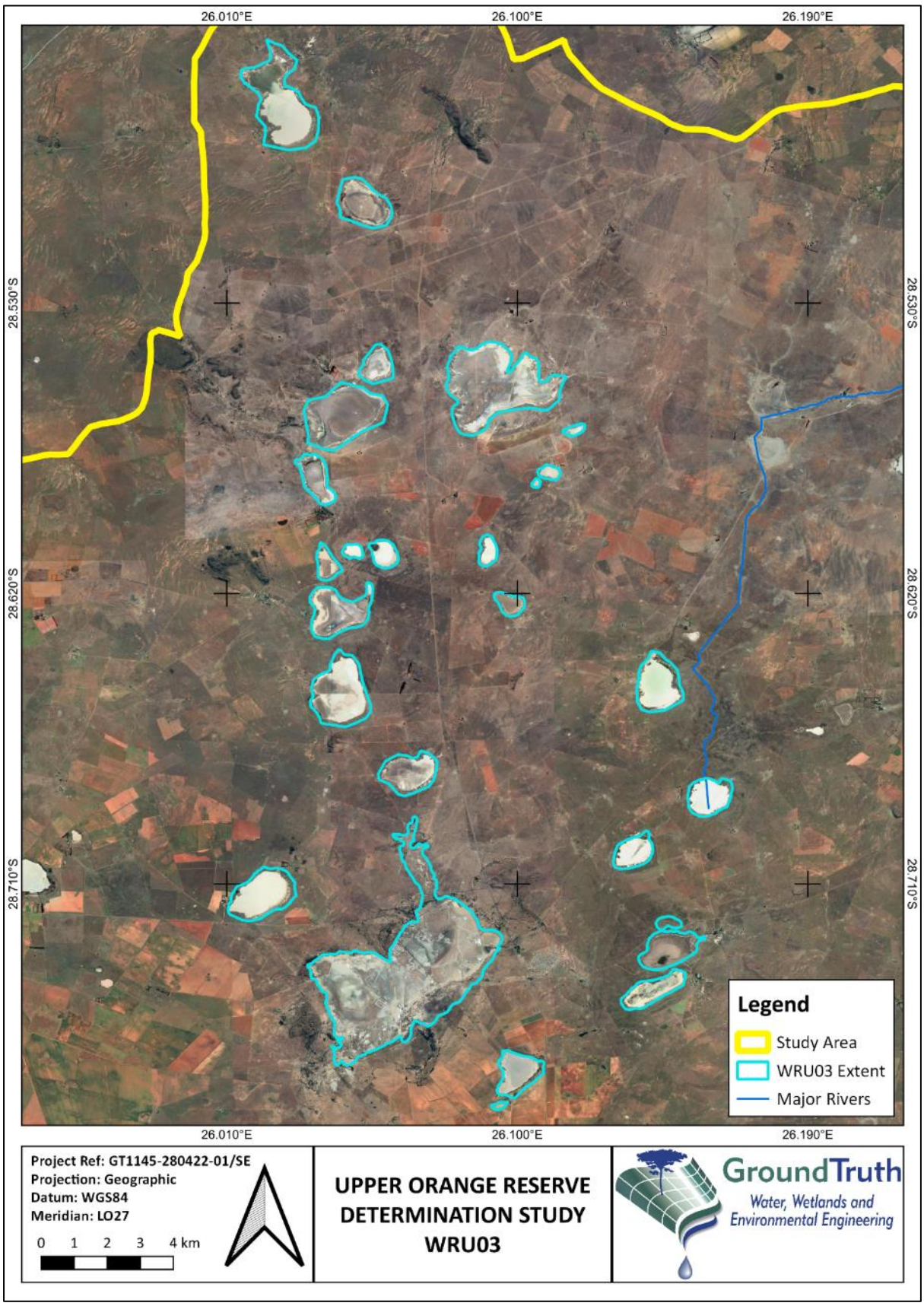


Figure 3-4 Overview of WRU03

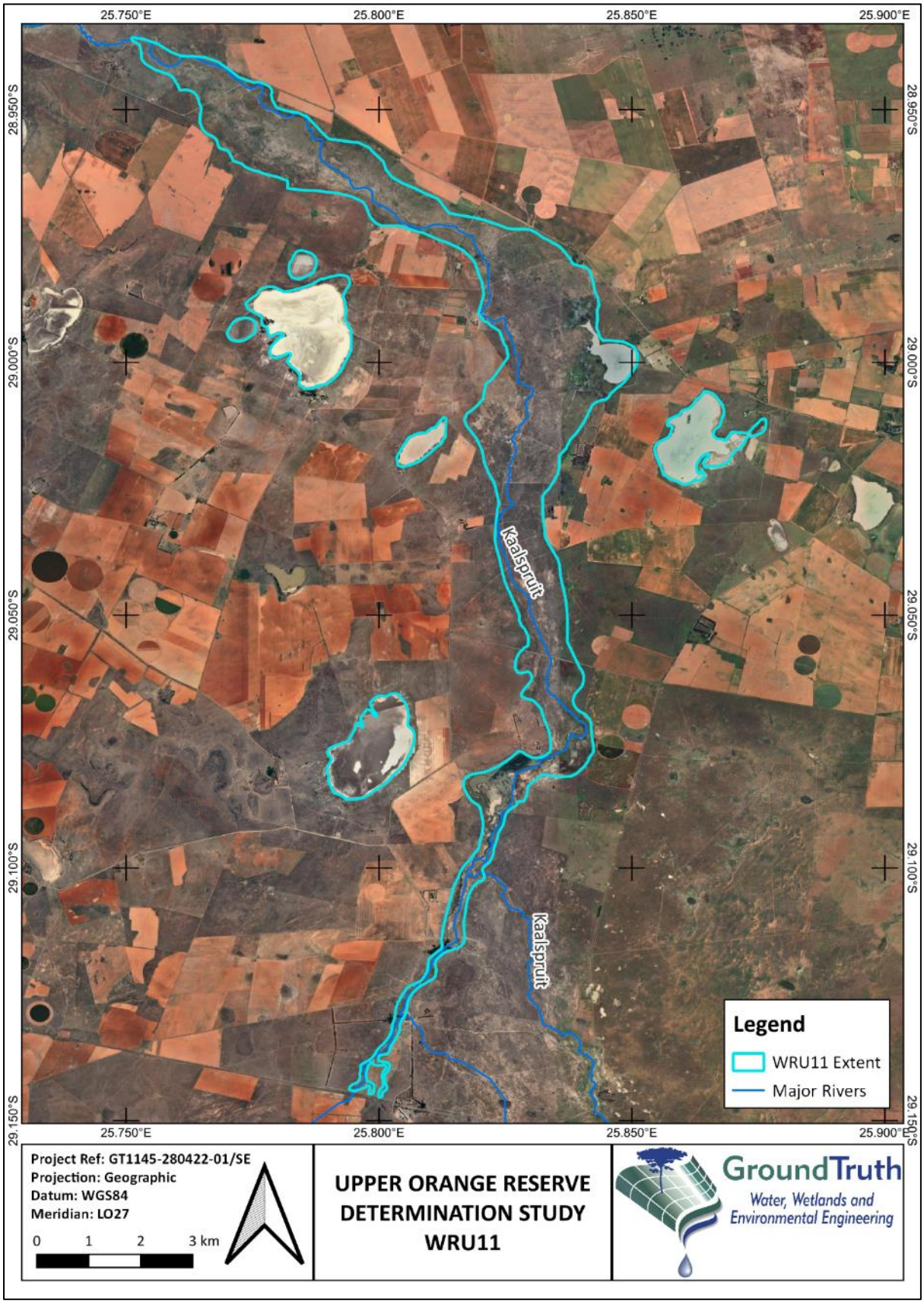


Figure 3-5 Overview of WRU11

3.2.1 Photo log

Site Name: WRU12

Left: Middle section of the large wetland flat looking upstream. Extremely flat topography with extensive areas of standing water due to recent heavy rains in the region.
Right: Evidence of very shallow soils in areas of the wetland. Picture depicts area of non-wetland, but similar outcrops were encountered frequently when augering within the wetland boundary itself.

Site Name: WRU03

Left: Large depression wetland forming a part of WRU03. Grassed depression wetland is depicted within the black line in the photograph.

Right: Picture of Soutpan with evidence of vegetation clearing in the foreground in preparation to set up a salt mining operation, and an active salt mining operation located to the right of the photograph.

Site Name: WRU11

Top: Large depression wetland forming a part of WRU11. This depression wetland is unique in that it receives water from the main valley-bottom wetland at its head and feeds water back into the valley-bottom wetland at its toe.

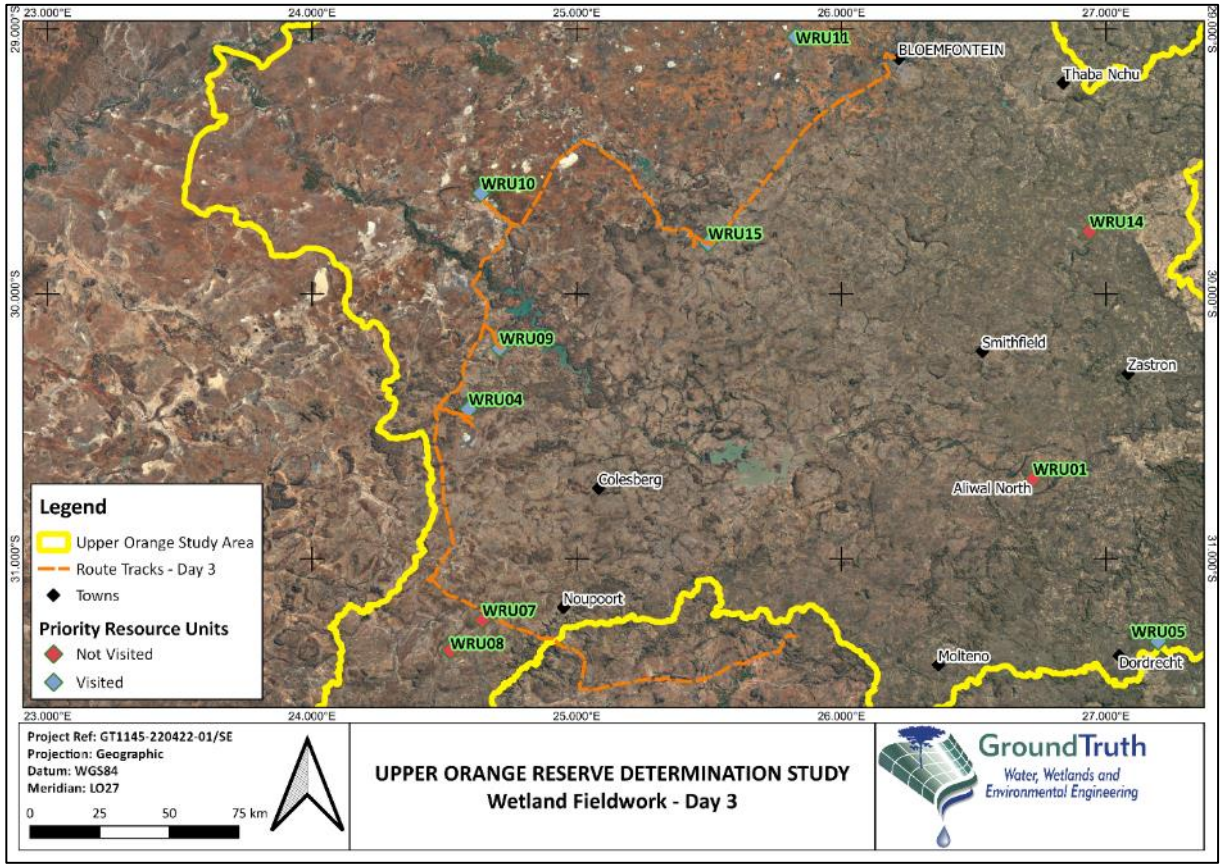
Bottom Left: Channelled section of wetland towards the north of the mainstem valley-bottom wetland.

Bottom Right: Discontinuously channelled valley-bottom section in the wide central portion of the mainstem wetland.

3.3 Day 3

Dates:	**Fieldwork Team:**
12th April	Craig Cowden and Steven Ellery

Fieldwork route:



Survey Sites:

Site Name	Site Coordinates		Level of Survey	Comments / brief description
	Latitude	Latitude		
WRU15	29°49'01.45"S	25°28'32.13"E	Tier 2	WRU15 is a large contiguous series of wetlands that originate from four different river/watercourse systems and coalesce into a valley-bottom wetland (**Figure 3-6**). The wetland type can be considered to be a discontinuously channelled valley-bottom wetland as the channel is not consistent throughout the HGM unit. The entire wetland complex is approximately 1900ha in size and flows into the Prosesspruit River. The northern arm of the wetland receives water inputs from the Jagersfontein diamond mine as well as the Jagersfontein wastewater treatment works. The central two arms that flow from west to east are both characterised by straightened channels – possibly as a result of the railway embankment and associated culverts beneath the embankment. Large areas of erosion were also observed onsite.
WRU10	29°38'02.89"S	24°39'00.21"E	Tier 1	WRU10 is a large series of depression wetlands that are hydrologically connected both via surface and groundwater. These depression wetlands range in size from 7ha to 1'200ha ha. These fluvially connected wetlands appear to flow in a south-easterly direction into the Lemoenspruit River which is a tributary of the Orange River (**Figure 3-7**). The large area to the south of the depression wetlands initially appeared to have wetland characteristics from a desktop scan of the area, but upon arriving onsite it was clear that these features are indicative of an active dune field and are not wetlands. A number of these wetlands have been impacted upon by the agriculture to the north and east of the complex, resulting in sedimentation and water quality issues in the adjacent wetland.
WRU09	30°12'03.82"S	24°41'54.63"E	Tier 1	WRU09 is predominantly a fluvial system that has wetland indicators which have formed in the flood back of a dam along the Hondeblaf River before it flows into the Vanderkloof Dam. Its close link to the Vanderkloof Dam was the primary reason for its inclusion as a WRU. However, upon visiting the WRU it was decided to exclude it from any further assessment as the wetland area is in fact artificial in nature and is significantly smaller than initially expected based on the desktop assessment of the system.
WRU04	30°29'03.80"S	24°37'01.38"E	Tier 1	WRU04 is a complex of two different wetlands, a depression wetland approximately 1'100ha in size and an unchannelled valley-bottom wetland approximately 190ha in size

				(**Figure 3-8**). It was included for its proximity and hydrological connection to the Vanderkloof Dam, and the unchannelled valley-bottom wetland provides important ecosystem services in terms of water quality enhancement and sediment trapping to these downstream freshwater ecosystems. The depression wetland was included in the WRU because it has a significant catchment and may have groundwater linkages to the valley-bottom wetland downstream. It is also an important wetland for unique assemblages of fauna and flora in the area. The large grey area to the east of the depression wetland is a dam in which wetland conditions have been created.	

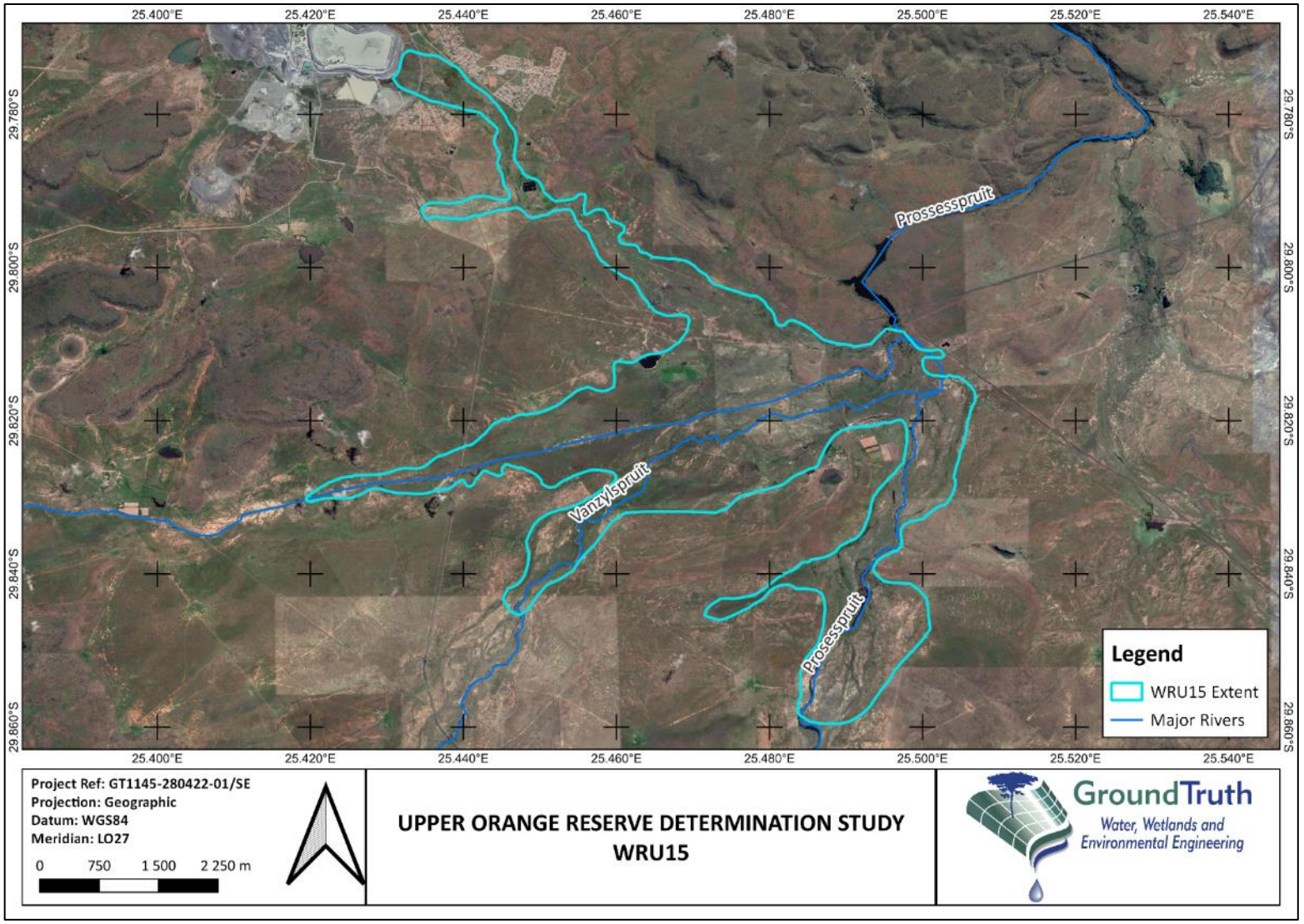


Figure 3-6 Overview of WRU15

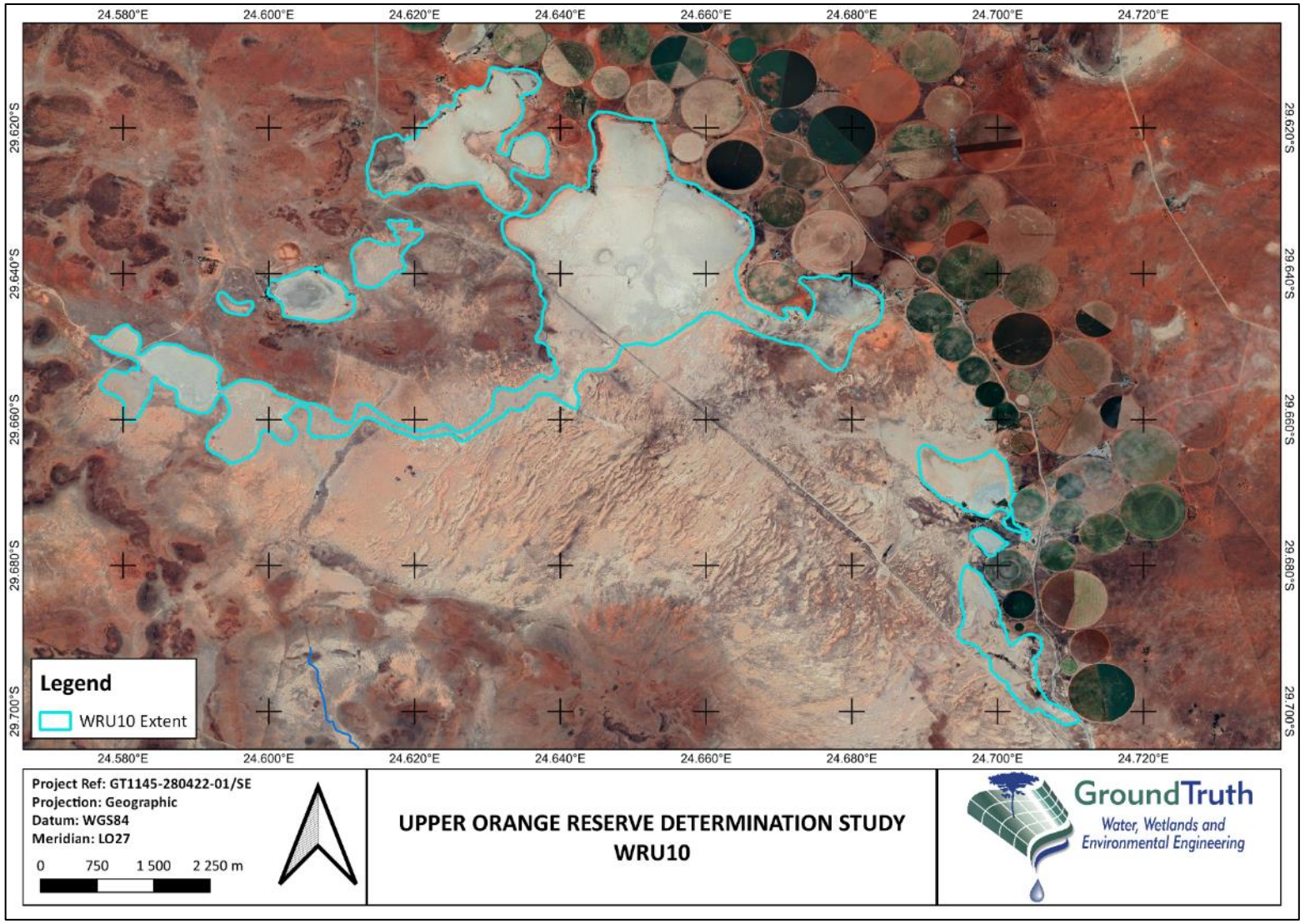


Figure 3-7 Overview of WRU10

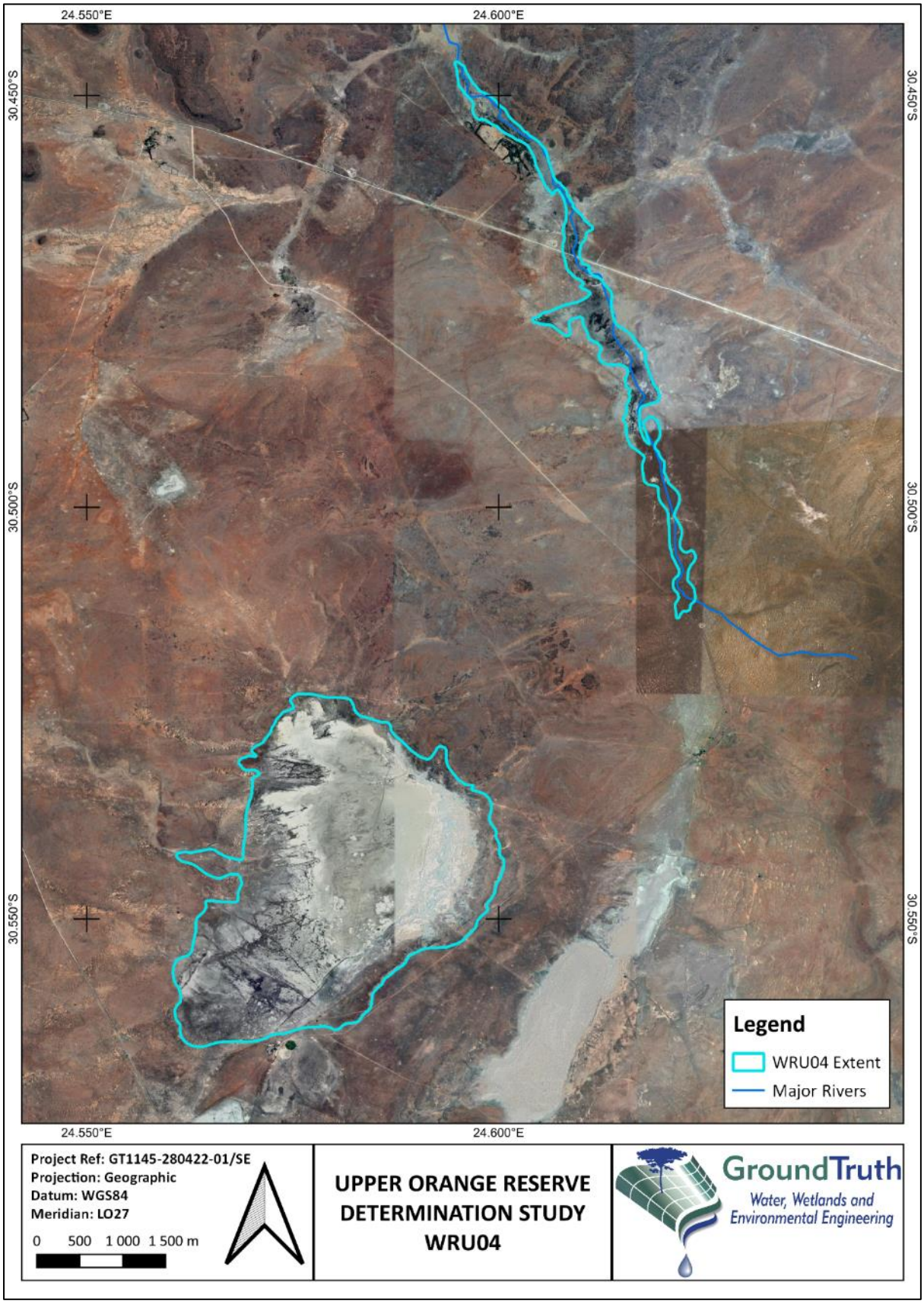


Figure 3-8 Overview of WRU04

3.3.1 Photo log

Site Name: WRU15

Left: Large reedbed at the confluence of the four valley-bottom wetlands.

Right: Photograph of the northern-most wetland arm with foam and signs of pollution evident within the channel

Site Name: WRU10

Left: The depression wetlands are connected by large reedbeds as depicted by the tall green vegetation in this photograph.

Right: Extensive water within the depression wetlands (the road runs through the temporary zone of the wetland). Recent heavy rain has resulted in the wetting of the temporary zone of these depression wetlands.

Site Name: WRU09

Left: Little evidence of wetland vegetation with extensive bush encroachment into the area where the WRU had been mapped.

Right: Predominantly fluvial and riparian habitat at the toe of the WRU. Some wetland vegetation was present but limited to the confines of the channel.

Site Name: WRU04

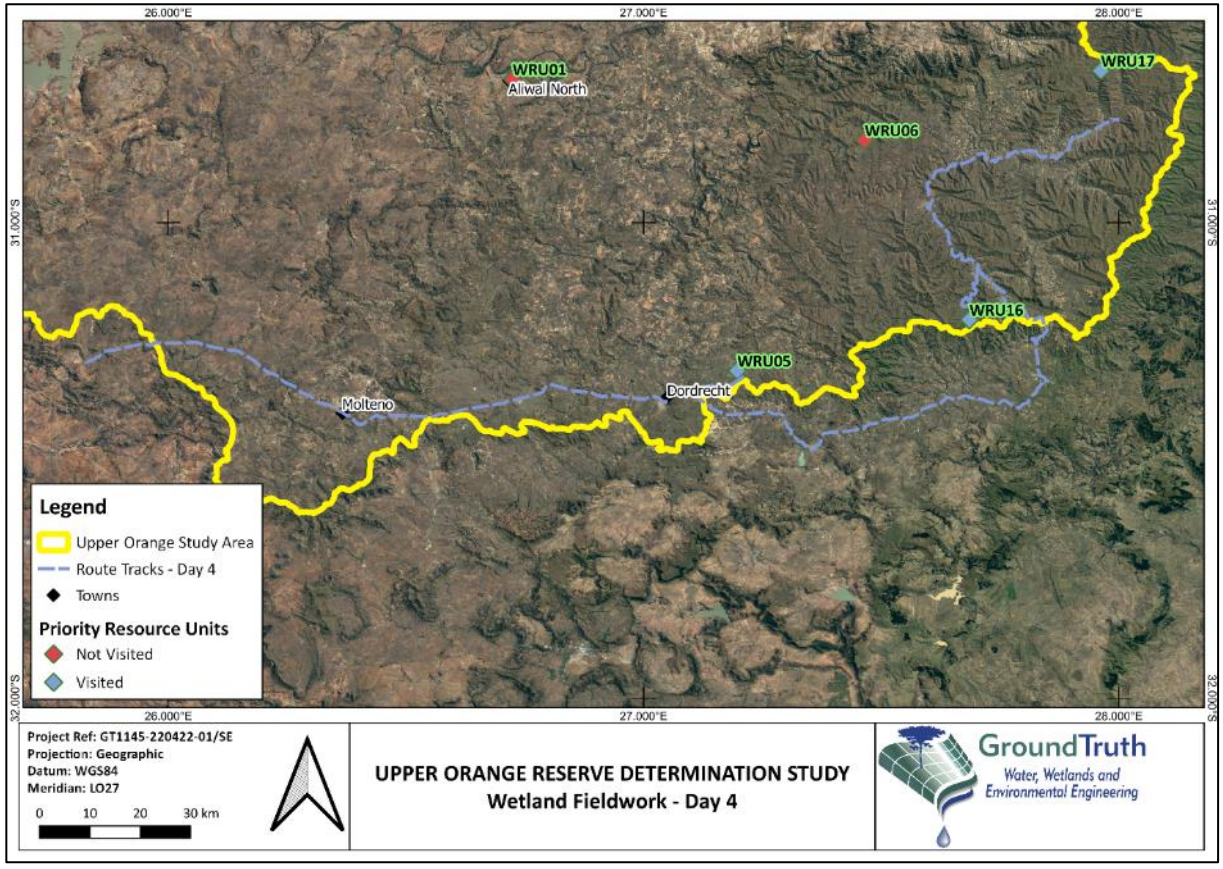
Left: Extensive *Phragmites australis* reedbed located upstream of gradient change in wetland.

Right: Extensive *Phragmites australis* reedbed located downstream of road crossing with extensive stands of *Miscanthus capensis* along the valley-bottom wetland.

3.4 Day 4

Dates:	**Fieldwork Team:**
13th April	Craig Cowden and Steven Ellery

Fieldwork route:



Survey Sites:

Site Name	Site Coordinates		Level of Survey	Comments / brief description
	Latitude	Latitude		
WRU05	27°33'30.68"S	30°31'40.58"E	Tier 1	WRU05 is a large wetland complex consisting of a series of unchannelled valley-bottom wetlands which are fed by multiple hillslope seep wetlands (**Figure 3-9**). In total, the WRU covers an area of approximately 340ha and forms the headwaters of the Wolvespruit River. The valley-bottom wetlands have been extensively dammed, with over 15 dams along the length of the mainstem valley. The wetlands are predominantly used directly for grazing and as a water source for cultivation in the catchment areas. A large number of Blue and Crowned Cranes were noted in the wetland.
WRU16	27°33'30.68"S	30°31'40.58"E	Tier 3	WRU16 is a significant wetland complex consisting of multiple valley-bottom and hillslope seep wetlands which, in total, spread across an area of approximately 230ha (**Figure 3-10**). This large wetland complex is situated on a tributary of the Langkloofspruit River which is a tributary of the Kraai River – an extremely important water source to the Orange River. Due to the recent rains and the deterioration of the road to the WRU, the survey team were unable to gain access to the wetlands. However, extensive vegetation data has been collected for this wetland. This data will be utilised to inform the assessment of the system. The survey team were able to meet the landowner and capture his contact details for future visits.

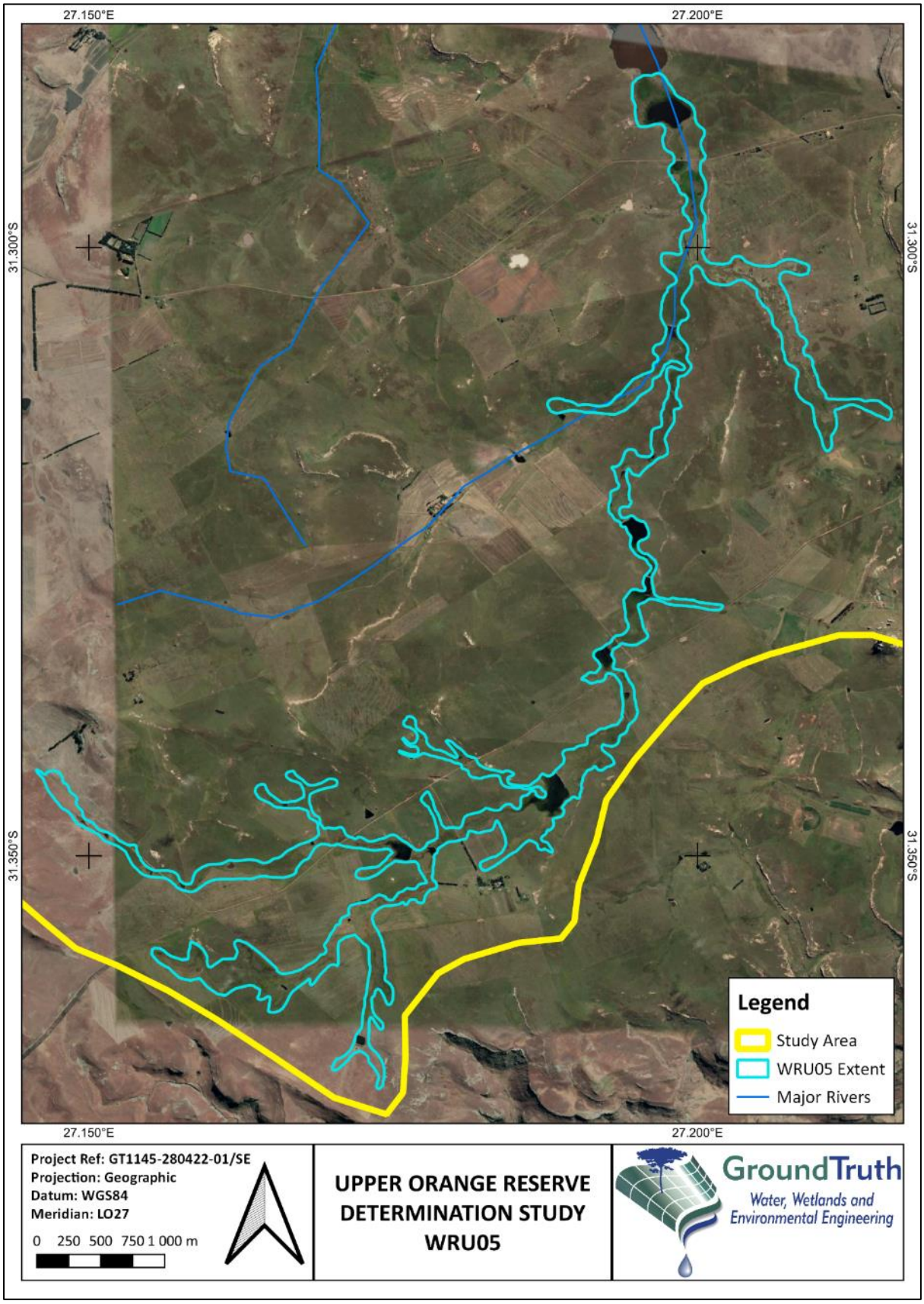


Figure 3-9 Overview of WRU05

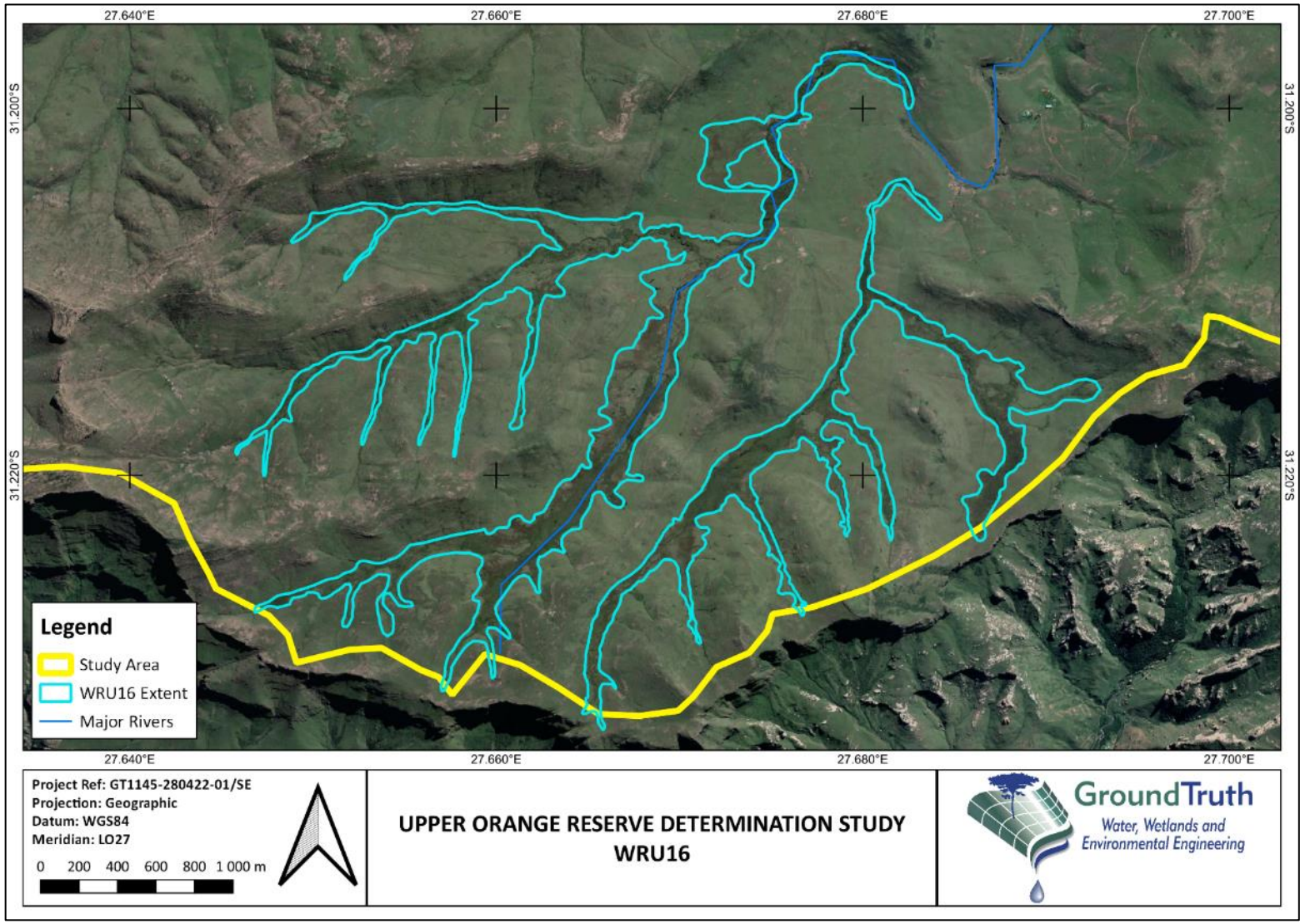


Figure 3-10 Overview of WRU16

3.4.1 Photo log

Site Name: WRU05

Left: Broad valley-bottom wetland with a number of head of cattle on either side of the wetland.

Right: Indication of the level of flows from one of the seep wetlands into the mainstem valley-bottom wetland.

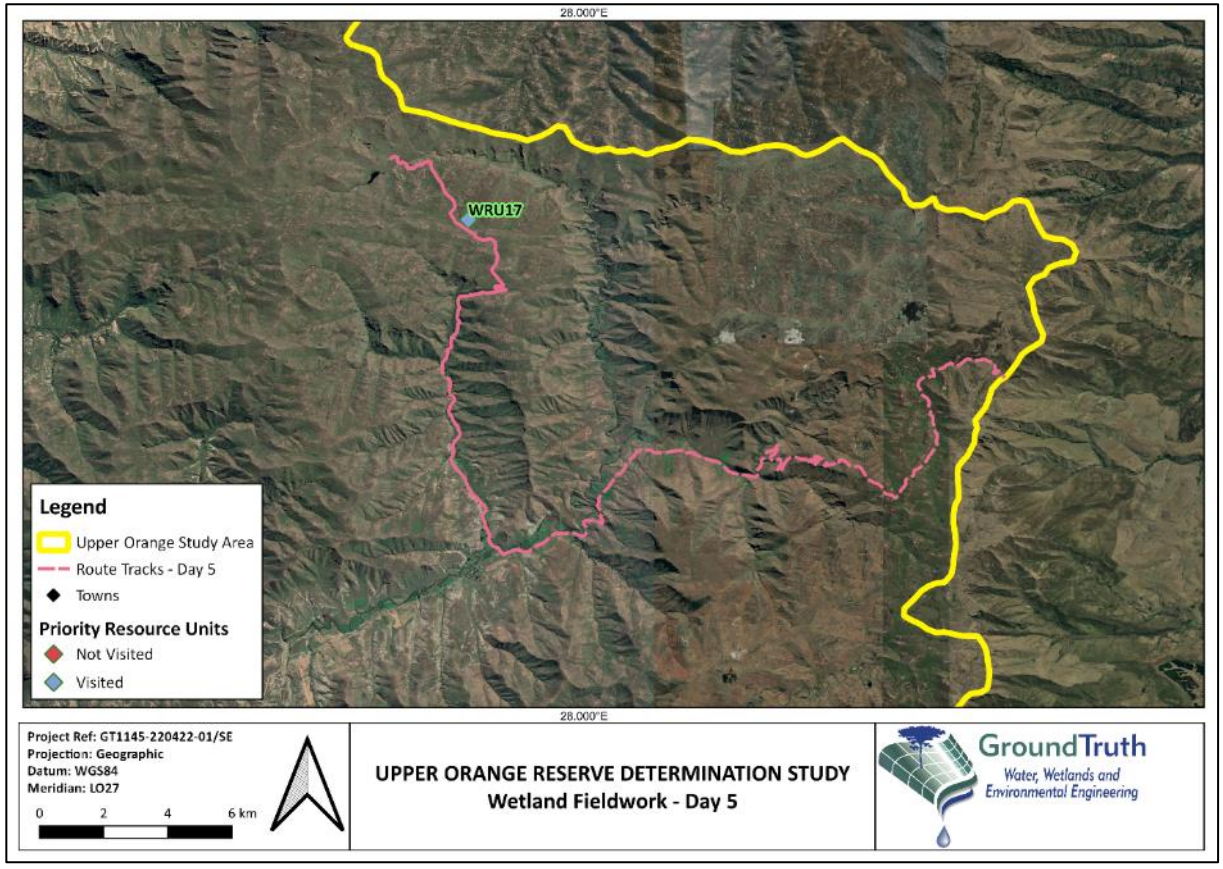
Site Name: WRU16

Centre: A small hillslope seep downstream of WRU16 which would be indicative of the hillslope seep habitat in WRU16 – the vegetation dominated by *Merxmuellera disticha*.

3.5 Day 5

Dates:	**Fieldwork Team:**
14th April	Craig Cowden and Steven Ellery

Fieldwork route:



Survey Sites:

Site Name	Site Coordinates		Level of Survey	Comments / brief description
	Latitude	Latitude		
WRU17	30°40'33.81"S	27°57'24.79"E	Tier 1	WRU17 is similar to WRU16 in that it is a high-altitude wetland complex consisting of a series of hillslope seeps and valley-bottom wetlands which cover a total area of 190ha (**Figure 3-11**). These wetlands are characterised by very shallow soils and the predominance of *Merxmuellera disticha*. In some of the deeper portions of the valley-bottom wetlands, a combination of the nutrient poor and very cold water has resulted in the formation of peat. These wetlands form an important part of the headwaters of the Bell River, which is a large tributary of the Kraai River. The wetlands in WRU17 appear to have been grazed extensively, and a large herd of cattle was observed by the survey team. Aside from the cattle pressure, the wetlands appeared to be in good condition.

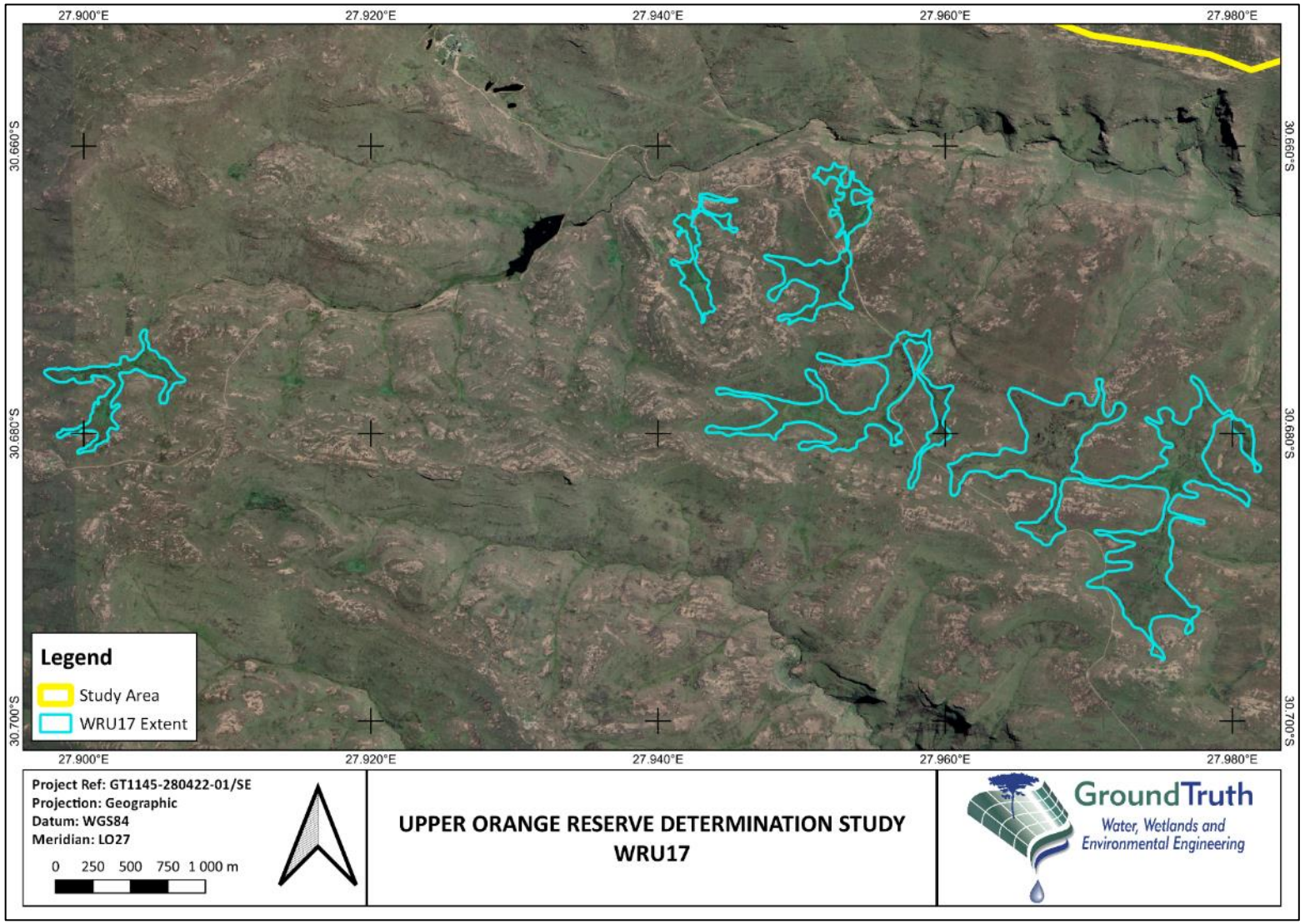


Figure 3-11 Overview of WRU17

3.5.1 Photo log

Site Name: WRU17

Left: Broad valley-bottom wetland with a number of seeps feeding into it. The darker colour in the landscape indicates the approximate valley-bottom wetland extent.

Right: An example of an intact hillslope seep wetland dominated by *Merxmuellera disticha*.

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 DWS. Three members from DWS joined the field survey namely Ndivhuwo Netshiendeulu, Kwazikwakhe Majola and Tinyiko Mpete. The DWS officials joined the survey team at most of the WRUs with the survey team, but due to some accessibility and logistical complications generally linked to the extreme rainfall experienced across the study area, they were unable to join the team at every single WRU. However, the learning that did occur at the WRUs that were visited together was valuable and detailed - where time allowed. The survey team 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). In addition, the survey team shared a number of 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. Furthermore, general discussions were had about groundwater/surface water interactions in depression 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.

5. REFERENCES

Department of Water and Sanitation, South Africa. February 2022. A High Confidence Reserve Determination Study for Surface Water, Groundwater and Wetlands in the Upper Orange Catchment: Resource Units Report. No: RDM/WMA13/00/CON/COMP/0422.

Macfarlane, DM; Ollis, D; Kotze, D. 2020. WET-Health (Version 2): A refined suite of tools for assessing the present ecological state of wetland ecosystems. WRC Report No. TT 820/20, Water Research Commission, Pretoria.

6. APPENDICES

6.1 Appendix 1 – WET-Health Datasheet Example

Indicator Groups	Indicators	
WETLAND ATTRIBUTES		
Wetland HGM Type	Confirm HGM type	
	Does the HGM type need refinement?	
Conceptual model	Review conceptual model. Is it appropriate?	
Wetland attributes	Natural channel characteristics (size, sinuosity, variability, stability)	
	Present channel characteristics (size, sinuosity, variability, stability)	
	Natural wetness regime	
	Present wetness regime	

	Natural broad vegetation attributes	
	Present broad vegetation attributes	
CATCHMENT ASSESSMENT		
Wetland buffer zone characteristics	Soil permeability	
	Structural characteristics of the dominant vegetation in the buffer	
	Concentration of flows	
Dams in the catchment	Relative importance of bedload relative to suspended load: Wetland fill	
	Relative importance of bedload relative to suspended load: Channel pattern	

Invasive alien woody plants	Plant type in buffer	
Plantations	Tree type in buffer	

Indicator Groups	Indicators	Notes
1. Stream channel modification	Channel width	
	Channel depth	
	Average depth of sediment deposits	
	Channel roughness	
	Evidence of within wetland anthropogenic factors causing changes in channel form	
2. Anthropogenic deposition, infilling / excavation - <u>Direct impacts</u>		

Indicator Groups	Indicators	Notes
2.1. Excavation and removal of sediment	Average depth of excavation and removal	
2.2. Depositional features	Average depth of recent sedimentary deposits	
	Direct evidence of within wetland anthropogenic factors contributing to sediment deposition	
2.3. Infilling - direct	Average depth of infill	
3. Anthropogenic deposition, infilling /excavation - <u>Indirect impacts</u>		
3.1. Anthropogenic deposition / infilling including roads & berms (Upstream effects)	Degree to which flows are impounded	
3.2. Dams that extend laterally across the wetland (Upstream effects)	Importance of bedload relative to suspended load: Wetland fill	
	Representation of different wetness zones prior to impoundment	
3.3. Anthropogenic deposition / infilling including roads & berms (Downstream effects)	Degree to which flows are intercepted and deflected away	

Indicator Groups	Indicators	Notes
3.4. Dams upstream of the disturbance unit (Downstream effects)	Degree to which dams interrupt low flows	
	Interception of incoming streamflow to downstream wetland	
4. Drains and erosion gullies	Confirm presence of drains and erosion gullies	
	Location of drains and gullies in relation to flows delivered from upstream catchment	
	Location of drains and gullies in relation to diffuse flows delivered from lateral inputs	
	Average depth of the drains / gullies	
	Texture of mineral soil[1]	
	Degree of humification of organic soil	
	Average gully width	
	Density of drains / gullies (m/ha)	

[1] For mineral soil, take a teaspoon-size piece of soil and add sufficient water to work it in your hand to a state of maximum stickiness, breaking up any lumps that may be present. Now try to form the soil into a coherent ball.

- If this is impossible or very difficult (i.e. the ball collapses easily) then soil is sand or loamy sand.
- If the balls forms easily but collapses when pressed between the thumb and the fore-finger then soil is sandy loam.
- If the soil can be rolled into a thread but this cracks when bent then soil is loam.
- If the thread can be bent without cracking and it feels slightly gritty then soil is clay loam, but if it feels very smooth then soil is clay.

Indicator Groups	Indicators	Notes
	Obstruction in drains / gullies	
	Evidence of within wetland anthropogenic factors causing erosion excl. drains	
5. Changes in surface roughness of wetland	Present wetland surface roughness	
6. Peat fires	Depth of peat fires	
7. Direct water abstraction	Direct water abstractions	
8. Increased transpiration (plantations, aliens, sugarcane)	Confirm presence of alien plants and whether shrubs or trees	
	Confirm presence of plantations and whether wattle, pine, or Eucalyptus	
	Confirm presence of sugarcane and growth rate	
9. Point source discharges directly into wetland	Number	
	Type of effluent per point source	
	Proportion of wetland affected	

Indicator Groups	Indicators	Notes
10. Presence of inflowing channels for depressions	Inflowing channel/s into an endorheic or exorheic depression	