# *FAUNAL, FLORAL AND WETLAND ASSESSMENT AS PART OF THE ENVIRONMENTAL ASSESSMENT AND AUTHORISATION PROCESS OF THE IMPALA 18 SHAFT AND ASSOCIATED INFRASTRUCTURE, NORTH WEST PROVINCE*

**Prepared for**

**SLR Consulting (Africa) (Pty) Ltd.**

2013

# SECTION D – Wetland Assessment


| | |
|---|---|
| **Prepared by:** | **Scientific Aquatic Services** |
| **Report author** | **S. van Staden (Pr. Sci. Nat)** |
| | **E. van der Westhuizen** |
| | **M. Hanekom** |
| | **M. de Klerk** |
| | **L. Zdanow** |
| **Report Reference:** | **SAS 213068** |
| **Date:** | **June 2013** |

Scientific Aquatic Services CC
CC Reg No 2003/078943/23
*Vat Reg. No. 4020235273*
91 Geldenhuis Rd
Malvern East, Ext 1

Tel: 011 616 7893
Fax: 011 615 4106
E-mail: admin@sasenvironmental.co.za

# Table of Contents

## List of Figures



## List of Tables

# 1 INTRODUCTION

Scientific Aquatic Services (SAS) was appointed to conduct a faunal, floral and wetland ecological assessment as part of the environmental assessment and authorisation process for the proposed Impala Shaft Project, hereafter referred to as the "study area" (Section A: Figure 1 and Figure 2). The study area consists of the proposed Impala 18 shaft, linear infrastructure including roads, railway lines, power lines and pipelines as well as a sewage pipeline and associated sewage treatment plant. The study area is located to the east of the R565 roadway and to the west of the R510 roadway and is located approximately 16km to the north of Rustenburg within the North West Province. The study area is surrounded by properties in which agricultural and mining activities dominate, leaving the surrounding areas largely transformed. Therefore, the ecological assessment was confined to the study area and its immediate vicinity and did not include an ecological assessment of surrounding properties. The surrounding area was however considered as part of the desktop assessment of the area.

This report, after consideration and the description of the ecological integrity of the study area, must guide the Environmental Assessment Practitioner (EAP), regulatory authorities and mining proponent, by means of the presentation of results and recommendations, as to the ecological viability of the proposed development activities.

## *1.1 Legislative requirements*

### 1.1.1 National Environmental Management Act, 1998

- The National Environmental Management Act (Act 107 of 1998) and the associated Regulations (Listing No R. 544, No R. 545 and R. 546) as amended in June 2010, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment process or the Environmental Impact Assessment (EIA) process depending on the nature of the activity and scale of the impact.

### 1.1.2 National Water Act, 1998

- The National Water Act (Act 36 of 1998) recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved.
- No activity may therefore take place within a water course unless it is authorised by the Department of Water Affairs (DWA).

- Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from DWA in terms of Section 21.

### 1.1.3 GN 704 – Regulations on use of water for mining and related activities aimed at the protection of water resources, 1999

- These Regulations, forming part of the National Water Act, were put in place in order to prevent the pollution of water resources and protect water resources in areas where mining activity is taking place from impacts generally associated with mining.

# 2 METHODOLOGY

## 2.1 National Wetland Classification System

All wetland features encountered within the study area were assessed using the National Wetland Classification System for South Africa (NWCS), prepared by the South African National Biodiversity Institute (SANBI) (2009). This was done in order to achieve the Recommended Ecological Category (REC) of the wetland features. The methodology is discussed in the section below.

## 2.2 Inland systems

For the proposed NWCS, Inland Systems are ***ecosystems that have no existing connection to the ocean***[1] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but ***which are inundated or saturated with water, either permanently or periodically.*** It is important to bear in mind, however, that certain inland Systems may have had an historical connection to the ocean, which in some cases may have been relatively recent.

Levels 1 to 4 of the proposed NWCS for Inland Systems are presented in **Table 1**, on the following Page.

[1] Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e. the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.

**Table 1: Proposed classification structure for Inland Systems, up to Level 4**

| LEVEL 1: SYSTEM | LEVEL 2: REGIONAL SETTING | LEVEL 3: LANDSCAPE UNIT | LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT | | | |
|---|---|---|---|---|---|---|
| CONNECTIVITY TO OPEN OCEAN | ECOREGION | LANDSCAPE SETTING | *HGM TYPE* | LONGITUDINAL ZONATION/LANDFORM | DRAINAGE OUTFLOW* | DRAINAGE INFLOW* |
| | | | **A** | **B** | **C** | **D** |
| **INLAND** | DWAF Level/Ecoregions | SLOPE | Channel (river) | Mountain headwater stream | (not applicable) | (not applicable) |
| | | | | Mountain stream | (not applicable) | (not applicable) |
| | | | | Transitional river | (not applicable) | (not applicable) |
| | | | | Rejuvenated bedrock fall | (not applicable) | (not applicable) |
| | | | Hillslope seep | (not applicable) | With ch. Outflow | (not applicable) |
| | | | | | Without ch. Outflow | (not applicable) |
| | | | Depression | (not applicable) | Exorheic | With ch. inflow |
| | | | | | | Without ch. inflow |
| | | | | | Endorheic | With ch. inflow |
| | | | | | | Without ch. inflow |
| | | | | | Dammed | With ch. inflow |
| | | | | | | Without ch. inflow |
| | | VALLEY FLOOR | Channel (river) | Mountain stream | (not applicable) | (not applicable) |
| | | | | Transitional river | (not applicable) | (not applicable) |
| | | | | Rejuvenated bedrock fall | (not applicable) | (not applicable) |
| | | | | Upper foothill river | (not applicable) | (not applicable) |
| | | | | Lover foothill river | (not applicable) | (not applicable) |
| | | | | Lowland river | (not applicable) | (not applicable) |
| | | | | Rejuvenated foothill river | (not applicable) | (not applicable) |
| | | | | Upland floodplain river | (not applicable) | (not applicable) |
| | | | Channelled valley-bottom wetland | Valley-bottom depression | (not applicable) | (not applicable) |
| | | | | Valley-bottom flat | (not applicable) | (not applicable) |
| | | | Unchannelled valley-bottom wetland | Valley-bottom depression | (not applicable) | (not applicable) |
| | | | | Valley-bottom flat | (not applicable) | (not applicable) |
| | | | Floodplain wetland | Valley-bottom depression | (not applicable) | (not applicable) |
| | | | | Valley-bottom flat | (not applicable) | (not applicable) |
| | | | Depression | (not applicable) | Exorheic | With ch. inflow |
| | | | | | | Without ch. inflow |
| | | | | | Endorheic | With ch. inflow |
| | | | | | | Without ch. inflow |
| | | | | | Dammed | With ch. inflow |
| | | | | | | Without ch. inflow |
| | | | Valleyhead seep | (not applicable) | (not applicable) | (not applicable) |
| | | PLAIN | Channel (river) | Lowland river | (not applicable) | (not applicable) |
| | | | | Upland floodplain river | (not applicable) | (not applicable) |
| | | | Floodplain wetland | Floodplain depression | (not applicable) | (not applicable) |
| | | | | Floodplain flat | (not applicable) | (not applicable) |
| | | | Unchannelled valley-bottom wetland | Valley-bottom depression | (not applicable) | (not applicable) |
| | | | | Valley-bottom flat | (not applicable) | (not applicable) |
| | | | Depression | (not applicable) | Exorheic | With ch. inflow |
| | | | | | | Without ch. inflow |
| | | | | | Endorheic | With ch. inflow |
| | | | | | | Without ch. inflow |
| | | | Flat | (not applicable) | (not applicable) | (not applicable) |
| | | BENCH (HILLTOP/SADDLE/SHELF) | Depression | (not applicable) | Exorheic | With ch. inflow |
| | | | | | | Without ch. inflow |
| | | | | | Endorheic | With ch. inflow |
| | | | | | | Without ch. inflow |
| | | | | | (not applicable) | (not applicable) |
| | | | Flat | (not applicable) | (not applicable) | (not applicable) |

**Note: 2nd row of Table provides the criterion for distinguishing between wetland units in each column**
*** Ch. = channelled (outflow/inflow)**

### 2.2.1 Level 2: Ecoregions

For Inland Systems, the regional spatial framework that has been included at Level 2 of the proposed NWCS is that of the DWA's Level 1 Ecoregions for aquatic ecosystems (after Kleynhans *et al.,* 2005). There are a total of 31 Ecoregions, which have been delineated mainly on the basis of physical/abiotic factors. See Figure below.

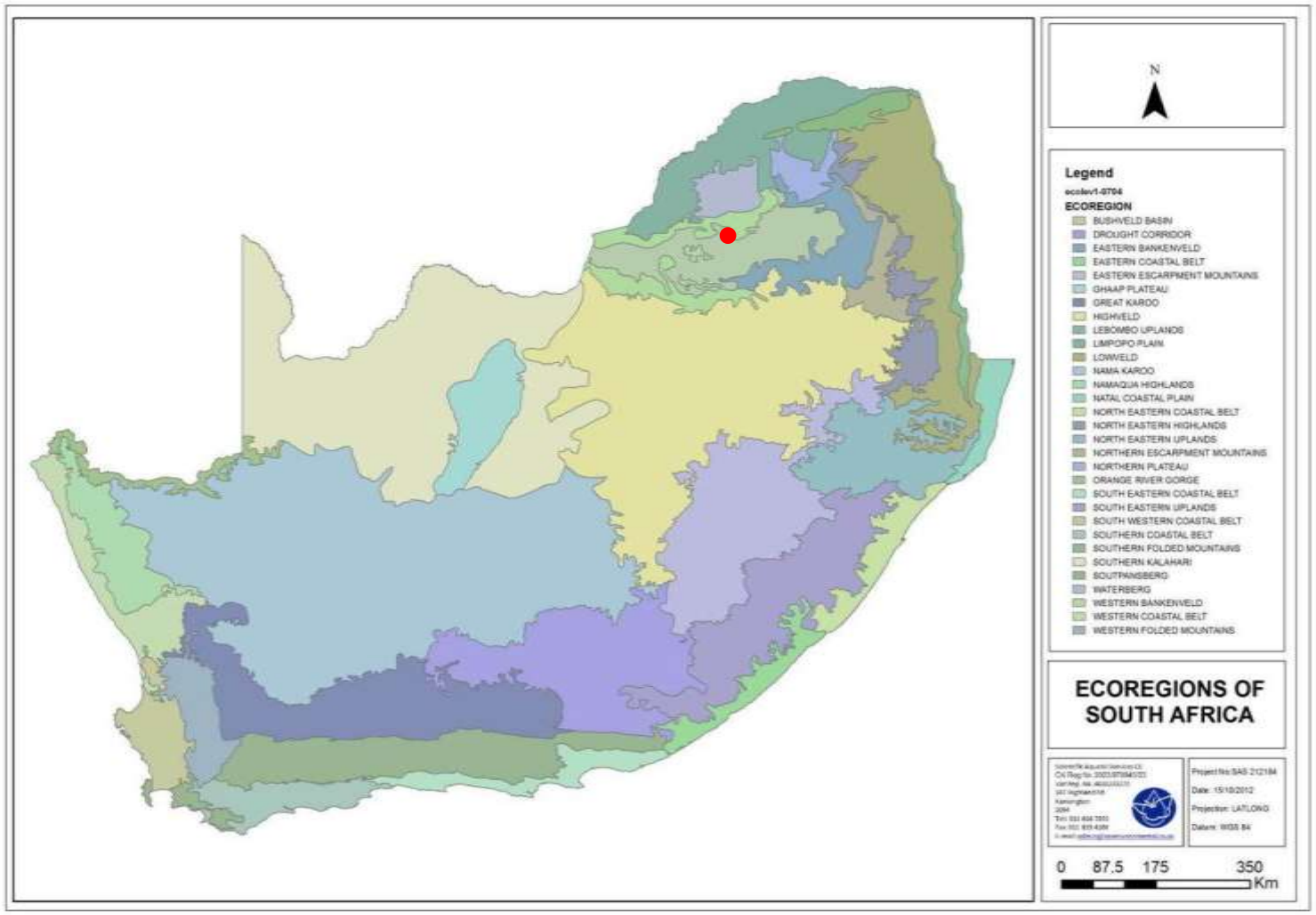


**Figure 1: Map of Level 1 Ecoregions of South Africa (approximate location of study area indicated in red).**

### 2.2.2 Level 3: Landscape Units

At Level 3 of the proposed NWCS, for Inland Systems, a distinction is made between four Landscape Units (Table 2) on the basis of the landscape setting (i.e. topographical position) within which a Hydrogeomorphic HGM Unit is situated, as follows (SANBI, 2009):

- ***Slope*****:** an included stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley.
- ***Valley floor:*** the typically gently sloping, lowest surface of a valley[2].
- ***Plain:*** an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land.
- ***Bench (hilltop/saddle/shelf):*** an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

In addition, a schematic diagram of the different landscape settings is shown in the figure below.

[2] Valley: an elongated, relatively narrow region of low land between ranges of mountains, hills, or other high areas (such as sand dunes), often having a river or stream running along the bottom.

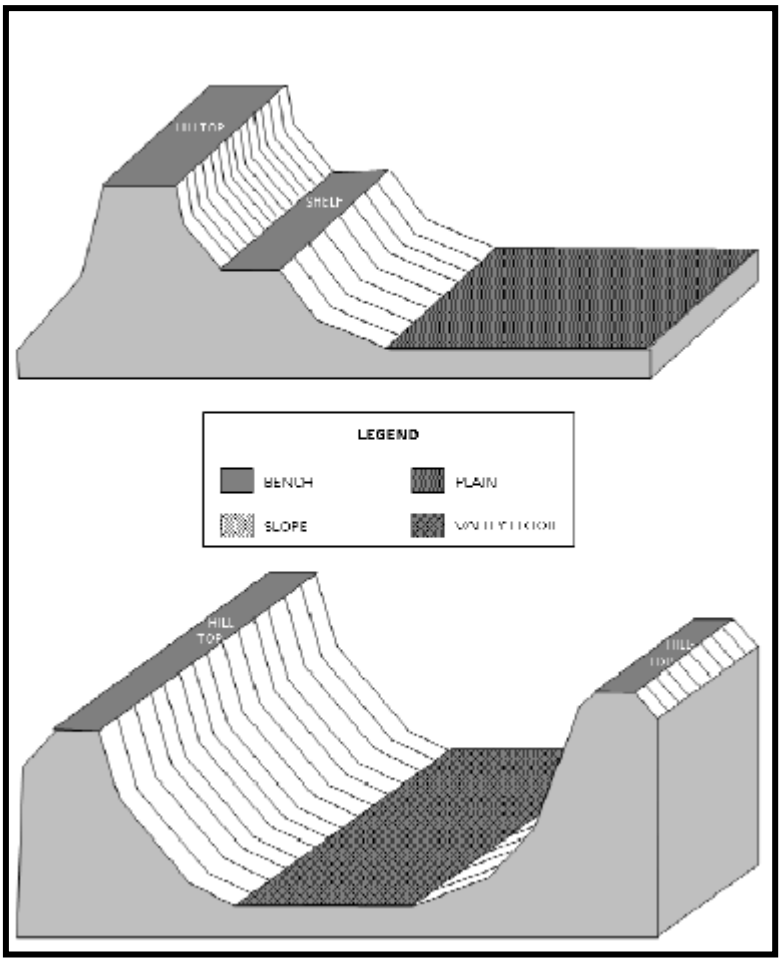


**Figure 2: Schematic diagram of the different landscape settings within which an Inland System can occur (Ollis *et al*., 2009).**

### 2.2.3 Level 4: HGM Units

Eight primary HGM Types are recognised for Inland Systems at Level 4A of the proposed NWCS (Table 2), on the basis of hydrology and geomorphology (SANBI, 2009), namely:

- ***Channel (river, including the banks):*** an open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies.
- ***Channelled valley-bottom wetland:*** a mostly flat valley-bottom wetland dissected by and typically elevated above a channel (see channel).
- ***Unchannelled valley-bottom wetland:*** a mostly flat valley-bottom wetland area within a major channel running through it, characterised by an absence of distinct channel banks and the prevalence of diffuse flows, even during and after high rainfall events.
- ***Floodplain wetland:*** the mostly flat or gently sloping wetland area adjacent to and formed by a **Lowland** or **Upland Floodplain** river, and subject to periodic inundation by overtopping of the channel bank.
- ***Depression:*** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.
- ***Flat:*** a near-level wetland area (i.e. with little or no relief) with little or no gradient, situated on a plain or a bench in terms of landscape setting.
- ***Hillslope seep:*** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope.
- ***Valleyhead seep:*** a gently-sloping, typically concave wetland area located on a valley floor at the head of a drainage line[3], with water inputs mainly from subsurface flow (although there is usually also a convergence of diffuse overland water flow in these areas during and after rainfall events).

The above terms have been used for the primary HGM Units in the proposed NWCS to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for “channel”, “flat” and “valleyhead seep”) is used, for example, in the recently developed tools produces as part

[3] Valleyhead seeps tend to occur at relatively high altitudes, often in association with an escarpment. This wetland type is, therefore, relatively common in the Lesotho Highlands and the KwaZulu-Natal Drakensberg area (M.Rountree, Fluvius Environmental Consultants, pers.comm.).

of the Wetland Management Series (Dada *et al.,* 2007), including WET-Health (Macfarlene *et al.,* 2008) and WET-EcoServices (Kotze *et al.,* 2008).

At Level 4B of the classification system, certain of the primary HGM Units can further be divided into sub-categories on the basis of longitudinal geomorphological zonation or localised landform, as follows:

- Channels (including their banks) are divided into six primary longitudinal zones and three zones associated with a rejuvenated longitudinal profile, according to the geomorphological zonation scheme of Rowntree & Wadeson (2000). The sub-categories are *Mountain Headwater Stream, Mountain Stream, Transitional River, Upper Foothill River, Lower Foothill River,* and *Lowland River* (i.e. the primary zones); and *Rejuvenated Bedrock Fall, Rejuvenated Foothill River,* and *Upland Floodplain River* (i.e. the zones associated with a rejuvenated long profile).
- Channelled and unchannelled valley-bottom wetlands are divided into '*valley-bottom flats'* and *'valley-bottom depressions'*.
- Floodplain wetlands are divided into *'floodplain depressions'* and *'floodplain flats'*.

**Table 2: Characteristics of the different Hydrogeomorphic (HGM) Types included in the proposed National Wetland Classification System (NWCS) (SANBI, 2009).**

| Primary (Level 4A) HGM Type* | Secondary (Level 4B) HGM Units (Longitudinal Zonation/Landform) | Landscape setting/s | Dominant hydrological characteristics | | | Dominant hydrodynamics |
|---|---|---|---|---|---|---|
| | | | Inputs | Throughputs | Outputs | |
| **CHANNEL** | Mountain Headwater Stream | Slope | Overland flow from catchment runoff, concentrated surface flow from upstream channels and tributaries, diffuse surface flow from an unchannelled upstream drainage line (i.e. an unchannelled valley-bottom wetland), seepage from adjacent hillslope or valleyhead seeps, and/or groundwater (e.g. via inchannel springs) | Concentrated surface flow | Concentrated surface flow, generally, but can be diffuse surface flow (e.g. where a channelled valley-bottom wetland becomes an unchannelled valley-bottom wetland because of a change in gradient or geological control) | Horizontal: unidirectional |
| | Mountain Stream | Slope/Valley floor | | | | |
| | Transitional River | Slope/Valley floor | | | | |
| | Upper Foothill River | Valley floor | | | | |
| | Lower Foothill River | Valley floor | | | | |
| | Lowland River | Valley floor/Plain | | | | |
| | Rejuvenated Foothill Fall (gorge) | Slope/Valley floor | | | | |
| | Rejuvenated Foothill River | Slope/Valley floor | | | | |
| | Upland Floodplain River | Valley floor/Plain (specifically a plateau) | | | | |
| **CHANNELLED VALLEY-BOTTOM WETLAND** | Valley-bottom flat | Valley floor | Overland flow from adjacent valley-side slopes, lateral seepage (interflow) from adjacent hillslope seeps, channel overspill during flooding | Diffuse surface flow, temporary containment and storage of water in depressional areas, possible short-lived concentrated flows during flooding events | Diffuse surface flow and interflow into adjacent channel, infiltration and evaporation (particularly from depressional areas) | Horizontal: bidirectional; Limited vertical: bidirectional (mostly in depressions) |
| | Valley-bottom depression | Valley floor | | | | |
| **UNCHANNELLED VALLEY-BOTTOM WETLAND** | Valley-bottom flat | Valley floor/Plain | Concentrated or diffuse surface flow from upstream channels and tributaries; overland flow from adjacent valley-side slopes (if present); lateral seepage from adjacent hillslope seeps (if present); groundwater | Diffuse surface flow, interflow, temporary containment and storage of water in depressional areas, possible short-lived concentrated flows during high-flow events | Diffuse or concentrated surface flow, infiltration and evaporation (particularly from depressional areas) | Horizontal: unidirectional; Limited vertical: bidirectional (mostly in depressions) |
| | Valley-bottom depression | Valley floor/Plain | | | | |

| Primary (Level 4A) HGM Type* | Secondary (Level 4B) HGM Units (Longitudinal Zonation/Landform) | Landscape setting/s | Dominant hydrological characteristics | | | Dominant hydrodynamics |
|---|---|---|---|---|---|---|
| | | | Inputs | Throughputs | Outputs | |
| **FLOODPLAIN WETLAND** | Floodplain flat | Valley floor/Plain | Channel overspill during flooding (predominantly), but there could also be some overland flow from adjacent valley-side slopes (if present) and lateral seepage from adjacent hillslope seeps (if present) | Diffuse surface flow, interflow, temporary containment and storage of water in depressional areas, possible short-lived concentrated flows during flooding events | Diffuse surface flow and interflow into adjacent channel, infiltration and evaporation (particularly from depressional areas) | Horizontal: bidirectional; Limited vertical: bidirectional (mostly in depressions) |
| | Floodplain depression | Valley floor/Plain | | | | |
| **DEPRESSION (EXHORHEIC, with channelled inflow)** | n/a | Slope/Valley floor/Plain/Bench | Precipitation, concentrated and (possibly) diffuse surface flow, interflow, groundwater | Containment and storage of water, slow through-flow | Concentrated surface flow | Horizontal: unidirectional; Vertical: bidirectional |
| **DEPRESSION (EXHORHEIC, without channelled inflow)** | n/a | Slope/Valley floor/Plain/Bench | Precipitation, diffuse surface flow, interflow, groundwater | Containment and storage of water, slow through-flow | Concentrated surface flow | Horizontal: unidirectional; Vertical: bidirectional |
| **DEPRESSION (ENDORHEIC, with channelled inflow)** | n/a | Slope/Valley floor/Plain/Bench | Precipitation, concentrated and (possibly) diffuse surface flow, interflow, groundwater | Containment and storage of water | Evaporation, infiltration | Vertical: bidirectional |
| **DEPRESSION (ENDORHEIC, without channelled inflow)** | n/a | Slope/Valley floor/Plain/Bench | Precipitation, diffuse surface flow, interflow, groundwater | Containment and storage of water | Evaporation, infiltration | Vertical: bidirectional |
| **FLAT** | n/a | Plain/Bench | Precipitation, groundwater | Containment of water, some diffuse surface flow and/or interflow | Evaporation, infiltration | Vertical: bidirectional Limited horizontal: multidirectional |
| **HILLSLOPE SEEP (with channelled outflow)** | n/a | Slope | Groundwater, precipitation (perched) | Diffuse surface flow, interflow | Concentration surface flow | Horizontal: unidirectional |
| **HILLSLOPE SEEP (without channelled outflow)** | n/a | Slope | Groundwater, precipitation (perched) | Diffuse surface flow, interflow | Diffuse surface flow, interflow, evaporation, infiltration | Horizontal: unidirectional |
| **VALLEYHEAD SEEP** | n/a | Valley Floor | Groundwater surface flow, interflow | Diffuse surface flow, interflow | Concentration surface flow | Horizontal: unidirectional |

* **For completeness, in this list a distinction is also made tween *depressions* and *hillslope seeps* with different *drainage (outflow and inflow)* characteristics, as recorded at Levels 4C and 4D of the proposed NWCS (the drainage criteria are not applicable to other HGM Types).**

## 2.3 Present Ecological State (PES)

After wetland systems have been classified according to the characteristics stipulated above it is important to determine any modifying aspects that may have altered the natural ecological state of the wetland system. *Resource Directed Measures (*RDM) (Dini, J; Cowan, G. & Goodman, P. First Draft: DWAF, *Version 1.0, 1999*) identifies three groups of modifiers: Water Regime Modifiers, Water Chemistry Modifiers, and Artificial Modifiers. A desktop study as well as the field assessment was used in order to determine any of these modifiers present at the study area.

All the information gathered as well as hydrology-, hydraulic/geomorphic-, biological criteria and water quality were then used to assign a Present Ecological Status (PES) for the wetland features. The table below lists the attributes as well as criteria assessed during the PES assessment.

**Table 3: Criteria and attributes assessed during the determination of the PES.**

| Criteria and attributes | |
|---|---|
| **Hydrologic** | **Hydraulic/Geomorphic** |
| Flow modification | Canalisation |
| Permanent Inundation | Topographic Alteration |
| **Water Quality** | **Biota** |
| Water Quality Modification | Terrestrial Encroachment |
| Sediment load modification | Indigenous Vegetation Removal |
| | Invasive plant encroachment |
| | Alien fauna |
| | Overutilization of biota |

Each of the attributes where given a score according to ecological state observed during the site visit, as well as a confidence score to indicate areas of uncertainty (table below).

**Table 4: Scoring guidelines.**

| Scoring guidelines | | Relative confidence score | |
|---|---|---|---|
| Natural, unmodified | **5** | Very high | **4** |
| Largely natural | **4** | High | **3** |
| Moderately modified | **3** | Moderate | **2** |
| Largely modified | **2** | Low | **1** |
| Seriously modified | **1** | | |
| Critically modified | **0** | | |

A mean score for all attributes were then calculated and the final score was then used in the PES category determination as indicated in the table below.

**Table 5: Present Ecological Status Category descriptions**[4]

| Score | Class | Description |
|---|---|---|
| >4 | A | Unmodified, natural |
| >3 and <=4 | B | Largely natural with few modifications |
| >2 and <=3 | C | Moderately modified |
| 2 | D | Largely modified |
| >0 and <2 | E | Seriously modified |
| 0 | F | Critically modified |

## *2.4 Wetland function assessment*

"The importance of a water resource, in ecological social or economic terms, acts as a modifying or motivating determinant in the selection of the management class".[5] The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines as described by Kotze *et al*. (2005). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation
- Stream flow regulation
- Sediment trapping
- Phosphate trapping
- Nitrate removal
- Toxicant removal
- Erosion control
- Carbon storage
- Maintenance of biodiversity
- Water supply for human use
- Natural resources
- Cultivated foods
- Cultural significance
- Tourism and recreation
- Education and research

[4] Department of Water Affairs and Forestry, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999* [Table G2].

[5] Department of Water Affairs and Forestry, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999*

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the wetlands. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the wetland.

**Table 6: Classes for determining the likely extent to which a benefit is being supplied.**

| Score | Rating of the likely extent to which the benefit is being supplied |
|---|---|
| <0.5 | Low |
| 0.6-1.2 | Moderately low |
| 1.3-2 | Intermediate |
| 2.1-3 | Moderately high |
| >3 | High |

## 2.5 Ecological Management Class

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability, but carries a higher risk of ecosystem failure." [6]

The Ecological Management Class (EMC) was determined based on the results obtained from the PES, reference conditions and Ecological Importance and Sensitivity of the resource (sections above). Followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired EMC.

A wetland may receive the same class for the PES, as the EMC if the wetland is deemed in good condition, and therefore must stay in good condition. Otherwise, an appropriate EMC should be assigned in order to prevent any further degradation as well as to enhance the PES of the wetland feature.

**Table 7: Description of EMC classes.**

| Class | Description |
|---|---|
| **A** | Unmodified, natural |
| **B** | Largely natural with few modifications |
| **C** | Moderately modified |
| **D** | Largely modified |

[6] Department of Water Affairs and Forestry, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources 1999*

## 2.6 Wetland delineation

For the purposes of this investigation, a wetland habitat is defined in the National Water Act (1998) as including the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas.

The wetland zone delineation took place according to the method presented in the final draft of "A practical field procedure for identification and delineation of wetlands and riparian areas" published by the DWA in February 2005. The foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils;
- Vegetation adapted to saturated soils and
- The presence of alluvial soils in stream systems.

By observing the evidence of these features, in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (Department of Water Affairs and Forestry (DWAF), 2005).

Riparian and wetland zones can be divided into three zones (DWAF, 2005). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant part of the rainy season and the temporary zone surrounds the seasonal zone and is only saturated for a short period of the year, but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation. The object of this study was to identify the outer boundary of the temporary zone and then to identify a suitable buffer zone around the wetland area.

# 3 RESULTS

## *3.1 Ecoregions*

When assessing the ecology of any area (aquatic or terrestrial), it is important to know which ecoregion the study area is located within. This knowledge allows for improved interpretation of data to be made, since reference information and representative species lists are often available on this level of assessment, which aids in guiding the assessment.

The study area falls within the Bushveld Basin Ecoregion and is located within the A22F and A22J quaternary catchments.

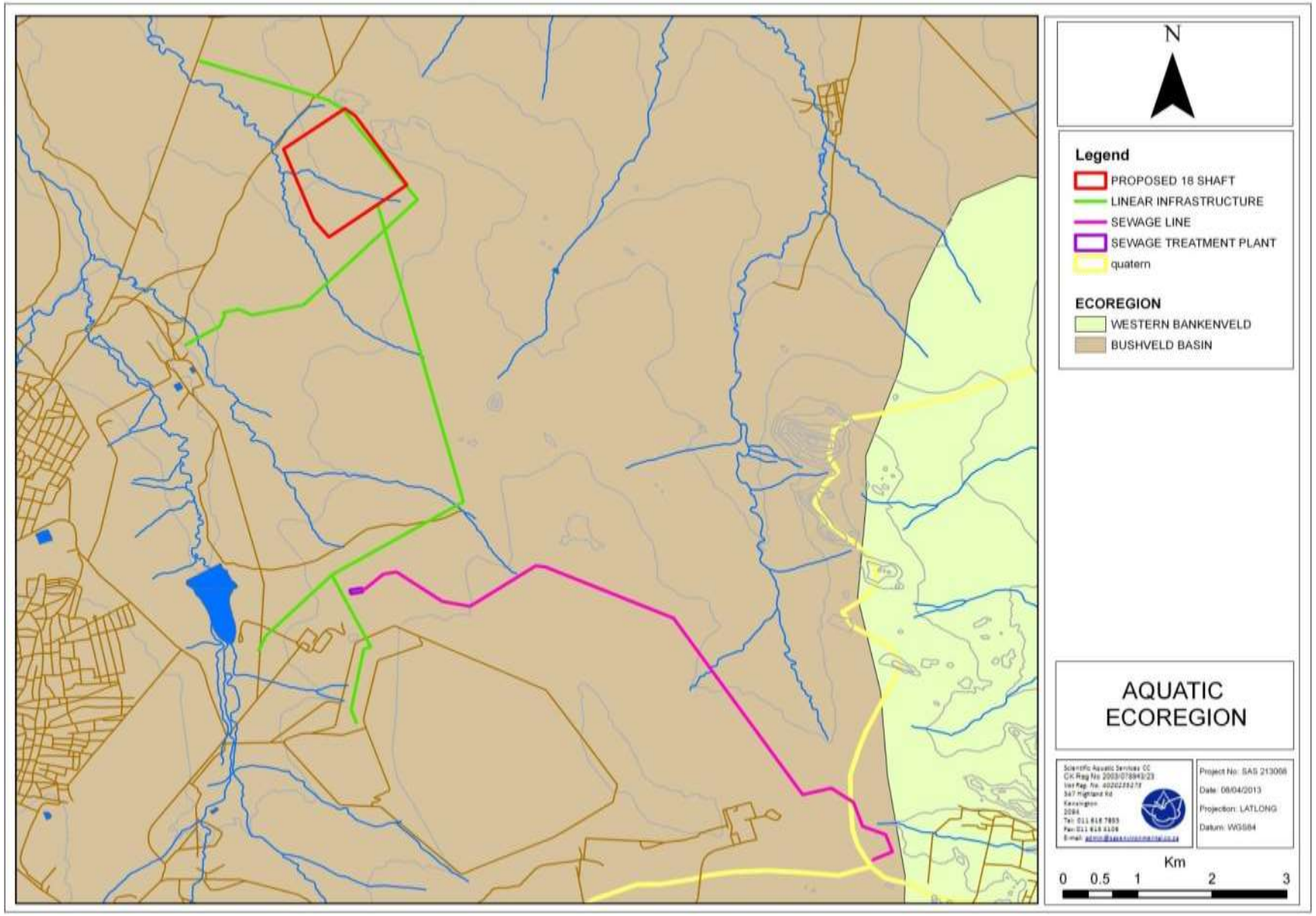


**Figure 3: Map of the three quaternary catchments of the area.**

**Table 8: Quaternary Catchment information.**

| Catchment | Resource | EIS | PESC | DEMC |
|---|---|---|---|---|
| A22F | Elands River | MODERATE | CLASS D | C: Moderately sensitive system |
| A22J | Hex River | MODERATE | CLASS C | C: Moderately sensitive system |

**A22F**

According to the ecological importance classification for the quaternary catchment, the system can be classified as a Moderately Sensitive System which, in its present state, can be considered a Class D (Largely modified) stream.

The points below summarise the impacts on the aquatic resources in the quaternary catchment A22F (Kleynhans 1999):

- The aquatic resources within this quaternary catchment have been moderately affected by bed modification with special mention of sedimentation pools.
- High flow modifications have occurred within the quaternary catchment and it is assumed that the perennial river has changed into a seasonal one.
- Moderate impacts have occurred as a result of introduced aquatic biota with special mention of the impact of *Cyprinus carpio* (Carp) and *Micropterus salmoides* (Largemouth Bass) on biota in pools.
- Impact due to inundation is considered low.
- Riparian zones and stream bank conditions are considered to be highly impacted by factors such as overgrazing, erosion and the spread of exotics.
- Impact from water quality modification is of a moderate degree and is assumed to be caused by water turbidity in the catchment.

In terms of ecological functions, importance and sensitivity, the following points summarise the conditions in this catchment:

- The riverine systems in this catchment have a moderate diversity of habitat types.
- The quaternary catchment has a very low importance in terms of conservation and natural areas.
- *Labeobarbus marequensis* (Largescale yellowfish) breed within the system and have a moderate intolerance to flow and flow related water quality changes.
- The quaternary catchment is regarded as having no importance for rare and endangered species conservation.
- The quaternary catchment is considered of moderate importance in terms of provision of migration routes for bird and fish species in the instream and riparian environments.

- The quaternary catchment has a moderate importance in terms of providing refugia for aquatic community members.
- The quaternary catchment can be considered to have a moderate sensitivity to changes in water quality and water flow.
- The quaternary catchment is of moderate importance in terms of species richness.
- The quaternary catchment is of no importance in terms of endemic and isolated species.

**A22J**

According to the ecological importance classification for the quaternary catchment, the system can be classified as a Moderately Sensitive System which, in its present state, can be considered a Class C (Moderately modified) stream.

The points below summarise the impacts on the aquatic resources in the quaternary catchment A22J (Kleynhans 1999):

- The aquatic resources within this quaternary catchment have been moderately affected by bed modification and are overgrown by reeds.
- High flow modifications occur within the quaternary catchment. Regulation of flow by the Bospoort Dam has resulted in the change of the river from a perennial to seasonal river.
- Marginal impacts have occurred as a result of introduced aquatic biota with special mention of *Cyprinus carpio* (Carp).
- Impact due to inundation is considered low.
- Riparian zones and stream bank conditions are considered to be marginally impacted by the spread of alien species.
- Impact from water quality modification is of a moderate degree and is assumed to be caused by seasonal river influences.

In terms of ecological functions, importance and sensitivity, the following points summarise the conditions in this catchment:

- The riverine systems in this catchment have a marginal diversity of habitat types.
- The quaternary catchment has a very low importance in terms of conservation and natural areas.
- *Labeobarbus marequensis* (Largescale yellowfish) breed within the system and have a moderate intolerance to flow and flow related water quality changes.
- The quaternary catchment is regarded as having no importance for rare and endangered species conservation.

- The quaternary catchment is considered of moderate importance in terms of provision of migration routes for species in the instream and riparian environments.
- The quaternary catchment has a marginal importance in terms of providing refugia for aquatic community members.
- The quaternary catchment can be considered to have a moderate sensitivity to changes in water quality and water flow.
- The quaternary catchment is of moderate importance in terms of species richness.
- The quaternary catchment is of no importance in terms of endemic and isolated species.

## *3.2 General importance of the study area with regards to watercourse conservation*

### 3.2.1 Importance according to the National Freshwater Ecosystems Priority Areas database (2011) and the SANBI Wetland Inventory (2006)

The SANBI Wetland Inventory (2006) and National Freshwater Ecosystem Priority Areas (NFEPA) (2011) databases were consulted to define the aquatic ecology of the wetland or river systems close to or within the study area that may be of ecological importance. Aspects applicable to the study area and surroundings are discussed below:

- The study area falls within the Crocodile (West) and Marico Water Management Area (WMA). Each WMA is divided into several sub-Water Management Areas (subWMAs), where catchment or watershed is defined as a topographically defined area which is drained by a stream or river network. The Sub-Water management unit indicated for the study area is the Elands sub-WMA.
- The subWMA is not regarded important in terms of fish sanctuaries, rehabilitation or corridors.
- The subWMA is not considered important in terms of translocation and relocation zones for fish.
- The subWMA is not listed as a fish Freshwater Ecosystem Priority Areas (FEPA).
- Tributaries of the Leragane River cross the Impala 18 Shaft development footprint as well as some of the linear infrastructure of the study area (Figure 4).
- The Leragane River is a perennial river classified as a Class D (largely modified) river. It is not free flowing and is not classified as a flagship river or as a FEPA river.
- A tributary of the Molapongwamongana River crosses the sewage line of the study area.
- The Molapongwamongana River is a non-perennial river classified as a Class D (largely modified) river. It is not free flowing and is not classified as a flagship river or as a FEPA river.
- No wetland features as indicated by the NFEPA database (2011) are crossed or contained by the study area (Figure 4).

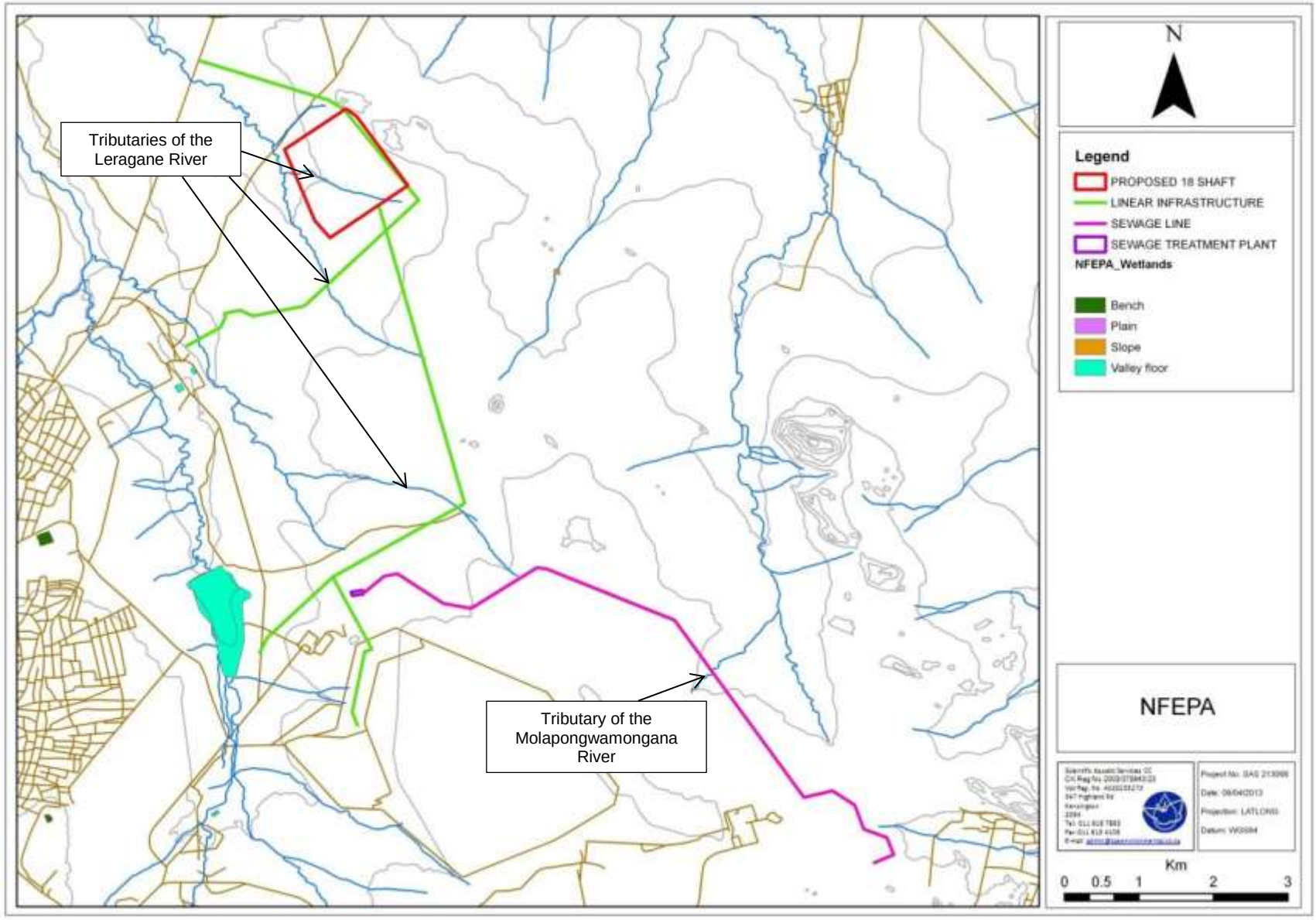


**Figure 4: NFEPA wetland types within the study area.**

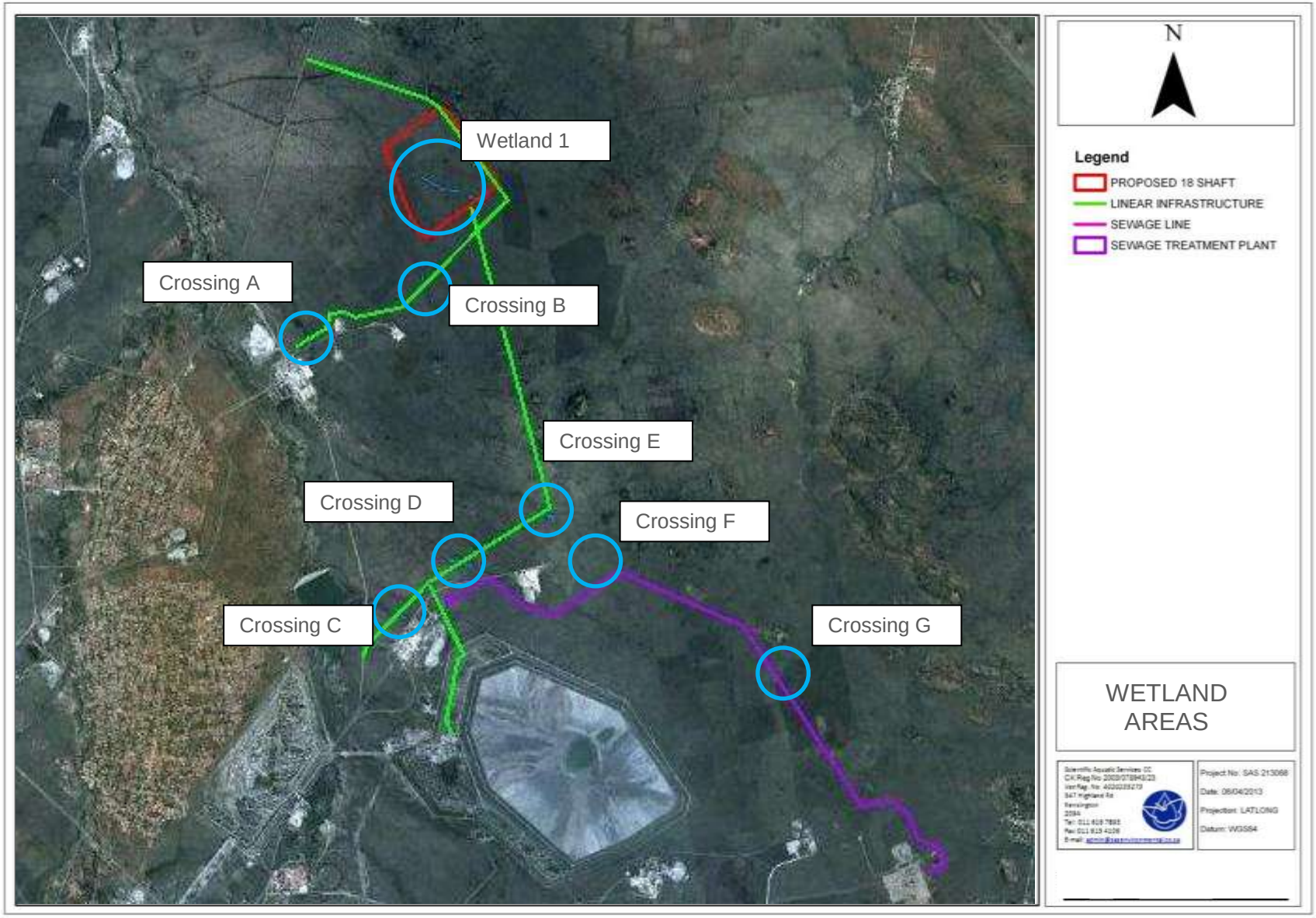


**Figure 5: Wetlands identified within the study area – the locations of wetlands and wetland crossings are indicated by blue circles.**

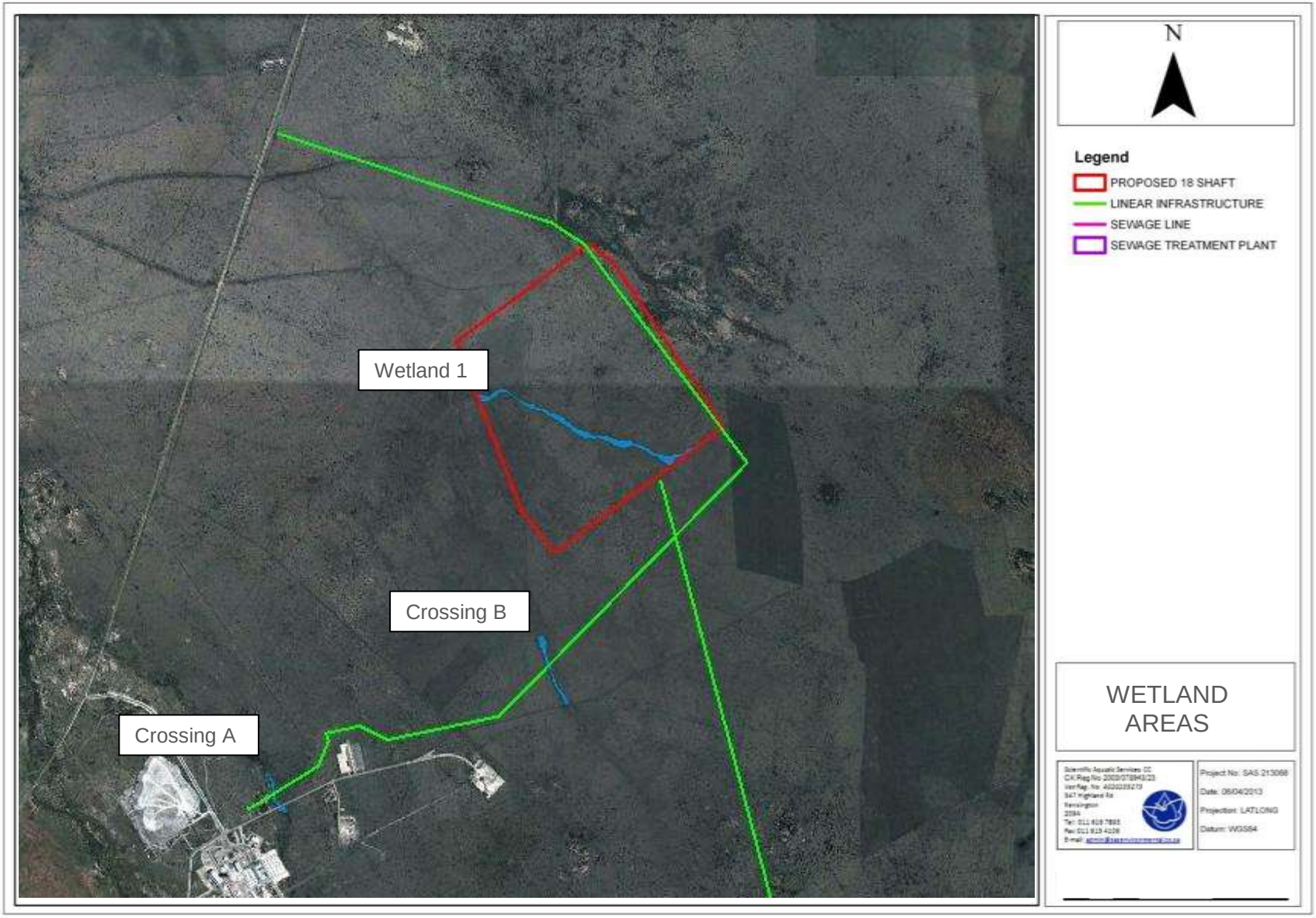


**Figure 6: Wetlands identified within the northern portion of the study area.**

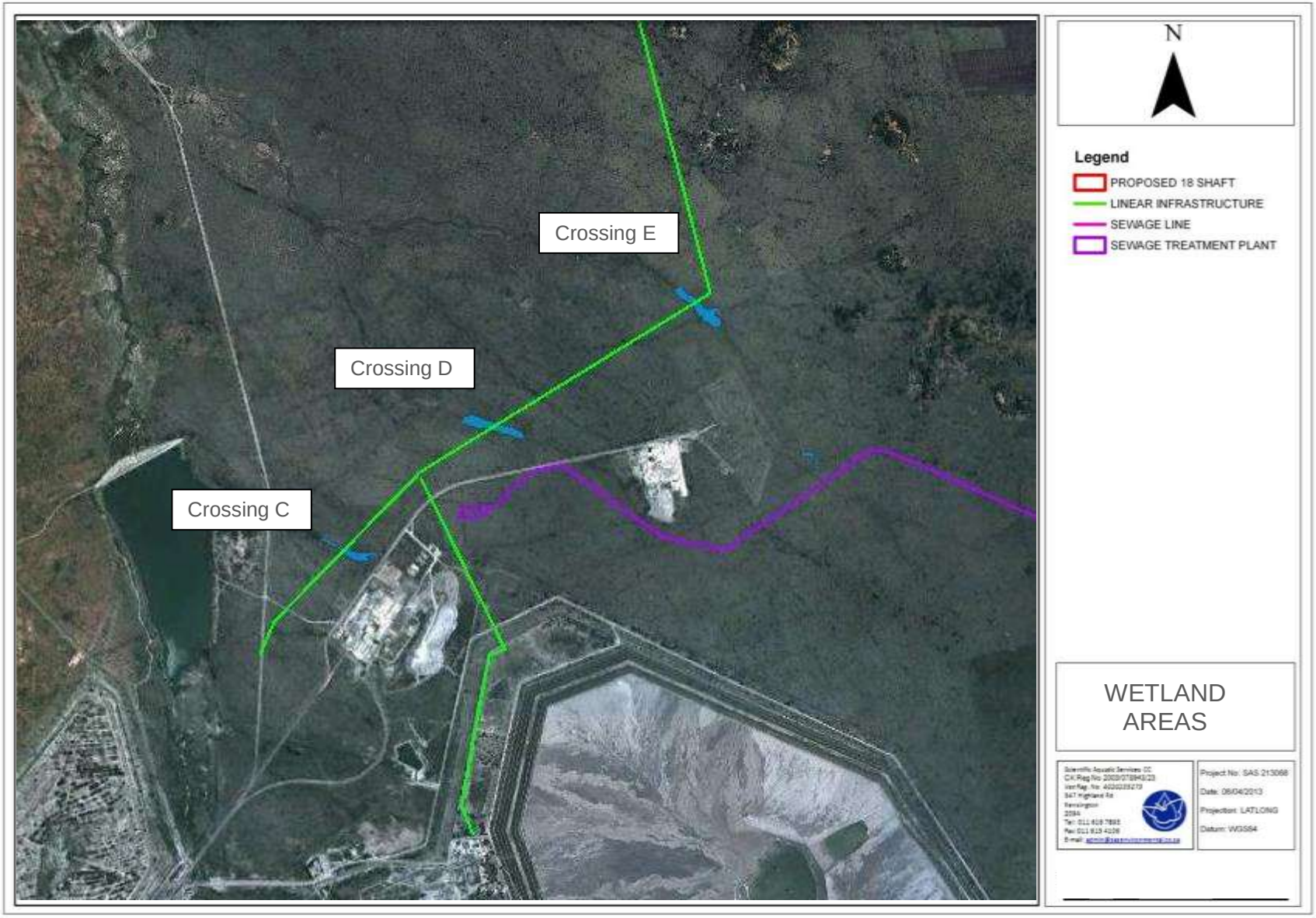


**Figure 7: Wetlands identified within central portion of the study area.**


**Figure 8: Wetlands identified within the southern portion of the study area.**

## 3.3 Wetland System Characterisation

The wetlands occurring within the study area (Figures 5 – 8) have been divided into two broad wetland types according to the Level 4 HGM classification system compiled by SANBI (2009), namely:

- Channelled valley-bottom wetlands; and
- Unchannelled valley-bottom wetlands.

All drainage lines present within the study area are considered to be non-perennial drainage lines that are poorly developed and may be classified as unchannelled valley bottom wetlands, with the exception of Wetland 1 and Wetland Crossing B. All wetland features present have been significantly impacted by the surrounding historical agricultural activities.

The results of the wetland system characterisation are illustrated in more detail in the tables below.

**Table 9: SANBI National Wetland Classification for Wetland 1 and Wetland Crossing B (channelled valley bottom wetlands).**

| Level 1: System | Level 2: Regional Setting | Level 3: Landscape unit | Level 4: Hydrogeomorphic (HGM) unit | |
|---|---|---|---|---|
| | | | HGM Type | Longitudinal zonation / landform |
| **Inland:** An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically. | **Ecoregion:** The study area falls within the Bushveld Basin Aquatic Ecoregion. | **Valley floor:** The typically gently sloping, lowest surface of a valley | **Channelled valley bottom wetland:** A mostly flat valley-bottom wetland dissected by and typically elevated above a channel. | **Valley-bottom flat:** A near-level wetland area with little or no relief and lacking depressional characteristics, forming part of a broader valley-bottom wetland complex |

**Table 10: SANBI National Wetland Classification for Wetland Crossings A, C, D, E, F and G (unchannelled valley bottom wetlands).**

| Level 1: System | Level 2: Regional Setting | Level 3: Landscape unit | Level 4: Hydrogeomorphic (HGM) unit | |
|---|---|---|---|---|
| | | | HGM Type | Longitudinal zonation / landform |
| **Inland:** An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically. | **Ecoregion:** The study area falls within the Bushveld Basin Aquatic Ecoregion. | **Valley floor:** The typically gently sloping, lowest surface of a valley | **Unchannelled valley-bottom wetland:** a mostly flat valley-bottom wetland area without a well-defined stream channel running through it, characterised by an absence of distinct channel banks and the prevalence of diffuse flows, even during and after rainfall events. Water inputs are typically from an upstream channel, as the flow becomes dispersed, and from adjacent slopes (if present). | **Valley-bottom flat:** A near-level wetland area with little or no relief and lacking depressional characteristics, forming part of a broader valley-bottom wetland complex (see channelled and unchannelled valley-bottom wetland). |

The various wetland features are discussed below with reference to the levels of ecoservices provided by each feature, the features' PES as well as the levels of disturbance and overall sensitivities of each feature as noted during the field assessment.

For the purpose of this assessment, the channelled valley bottom wetlands (Wetland 1 and Wetland Crossing B) are discussed first, followed by a discussion of the various unchannelled valley bottom wetlands (Wetland Crossing A and Wetland Crossings C – G) that are to be traversed by the proposed linear infrastructure. Due to the various unchannelled valley bottom wetlands being largely similar in nature, structure, ecological service provision and ecological functioning, Wetland Crossings C to G are discussed together, with only Wetland Crossing A, which is considered to be a more well-developed wetland feature, discussed separately.

## 3.1 Wetland 1 (channelled valley bottom wetland)

**Figure 9: Wetland 1 as present within the proposed 18 shaft development footprint.**

### 3.1.1 Wetland Function Assessment

Wetland 1 (Figure 9) comprises a poorly developed and weakly channelled wetland associated with an unnamed tributary of the Leragana River. The wetland functioning and service provision of the wetland feature was assessed and the average scores for each ecosystem service provided by the wetland are presented in Table 11 as well as the radar plot that follows.

**Table 11: Wetland function and service provision for Wetland 1.**

| Ecosystem service | Wetland 1 |
|---|---|
| Flood attenuation | 1.3 |
| Stream flow regulation | 1 |
| Sediment trapping | 1.2 |
| Phosphate assimilation | 0.6 |
| Nitrate assimilation | 0.8 |
| Toxicant assimilation | 0.8 |
| Erosion control | 1 |
| Biodiversity maintenance | 1 |
| Carbon Storage | 0.6 |
| Water Supply | 0.3 |
| Harvestable resources | 0.3 |
| Cultivated foods | 0.3 |
| Cultural Significance | 0 |
| Tourism and recreation | 0 |
| Education and research | 0 |
| **SUM** | **9.2** |
| **Average score** | **0.6** |

| Rating | Moderately low |
|---|---|

From the results of the assessment, it can be concluded that Wetland 1 provides a moderately low level of ecological functioning and service provision. The most important ecoservices provided by the feature is in terms of the role the feature plays in flood attenuation and sediment trapping. The feature is also somewhat important in terms of erosion control and streamflow regulation as well as toxicant and nitrate assimilation. Wetland 1 plays a role in biodiversity maintenance due to the unique habitat it provides for certain floral species and the opportunity for faunal migration afforded by the feature. The role played in socio-economic service provision is considered to be negligible.

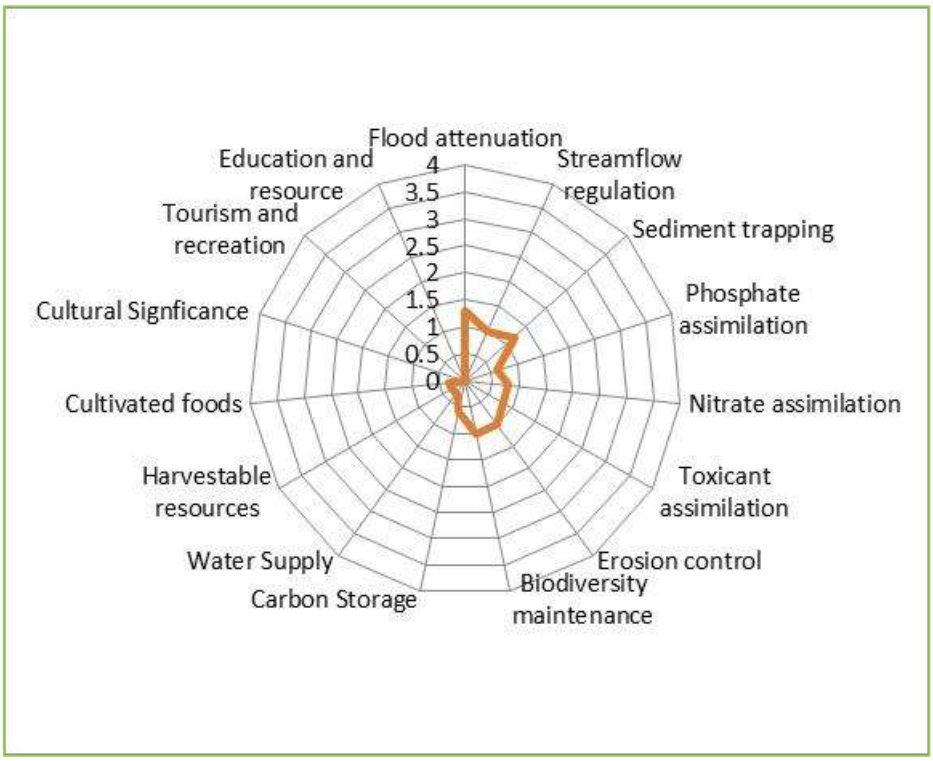


**Figure 10: Radar plot of wetland services provided by Wetland 1.**

## 3.1.2 Present Ecological State

The results for the criteria and attributes used for the calculation of the PES are stipulated in the table below.

**Table 12: Criteria and Attributes used with the calculation of the PES of Wetland 1.**

| Criteria and Attributes | Score | Confidence |
|---|---|---|
| **Hydrologic** | | |
| Flow modification | 3 | 2 |
| Permanent Inundation | 3 | 3 |
| **Water quality** | | |
| Water Quality Modification | 3 | 3 |
| Sediment load modification | 3 | 2 |
| **Geomorphic** | | |

| | | |
|---|---|---|
| Canalisation | 3 | 3 |
| Topographic Alteration | 2 | 2 |
| **Biota** | | |
| Terrestrial Encroachment | 2 | 2 |
| Indigenous Vegetation Removal | 3 | 3 |
| Invasive plant encroachment | 3 | 3 |
| Alien fauna | 3 | 3 |
| Overutilization of biota | 3 | 2 |
| **Total** | **31** | |
| **Mean** | **2.8** | |

The mean score obtained for the wetland features were calculated as a moderate score of 2.8, indicating the PES of the wetland features to fall within Class C – Moderately Modified. The main modifiers impacting on the PES of the wetland feature are grazing by cattle, terrestrial floral encroachment and historical agricultural activities in the immediate vicinity of the feature. Thus, the wetland is of moderately low ecological significance due to the system modifiers as presented in the analyses above.

## *3.2 Wetland Crossing B (channelled valley bottom wetland)*

**Figure 11: Wetland Crossing B.**

### 3.2.1 Wetland Function Assessment

Wetland Crossing B forms part of a tributary of the Leragana River and drains in a north-western direction. The wetland function and service provision of this feature was assessed and the average scores obtained are presented in the following table as well as the radar plot in Figure 12.

**Table 13: Wetland function and service provision for Wetland Crossing B.**

| Ecosystem service | Wetland Crossing B |
|---|---|
| Flood attenuation | 1.6 |
| Stream flow regulation | 1 |
| Sediment trapping | 1.3 |
| Phosphate assimilation | 0.8 |
| Nitrate assimilation | 0.9 |
| Toxicant assimilation | 0.8 |
| Erosion control | 1.2 |
| Biodiversity maintenance | 1.6 |
| Carbon Storage | 0.8 |
| Water Supply | 0.4 |
| Harvestable resources | 0.5 |
| Cultivated foods | 0.5 |
| Cultural Significance | 0 |
| Tourism and recreation | 0 |
| Education and research | 0 |
| **SUM** | **11.4** |
| **Average score** | **0.8** |
| **Rating** | **Moderately Low** |

From the results of the assessment, it can be concluded that Wetland Crossing B also provides a moderately low level of ecological function and service provision. The system plays a moderately important role in flood attenuation and sediment trapping, while providing potential habitat for a number of faunal and floral species. It furthermore plays a role in streamflow regulation, erosion control and nutrient trapping. The feature has been impacted by historic agricultural activities in its immediate vicinity and by grazing and trampling from cattle.

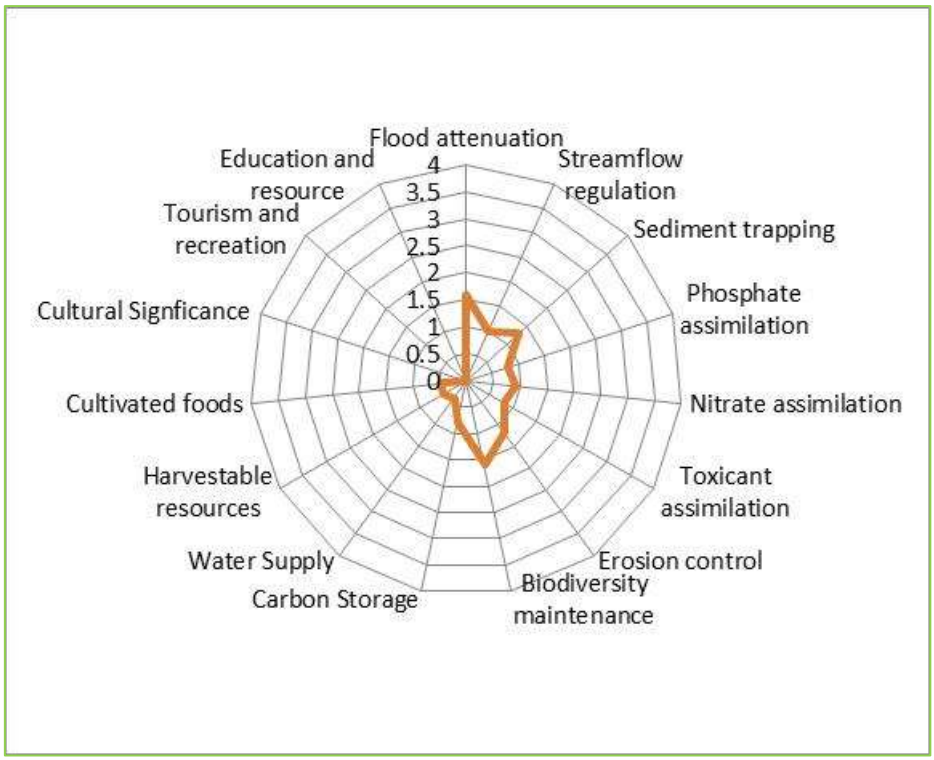


**Figure 12: Radar plot of wetland services provided by Wetland Crossing B.**

### 3.2.2 Present Ecological State

The results for the criteria and attributes used for the calculation of the PES are stipulated in the table below.

**Table 14: Criteria and Attributes used with the calculation of the PES of Wetland Crossing B.**

| Criteria and Attributes | Score | Confidence |
|---|---|---|
| **Hydrologic** | | |
| Flow modification | 3 | 3 |
| Permanent Inundation | 3 | 2 |
| **Water quality** | | |
| Water Quality Modification | 2 | 3 |
| Sediment load modification | 3 | 3 |
| **Geomorphic** | | |
| Canalisation | 3 | 3 |
| Topographic Alteration | 3 | 3 |
| **Biota** | | |
| Terrestrial Encroachment | 2 | 2 |
| Indigenous Vegetation Removal | 3 | 3 |
| Invasive plant encroachment | 3 | 3 |
| Alien fauna | 2 | 2 |
| Overutilization of biota | 3 | 2 |
| **Total** | **30** | |
| **Mean** | **2.7** | |

Wetland Crossing E has a moderate PES score of 2.7, indicating the feature to fall within Class C – Moderately Modified. As with Wetland 1, the main system modifiers are biotic and perceived water quality modifications. Thus, the wetland is of moderately low ecological significance due to the system modifiers as presented in the analyses above.

## 3.3 Wetland Crossing A (unchannelled valley bottom wetland)

**Figure 13: Wetland Crossing A.**

Wetland Crossing A comprises an unnamed tributary of the Leragana River. The feature in its present condition may be considered to be unchannelled, although the feature in general is more prominent and well-defined than the other wetland features in its vicinity, related to the study area. The wetland function and service provision of the three features were assessed. The average scores obtained during the wetland function and service provision of this wetland feature is presented in Table 15 and Figure 14 below.

**Table 15: Wetland functions and service provision for Wetland Crossing A.**

| Ecosystem service | Wetland Crossing A |
|---|---|
| Flood attenuation | 2.4 |
| Stream flow regulation | 2 |
| Sediment trapping | 2.1 |
| Phosphate assimilation | 1.6 |
| Nitrate assimilation | 1.6 |
| Toxicant assimilation | 2 |
| Erosion control | 2.5 |
| Biodiversity maintenance | 2 |
| Carbon Storage | 1.8 |
| Water Supply | 0.6 |
| Harvestable resources | 0.6 |
| Cultivated foods | 0.6 |
| Cultural Significance | 0 |

| | |
|---|---|
| Tourism and recreation | 0 |
| Education and research | 0 |
| **SUM** | **19.8** |
| **Average score** | **1.3** |
| **Rating** | **Intermediate** |

From the results of the assessment, it was found that Wetland Crossing A provides an intermediate level of ecological function and service provision. The feature is considered to be important in terms of erosion and sediment control, flood attenuation during both the early and late wet seasons and streamflow regulation. The feature furthermore provides ecological services in terms of toxicant and nutrient assimilation and biodiversity maintenance. The role the feature plays in providing socio-economic services and direct benefits for humans, such as tourism and education is very low. The wetland feature has been impacted by mining infrastructure and mining activities in its immediate vicinity.

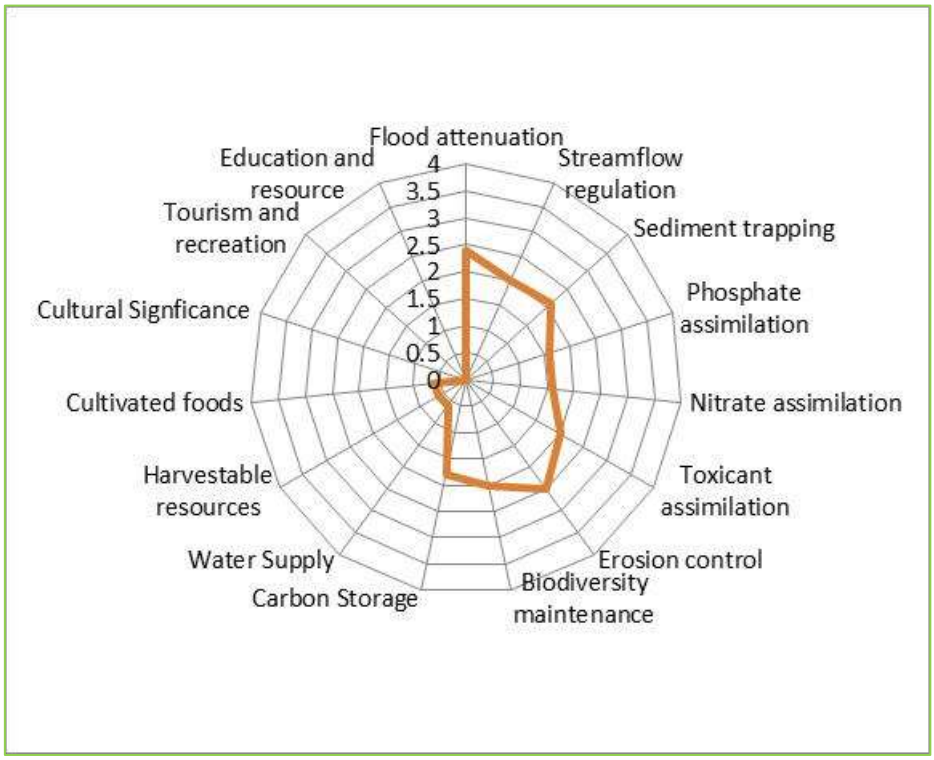


**Figure 14: Radar plot of wetland services provided by Wetland Crossing A.**

### 3.3.1 Present Ecological State

The results for the criteria and attributes used for the calculation of the PES are stipulated in the table below.

**Table 16: Criteria and Attributes used with the calculation of the PES of Wetland Crossing A.**

| Criteria and Attributes | Score | Confidence |
|---|---|---|
| **Hydrologic** | | |
| Flow modification | 3 | 2 |
| Permanent Inundation | 3 | 3 |
| **Water quality** | | |
| Water Quality Modification | 2 | 3 |
| Sediment load modification | 2 | 2 |
| **Geomorphic** | | |
| Canalisation | 4 | 3 |
| Topographic Alteration | 3 | 3 |
| **Biota** | | |
| Terrestrial Encroachment | 2 | 2 |
| Indigenous Vegetation Removal | 3 | 3 |
| Invasive plant encroachment | 3 | 3 |
| Alien fauna | 3 | 2 |
| Overutilization of biota | 3 | 2 |
| **Total** | **31** | |
| **Mean** | **2.8** | |

The mean score obtained for the wetland features were calculated as a moderate score of 2.8, indicating the PES of the wetland features to fall within Class C – Moderately Modified. This is largely due to perceived water quality modifications as well as due to impacts from encroachment by terrestrial species. Thus, the wetland is of moderately low ecological significance due to the system modifiers as presented in the analyses above.

## *3.4 Wetland Crossings C, D, E, F & G (unchannelled valley bottom wetlands)*

**Figure 15: Representative images of the wetland conditions associated with Wetland Crossing C, D, E, F and G.**

Wetland Crossings C, D, E and F (Figure 15) are unnamed tributaries of the Leragana River, while Wetland Crossing G comprises a tributary of the Molapongwamongana River. These features are poorly developed wetlands and mostly unchannelled. The wetland function and service provision of the five wetland features were assessed. The average score for the wetlands is presented in the following table as well as in the radar plot presented in Figure 16.

**Table 17: Wetland functions and service provision for Wetland Crossings C - G.**

| Ecosystem service | Wetland Crossings C - G |
|---|---|
| Flood attenuation | 1.3 |
| Stream flow regulation | 1 |
| Sediment trapping | 1.2 |
| Phosphate assimilation | 0.8 |
| Nitrate assimilation | 0.8 |
| Toxicant assimilation | 1 |
| Erosion control | 1.3 |
| Biodiversity maintenance | 1 |
| Carbon Storage | 0.6 |
| Water Supply | 0.3 |
| Harvestable resources | 0.3 |
| Cultivated foods | 0.3 |
| Cultural Significance | 0 |
| Tourism and recreation | 0 |
| Education and research | 0 |
| **SUM** | **9.9** |
| **Average score** | **0.6** |
| **Rating** | **Moderately low** |

From the results of the assessment, it was found that Wetland Crossings C, D, E, F and G provide a moderately low level of ecological function and service provision, with an average score of 0.6 having been achieved. The features can be considered to be of increased importance in terms of flood attenuation, sediment trapping and erosion control and also plays a role is biodiversity maintenance, streamflow regulation and toxicant assimilation. The system plays a limited role in provision of direct benefits for human use.

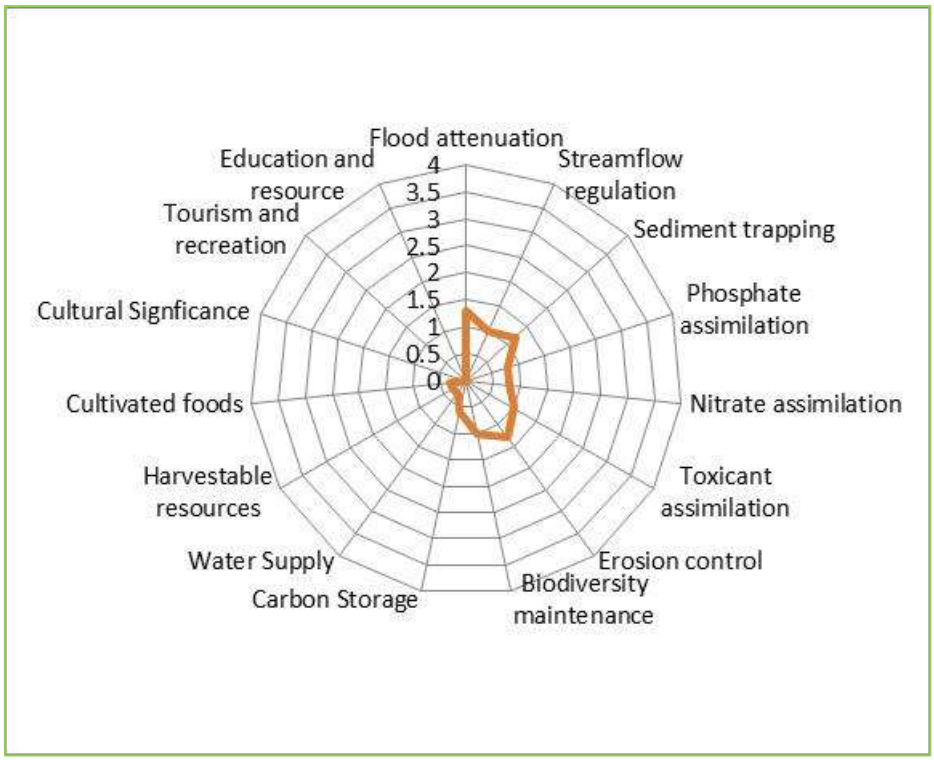


**Figure 16: Radar plot of wetland services provided by Wetland Crossings C - G.**

### 3.4.1 Present Ecological State

The results for the criteria and attributes used for the calculation of the PES are stipulated in the table below.

**Table 18: Criteria and Attributes used with the calculation of the PES of Wetland Crossing C - G.**

| Criteria and Attributes | Score | Confidence |
|---|---|---|
| **Hydrologic** | | |
| Flow modification | 2 | 2 |
| Permanent Inundation | 3 | 3 |
| **Water quality** | | |
| Water Quality Modification | 2 | 3 |
| Sediment load modification | 2 | 2 |
| **Geomorphic** | | |
| Canalisation | 4 | 3 |
| Topographic Alteration | 2 | 3 |
| **Biota** | | |
| Terrestrial Encroachment | 2 | 2 |
| Indigenous Vegetation Removal | 2 | 3 |
| Invasive plant encroachment | 3 | 3 |
| Alien fauna | 2 | 2 |
| Overutilization of biota | 3 | 2 |
| **Total** | **27** | |
| **Mean** | **2.5** | |

The mean score obtained for the wetland features were calculated as a moderate score of 2.5, indicating the PES of the wetland features to fall within Class C – Moderately Modified. This is primarily due to agricultural activities in the vicinity of the various wetland features. Thus, the wetlands are of moderately low ecological significance due to the system modifiers as presented in the analyses above.

## *3.5 Wetland vegetation*

During the assessment, the wetland vegetation components were assessed. Dominant species were characterised as either wetland or terrestrial species. The wetland species were then further categorised as temporary, seasonal and permanent zone species. Although the wetland features comprise a largely similar species composition to that of the adjacent terrestrial area, the vegetation within the wetland boundaries was clearly affected by a fluctuating water level at or near the soil surface, thus forming a distinct community indicative of wetland conditions. This characterisation is presented in the table below, including the terrestrial species identified within the wetland zones. Please note that vegetation and terrain units were found to be the most accurate indicators of the temporary zone boundary, as soils were of limited use due to black vertic soils being the dominant soil type in both wetland and terrestrial areas. Thus, a combination of distinct wetland vegetation communities and terrain units was utilised as primary indicator of the wetland temporary zone.

**Table 19: Main floral species identified during wetland delineation of the wetland present on the study area.**

| Terrestrial species | Seasonal zone species | Temporary zone species | Permanent zone species |
|---|---|---|---|
| *Andropogon schirensis* | *Andropogon schirensis* | *Aristida congesta* subsp | *Aristida bipartita* |
| *Aristida congesta* subsp | *Asparagus laricunus* | *barbicollis* | *Aristida congesta* subsp |
| *barbicollis* | *Botriochloa insculpta* | *Commelina africana* | *congesta* |
| *Asparagus laricunus* | *Chloris gayana* | *Corchorus confusus* | *Brachiaria serrata* |
| *Chloris gayana* | *Crabbea ovalifolia* | *Crabbea ovalifolia* | *Cymbopogon plurinoides* |
| *Commelina africana* | *Eragrostis suberba* | *Digitaria eriantha* | *Cynodon dactylon* |
| *Corchorus confusus* | *Eragrotis curvula* | *Eragrostis chloromelas* | *Eragrostis gummiflua* |
| *Crabbea ovalifolia* | *Eragrotis lehmanniana* | *Ischaemum fasciculatum* | *Eragrotis plana* |
| *Crabbea ovalifolia* | *Heteropogon contortus* | *Polygala hottentotta* | *Gladiolus crassifolius* |
| *Eragrostis suberba* | *Indigofera daleoides* | *Scabiosa columbaria* | *Hypoxis rigidula* |
| *Eragrotis curvula* | *Ledebouria cooperi* | *Setaria pallide-fusca* | *Scabiosa columbaria* |
| *Eragrotis lehmanniana* | *Ledebouria revoluta* | *Setaria sphacelata* | *Setaria pallide-fusca* |
| *Heteropogon contortus* | *Panicum schinzii* | *Sporobolus africanus* | *Setaria sphacelata* |
| *Indigofera daleoides* | *Themeda triandra* | *Vernonia oligocephala* | *Turbina oblongata* |
| *Ledebouria cooperi* | *Waltheria indica* | *Vernonia poskeana* | |
| *Panicum maximum* | | | |
| *Polygala hottentotta* | | | |
| *Solanum panduriforme* | | | |
| *Sorghum versicolor* | | | |
| *Vernonia oligocephala* | | | |
| *Vernonia poskeana* | | | |

## 3.6 Ecological Management Class

All results obtained from the NWCS that was used in the determination of the appropriate EMC class were considered. The results obtained from the wetland assessment indicate moderate to high levels of transformation on all levels of ecology and functionality. Therefore, the EMC class deemed appropriate to enhance and maintain currently ecology as well as functionality is Class C (Moderately modified) for all the wetland features. Mitigation measures and recommendations stipulated in this report, if followed, are deemed adequate to reach this goal. On a localised scale however, the catchment wide impacts related to mining and agriculture on the drainage system may limit the ability to reach this EMC objective.

## 3.7 Wetland delineation and sensitivity mapping

During the assessment, the following temporary zone indicators were used. Please note that vegetation and terrain units were found to be the most accurate indicators of the temporary zone boundary, as soils were of limited use due to black vertic soils being the dominant soil type in both wetland and terrestrial areas. Thus, a combination of distinct wetland vegetation communities and terrain units was utilised as primary indicator of the wetland temporary zone:

- Terrain units were utilised as the primary indicator of the wetland temporary zone, due to all the wetland features being valley bottom wetlands.
- Vegetation was utilised for the identification of the wetland temporary zone and was also used during the delineation of the wetland features. Although the wetland features comprise a largely similar species composition to that of the adjacent terrestrial area, the vegetation within the wetland boundaries was clearly affected by a fluctuating water level at or near the soil surface, thus forming a distinct community indicative of wetland conditions.
- Surface water was absent during the field assessment, but saturated soils were noted within some of the wetland areas.
- The soils in the area do not serve as an accurate wetland indicator due to black vertic soil forms being the dominant soil type in both wetland and terrestrial areas.

After consideration of findings during the wetland assessment, a suitable buffer zone was considered for the proposed development. Two buffer zones are applicable i.e. a 30m buffer in terms of NEMA (1998) and a 100m buffer in terms of GN704 of the National Water Act (NWA) (1998). This buffer zone is deemed sufficient to maintain the PES of the

various wetland features, limit any further impact the proposed development could have and to ultimately achieve the EMC determined by the South African Wetland Assessment Classification System (Class C). The wetland boundaries and buffer zones are conceptually presented in the figures below.

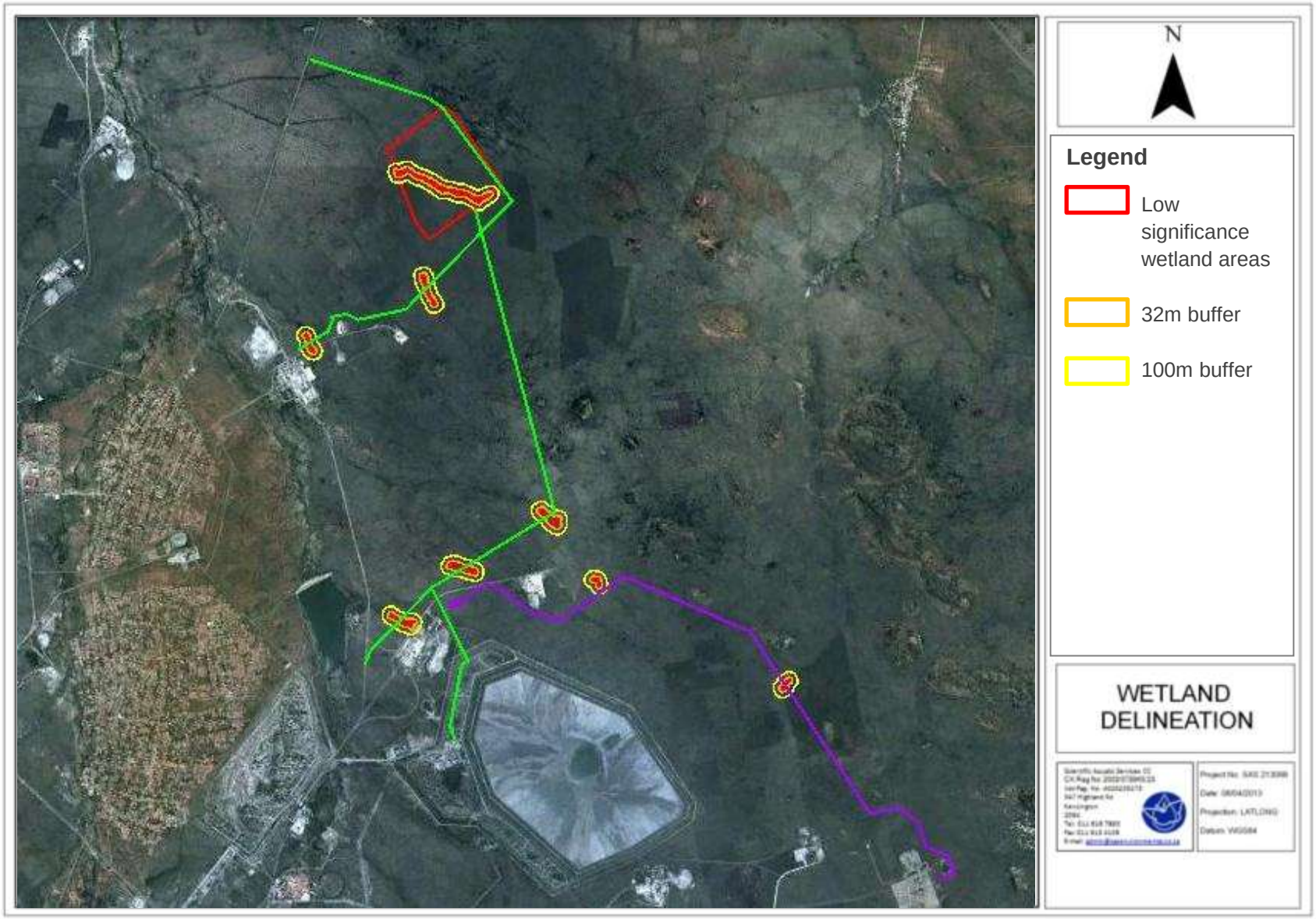


**Figure 17: Conceptual representation of the low significance wetlands present within the study area with associated buffers.**

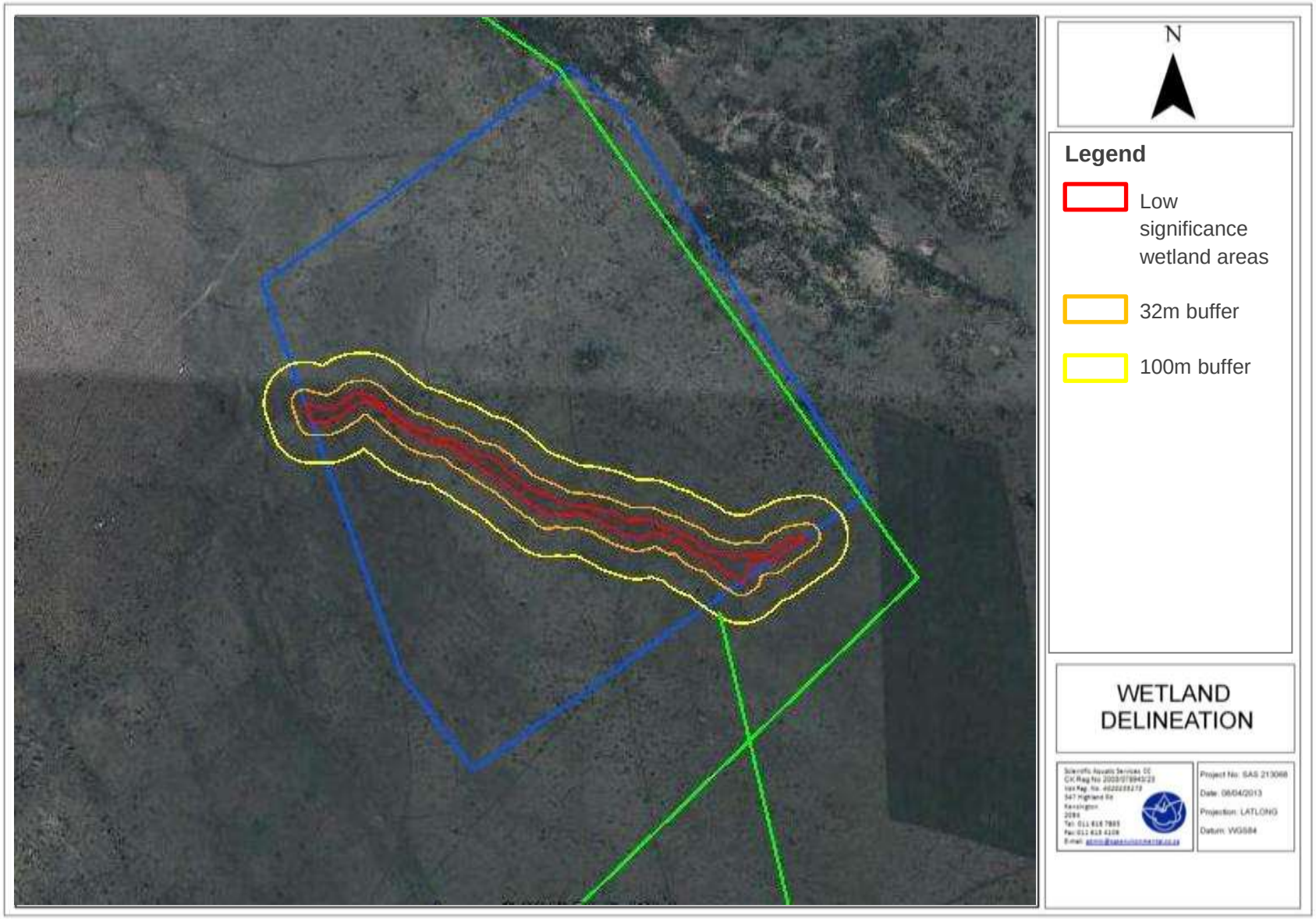


**Figure 18: Wetland delineation with associated buffer zones for low significance Wetland 1.**

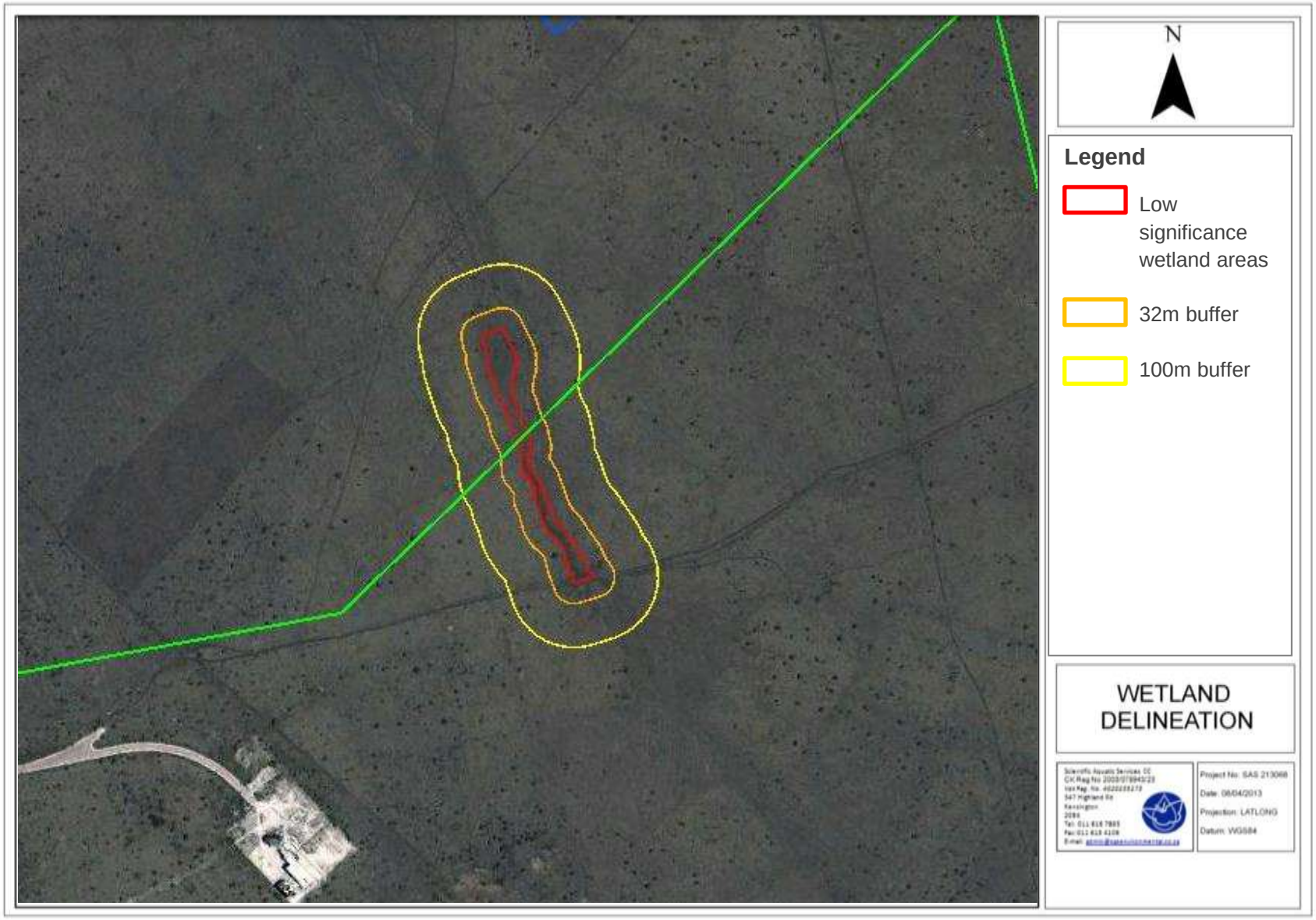


**Figure 19: Wetland delineation with associated buffer zones for low significance Wetland Crossing B.**

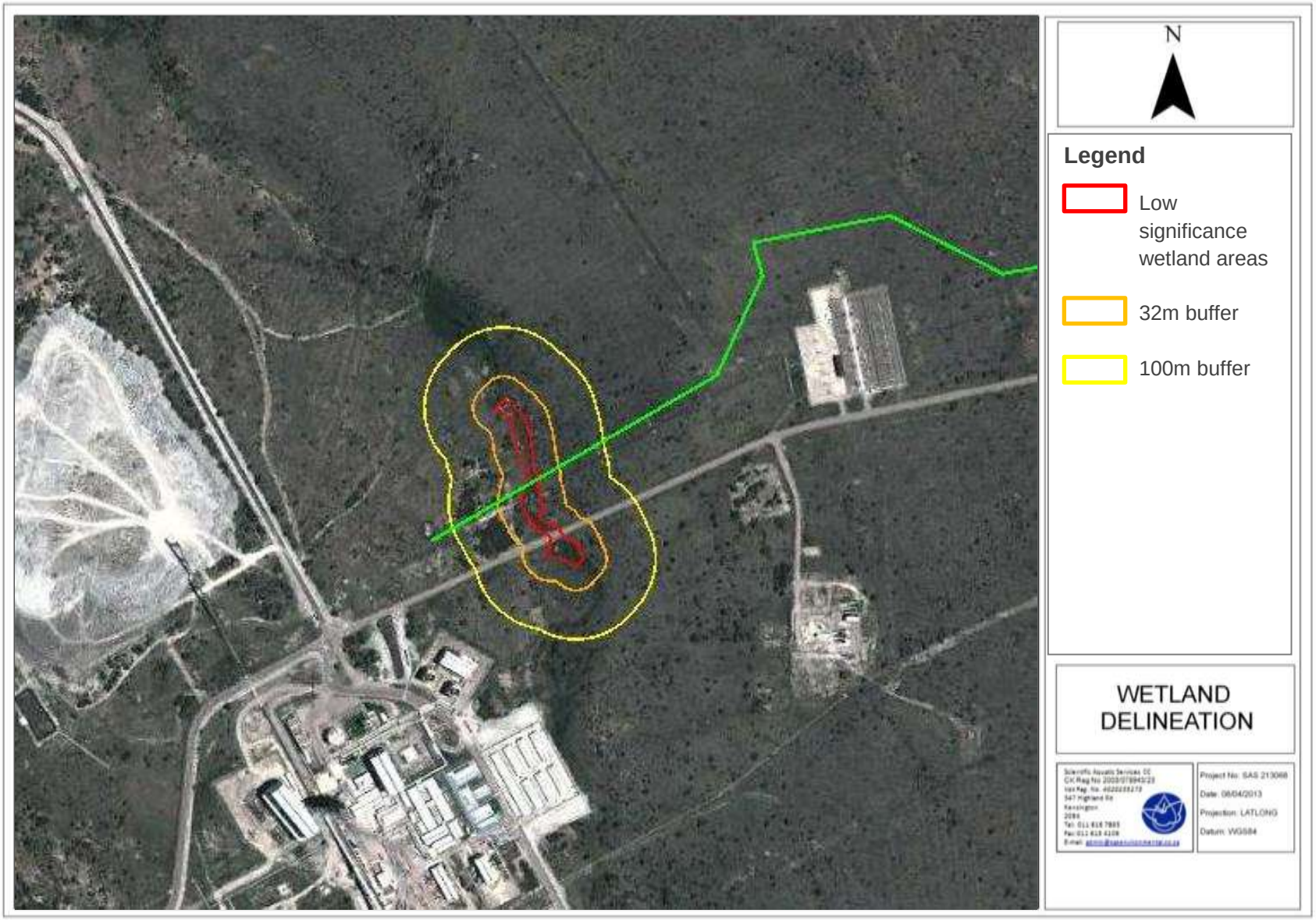


**Figure 20: Wetland delineation with associated buffer zones for low significance Wetland Crossing A.**

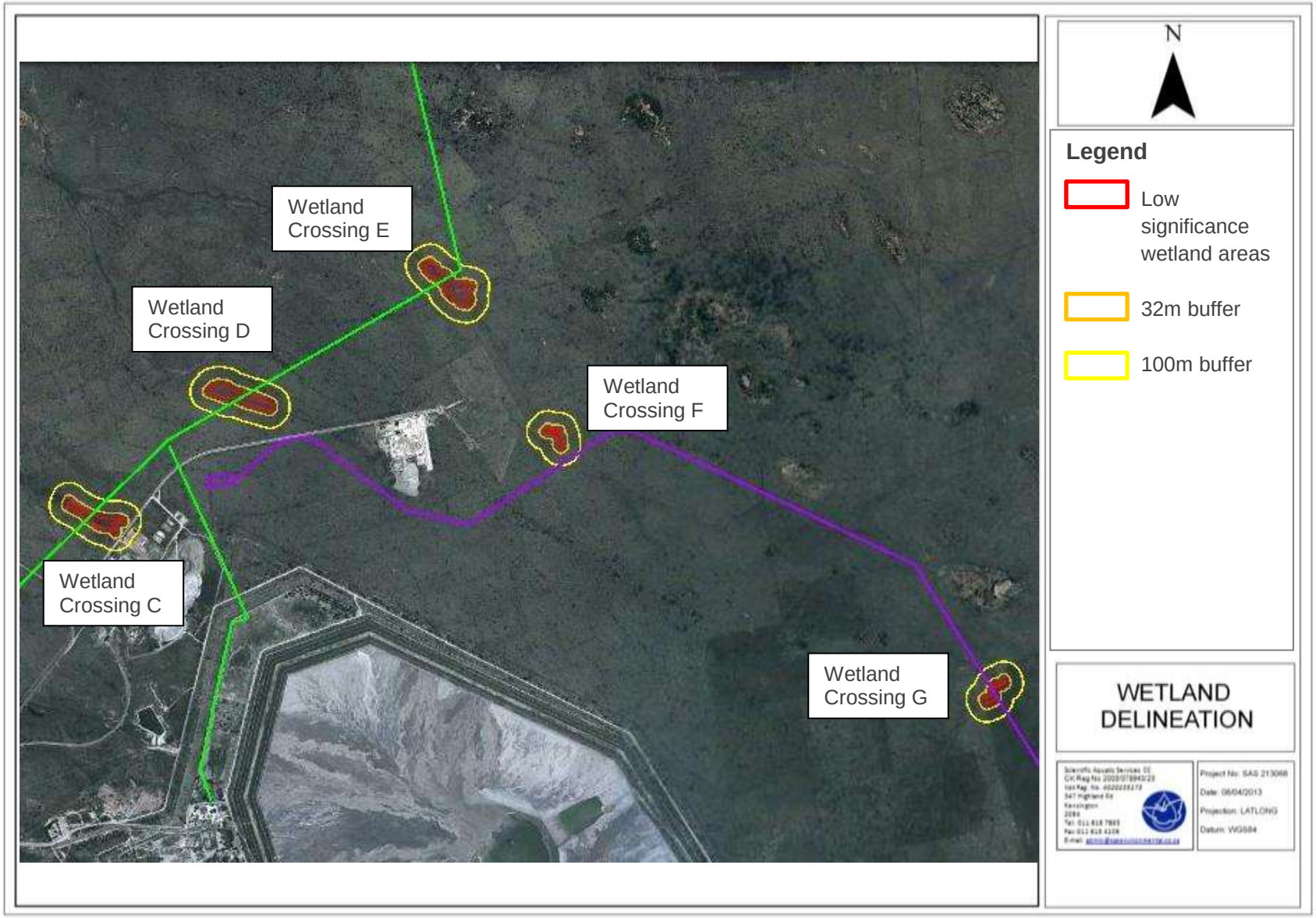


**Figure 21: Wetland delineation with associated buffer zones for low significance Wetland Crossings C, D, E, F and G.**

# 4 IMPACT ASSESSMENT

The tables below serve to summarise the significance of perceived impacts on the wetland ecology and biodiversity of the study area. The table presents the impact assessment according to the method described in Section A.

This section also indicates the required mitigatory measures needed to minimise any perceived impacts. The table presents an assessment of the significance of the impacts taking into consideration the available mitigatory measures assuming that they are fully implemented.

## *4.1 Impact Discussion*

**IMPACT 1: LOSS OF WETLAND HABITAT AND ECOLOGICAL STRUCTURE**

**Activities leading to impact**

| Pre-Construction | Construction | Operational | Decommissioning & Closure |
|---|---|---|---|
| Planning of infrastructure (with special mention of Shaft 18) within wetland areas | Site clearing and the removal of vegetation leading to increased runoff and erosion | Ongoing disturbance of soils with general operational activities | Disturbance of soils as part of demolition activities |
| Inadequate design of infrastructure leading to risks of pollution | Site clearing and the disturbance of soils leading to increased erosion | Spillages and seepage of hazardous waste material into the groundwater | Ongoing seepage and runoff from mining infrastructure to the groundwater regime |
| Inadequate design of infrastructure leading to changes to wetland habitat | Earthworks in the vicinity of wetland areas leading to increased runoff and erosion and altered runoff patterns | Risk of discharge from the mining infrastructure | Ongoing risk of discharge from mining infrastructure beyond closure |
| | Construction of stream crossings altering stream and baseflow patterns and water velocities | Potential contamination from mining infrastructure | Potential contamination from the decommissioning of mining infrastructure |
| | Topsoil stockpiling adjacent to wetlands and runoff from stockpiles | Runoff, seepage and potential discharge from mining infrastructure such as pipelines | Ongoing seepage and runoff from mining infrastructure to the groundwater regime beyond closure |
| | Movement of construction vehicles within wetlands | Dumping of hazardous and non-hazardous waste into the wetland areas | Decommissioning activities may lead to wetland habitat transformation and alien plant species proliferation |

| | | | |
|---|---|---|---|
| | Dumping of hazardous and non-hazardous waste into the wetland areas | Erosion and sedimentation of wetlands leading to loss of wetland habitat | Ineffective rehabilitation may lead to habitat transformation and alien vegetation encroachment |
| | Waste material spills and waste refuse deposits into the wetland features | | Ongoing erosion and sedimentation of wetlands |

**Aspects of wetland ecology affected**

| Pre-Construction | Construction | Operational | Decommissioning & Closure |
|---|---|---|---|
| | Direct impact on wetland habitat | Direct impact on wetland habitat | Direct impact on wetland habitat during decommissioning |
| | Loss of wetland biodiversity | Loss of wetland biodiversity | Loss of wetland biodiversity |
| | Contamination of wetland soils | Contamination of wetland soils | Ongoing contamination of wetland soils |
| | Contamination of water within wetlands | Contamination of water within wetlands | Ongoing contamination of water within wetlands |
| | Compaction and loss of wetland soils | Compaction and loss of wetland soils | Compaction and loss of wetland soils during decommissioning |
| | Sedimentation and incision leading to altered habitats | Sedimentation and incision leading to altered habitats | Sedimentation and incision leading to altered habitats |
| | Changes to the wetland community due to alien invasion vegetation leading to altered habitat conditions | Changes to the wetland community due to alien invasion vegetation leading to altered habitat conditions | Changes to the wetland community due to alien invasion vegetation leading to altered habitat |
| | Destruction of wetlands during contruction of Shaft 18 | Dewatering of wetlands and loss of habitat | Continued dewatering of wetlands and loss of habitat |

| Management level | Probability of Impact | Sensitivity of receiving environment | Severity | Spatial scale | Duration of impact | Likelihood | Consequence | Significance |
|---|---|---|---|---|---|---|---|---|
| **Unmanaged** | **5** | **3** | **4** | **3** | **5** | **8** | **12** | **96 (Medium-High)** |

**Essential mitigation measures:**

- A sensitivity map has been developed for the study area, indicating the various wetland features which are considered to be of increased ecological importance, although these wetlands are of low to moderately

low ecological significance due to impacts such as agriculture. It is recommended that this sensitivity map be considered during the planning/ pre-construction and construction phases of the proposed development activities to aid in the conservation of ecology within the study area.

- As the construction of Shaft 18 will have a direct impact on the moderately low significance wetland present within the shaft footprint, resulting in the destruction of this wetland, it is essential that the footprint of the shaft and associated infrastructure is minimised as far as possible.
- It must be ensured that planning of mining infrastructure, with particular reference to the low significance wetland crossings, includes consideration of adjacent wetland areas to ensure that these areas are avoided as far as possible.
- The development footprint area must be limited to what is absolutely essential in order to minimise environmental damage.
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas.
- Development impacts on the affected low significance wetland features should be managed to minimise impacts on adjacent wetland features.
- Edge effects of activities including erosion and alien/ weed control need to be strictly managed, with special mention of Shaft 18.
- Access into adjacent low significance wetland areas, particularly by vehicles, is to be strictly controlled.
- All vehicles should remain on designated roads with no indiscriminate driving through adjacent wetland areas.
- Run-off from dirty water areas entering wetland habitats must be prevented and clear separation of clean and dirty water in the vicinity of the proposed Shaft 18 must take place. Oil must be prevented from entering the clean water system.
- Ensure that seepage from dirty water systems is prevented as far as possible.
- It must be ensured that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage. All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil.
- All spills should be immediately cleaned up and treated accordingly.
- Appropriate sanitary facilities must be provided for the life of the mine and all waste removed to an appropriate waste facility.
- Effective waste management must be implemented in order to prevent construction related waste from entering the low significance wetland environment.
- All wetland areas must be rehabilitated upon decommissioning to ensure that wetland functions are re-instated during decommissioning and all disturbed wetland areas adjacent to the mining development must be revegetated with indigenous wetland species.
- All adjacent wetland systems must be monitored for erosion and incision.

**Recommended mitigation measures**

- Restrict construction to the drier winter months if possible to avoid sedimentation of wetland features in the vicinity of the proposed mine development areas.
- Desilt all adjacent wetland areas affected by mining and runoff from dirty water areas.
- Erosion berms may be installed in any areas where soil disturbances within the vicinity of the wetland features have occurred to prevent gully formation and siltation of the aquatic resources. The following points should serve to guide the placement of erosion berms:
    - Where the track has slope of less than 2%, berms every 50m should be installed.
    - Where the track slopes between 2% and 10%, berms every 25m should be installed.
    - Where the track slopes between 10% and15%, berms every 20m should be installed.
    - Where the track has slope greater than 15%, berms every 10m should be installed.

| Management level | Probability of Impact | Sensitivity of receiving environment | Severity | Spatial scale | Duration of impact | Likelihood | Consequence | Significance |
|---|---|---|---|---|---|---|---|---|
| Managed | 4 | 3 | 4 | 3 | 4 | 7 | 11 | 77 (Medium-High) |

**Probable latent impacts**

- Sedimentation of the systems may lead to altered wetland habitats.
- Wetlands within the study area may be permanently altered.
- Proliferation of alien and weed species in disturbed areas will lead to altered vegetation communities within the adjacent wetland and wetland buffer zones.
- Erosion and incision of the adjacent wetland areas may occur.

**IMPACT 2: CHANGES TO WETLAND ECOLOGICAL AND SOCIOCULTURAL SERVICE PROVISION**

**Activities leading to impact**

| Pre-Construction | Construction | Operational | Decommissioning & Closure |
|---|---|---|---|
| Planning of infrastructure (with special mention of Shaft 18) within wetland areas | Site clearing and the removal of vegetation leading to increased runoff and erosion | Ongoing disturbance of soils with general operational activities | Disturbance of soils as part of demolition activities |
| Inadequate design of infrastructure leading to risks of pollution | Site clearing and the disturbance of soils leading to increased erosion | Spillages and seepage of hazardous waste material into the groundwater | Ongoing seepage and runoff from mining infrastructure to the groundwater regime |
| Inadequate design of infrastructure leading changes to wetland habitat | Earthworks in the vicinity of wetland areas leading to increased runoff and erosion and altered runoff patterns | Risk of discharge from the mining infrastructure | Ongoing risk of discharge from mining infrastructure beyond closure |

| Pre-Construction | Construction | Operational | Decommissioning & Closure |
|---|---|---|---|
| | Construction of stream crossings altering stream and baseflow patterns and water velocities | Potential contamination from mining infrastructure | Potential contamination from the decommissioning of the plant and mining infrastructure |
| | Topsoil stockpiling and runoff from stockpiles may affect adjacent wetlands | Runoff, seepage and potential discharge from the waste rock dump and other mining infrastructure | Ongoing seepage and runoff from mining infrastructure to the groundwater regime |
| | Movement of construction vehicles within adjacent wetlands | Dumping of hazardous and non-hazardous waste into the wetland areas | Decommissioning activities may lead to wetland habitat transformation and alien |
| | Dumping of hazardous and non-hazardous waste into the wetland areas | Erosion and sedimentation of wetlands leading to loss of wetland habitat | Ineffective rehabilitation may lead to habitat transformation and alien vegetation encroachment |
| | Waste material spills and waste refuse deposits into the wetland features | Nitrates from blasting leading to eutrophication of the receiving environment | Ongoing erosion and sedimentation of wetlands |
| | | | Nitrates from blasting leading to eutrophication of the receiving environment |

### Aspects of wetland ecological and socio-cultural services affected

| Pre-Construction | Construction | Operational | Decommissioning & Closure |
|---|---|---|---|
| | Loss of phosphate, nitrate and toxicant removal abilities | Loss of phosphate, nitrate and toxicant removal abilities | Loss of phosphate, nitrate and toxicant removal abilities |
| | Loss of carbon storage capabilities | Loss of carbon storage capabilities | Loss of carbon storage capabilities |
| | Inability to support biodiversity | Inability to support biodiversity | Inability to support biodiversity |
| | Loss of water supply to the local community | Loss of water supply to the local community | Loss of water supply to the local community |

| Management level | Probability of Impact | Sensitivity of receiving environment | Severity | Spatial scale | Duration of impact | Likelihood | Consequence | Significance |
|---|---|---|---|---|---|---|---|---|
| **Unmanaged** | **5** | **3** | **3** | **3** | **5** | **8** | **11** | **88 (Medium-High)** |
| | | | | | | | | |

**Essential mitigation measures:**

- A sensitivity map has been developed for the study area, indicating the various wetland features which are considered to be of increased ecological importance, although these wetlands are of low to moderately low ecological significance due to impacts such as agriculture. It is recommended that this sensitivity map be considered during the planning/ pre-construction and construction phases of the proposed development activities to aid in the conservation of ecology within the study area.
- As the construction of Shaft 18 will have a direct impact on the moderately low significance wetland present within the shaft footprint, resulting in the destruction of this wetland, it is essential that the footprint of the shaft and associated infrastructure is minimised as far as possible.
- It must be ensured that planning of mining infrastructure includes consideration of adjacent low significance wetland areas to ensure that these areas are avoided as far as possible.
- All demarcated sensitive zones outside of the construction area must be kept off limits during any development and closure phases of the mine.
- The development footprint area must be limited to what is absolutely essential in order to minimise environmental damage.
- Run-off from dirty water areas entering adjacent wetland habitats must be prevented and clear separation of clean and dirty water in the vicinity of the proposed Shaft 18 must take place. Oil must prevented from entering the clean water system.
- It must be ensured that seepage from dirty water systems is prevented as far as possible.
- It must be ensured that the mine process water system is managed in such a way as to prevent discharge to the receiving environment.
- Edge effects of activities (with special mention of Shaft 18) including erosion and alien/ weed control need to be strictly managed in wetland areas.
- As much vegetation growth as possible should be promoted within the proposed development area in order to protect soils. In this regard special mention is made of the need to use indigenous vegetation species where hydroseeding, wetland and rehabilitation planting (where applicable) are to be implemented.
- Implement effective waste management in order to prevent construction related waste from entering the wetland environment.
- Rehabilitate all wetland areas upon decommissioning to ensure that wetland functions are re-instated during decommissioning.

**Recommended mitigation measures**

- Desilt all wetland areas affected by mining and runoff from dirty water areas.
- Revegetate all disturbed areas with indigenous wetland species.

| Management level | Probability of Impact | Sensitivity of receiving environment | Severity | Spatial scale | Duration of impact | Likelihood | Consequence | Significance |
|---|---|---|---|---|---|---|---|---|
| Managed | 4 | 3 | 2 | 3 | 4 | 7 | 9 | 63 (Medium-Low) |

**Probable latent impacts**

- Impacts on water quality may affect service provision to both the local community and the environment beyond closure.
- Sedimentation of the systems may lead to altered wetland habitats.
- Proliferation of alien and weed species in disturbed areas will lead to altered vegetation communities within the wetland as well as buffer zone.
- Erosion and incision of the wetland areas may occur.
- Inundation of wetland areas caused by stormwater channels and dams.

**IMPACT 3: IMPACTS ON WETLAND HYDROLOGICAL FUNCTION**

**Activities leading to impact**

| Pre-Construction | Construction | Operational | Decommissioning & Closure |
|---|---|---|---|
| Planning of infrastructure (with special mention of Shaft 18) within wetland areas | Site clearing and the removal of vegetation leading to increased runoff and erosion | Ongoing disturbance of soils with general operational activities | Disturbance of soils as part of demolition activities |
| Inadequate design of infrastructure leading to changes in hydrological function and sediment control capacity | Site clearing and the disturbance of soils leading to increased erosion | Earthworks in the vicinity of wetland areas leading to increased runoff and erosion and altered runoff patterns | Earthworks in the vicinity of wetland areas leading to increased runoff and erosion and altered runoff patterns |
| | Earthworks in the vicinity of wetland areas leading to increased runoff and erosion and altered runoff patterns | Topsoil stockpiling adjacent to wetlands and runoff form stockpiles leading to sedimentation of the system | Movement of construction vehicles within wetlands |
| | Construction of stream crossings altering stream and baseflow patterns and water velocities | Movement of construction vehicles within wetlands | Altered hydrology due to in channel stormwater dams |
| | Topsoil stockpiling adjacent to wetlands and runoff form stockpiles leading to sedimentation of the system | Altered hydrology due to stormwater channels and dams | Movement of construction vehicles within wetlands |
| | Movement of construction vehicles within wetlands | Increased runoff volumes due to increased paved and other impervious surfaces | |

| Pre-Construction | Construction | Operational | Decommissioning & Closure |
|---|---|---|---|
| | Increased runoff volumes due to increased paved and other impervious surfaces | Dewatering of wetlands and loss of habitat | |

**Aspects of wetland hydrology affected**

| Pre-Construction | Construction | Operational | Decommissioning & Closure |
|---|---|---|---|
| | Change in flood peak flows | Change in flood peak flows | Incision of wetland areas and erosion of wetland habitat |
| | Concentration and canalisation of flow | Concentration and canalisation of flow | Sediment deposition |
| | Incision of wetland areas and erosion of wetland habitat | Incision of wetland areas and erosion of wetland habitat | |
| | Sediment deposition | Sediment deposition | |

| Management level | Probability of Impact | Sensitivity of receiving environment | Severity | Spatial scale | Duration of impact | Likelihood | Consequence | Significance |
|---|---|---|---|---|---|---|---|---|
| **Unmanaged** | **5** | **3** | **4** | **3** | **5** | **8** | **12** | **96 (Medium-High)** |

**Essential mitigation measures:**

- A sensitivity map has been developed for the study area, indicating the various wetland features which are considered to be of increased ecological importance, although these wetlands are of low to moderately low ecological significance due to impacts such as agriculture. It is recommended that this sensitivity map be considered during the planning/ pre-construction and construction phases of the proposed development activities to aid in the conservation of ecology within the study area.
- As the construction of Shaft 18 will have a direct impact on the moderately low significance wetland present within the shaft footprint, resulting in the destruction of this wetland, it is essential that the footprint of the shaft and associated infrastructure is minimised as far as possible.
- It must be ensured that planning of mining infrastructure includes consideration of adjacent wetland areas to ensure that these areas are avoided as far as possible.
- Keep all demarcated sensitive zones outside of the construction area off limits during development phases.
- Limit the footprint area of any development and closure activity to what is absolutely essential in order to minimise environmental damage.

- Prevent run-off from dirty water areas entering wetland habitats.
- Ensure that seepage from dirty water systems is prevented as far as possible.
- Ensure that the mine process water system is managed in such a way as to prevent discharge to the receiving environment.
- Implement effective waste management in order to prevent construction related waste from entering the wetland environment.
- Rehabilitate all wetland areas upon closure to ensure that wetland hydrology and wetland and functioning is re-instated during decommissioning.
- It must be ensured that all activities potentially impacting on geohydrological resources are managed according to the relevant DWA Licensing regulations and groundwater monitoring requirements.
- Post closure groundwater management will need to be very carefully managed to ensure that no impact on the wetland areas and riparian resources in the area takes place after mine closure has taken place.
- Future mine planning should ensure that mining activities does not lead to a reduction of stream flow or dewatering of any wetland areas and connectivity of the wetland features in the vicinity of ventilation shafts should be maintained.

**Recommended mitigation measures**

- Desilt all adjacent wetland areas affected by mining and runoff from dirty water areas.
- Revegetate all disturbed areas with indigenous wetland species upon closure.

| Management level | Probability of Impact | Sensitivity of receiving environment | Severity | Spatial scale | Duration of impact | Likelihood | Consequence | Significance |
|---|---|---|---|---|---|---|---|---|
| Managed | 4 | 3 | 3 | 3 | 4 | 7 | 10 | 70 (Medium-Low) |

**Probable latent impacts**

- Impacts on water quality may affect service provision of wetland features to both the local community and the environment beyond closure.
- Sedimentation of the systems may lead to altered wetland habitats.
- Proliferation of alien and weed species in disturbed areas will lead to altered vegetation communities within the wetland as well as buffer zone.
- Erosion and incision of the wetland areas may occur.

## 4.2 Impact Assessment Conclusion

Based on the above assessment it is evident that there are three possible impacts that may affect the wetland ecology of the study area. The table below summarises the findings indicating the significance of the impacts before mitigation takes place and the likely impact levels if management and mitigation takes place. In the consideration of mitigation it is assumed that a high level of mitigation takes place but which does not lead to prohibitive costs. From the table it is evident that prior to mitigation all of the impacts are medium-high level impacts. If mitigation and effective management takes, considering that the impact on wetland resources due to the construction of Shaft 18 will only be slightly mitigable, impact significance can be slightly reduced to medium-high and medium-low significance.

**Table 20: A summary of the results obtained from the assessment of wetland ecological impacts for the proposed Impala 18 shaft and related infrastructure.**

| Impact | Unmanaged | Managed |
|---|---|---|
| 1: Loss oflow significance wetland habitat and ecological structure | Medium-High | Medium-high |
| 2: Changes tolow significance wetland ecological and sociocultural service provision | Medium-High | Medium-low |
| 3: Impacts on low significance wetland hydrological function | Medium-High | Medium-low |

# 5 RECOMMENDATIONS

*After conclusion of this wetland assessment, it is the opinion of the ecologists that the proposed mining development be considered favourably, provided that the recommendations below are adhered to:*

- A sensitivity map has been developed for the study area, indicating the various wetland features which are considered to be of increased ecological importance, although these wetlands are of low to moderately low ecological significance due to impacts such as agriculture. It is recommended that this sensitivity map be considered during the planning/ pre-construction and construction phases of the proposed development activities to aid in the conservation of ecology within the study area.
- As the construction of Shaft 18 will have a direct impact on the moderately low significance wetland present within the shaft footprint, resulting in the destruction of this wetland, it is essential that the footprint of the shaft and associated infrastructure is minimised as far as possible.
- It must be ensured that planning of mining infrastructure, with particular reference to wetland crossings, includes consideration of adjacent wetland areas to ensure that these areas are avoided as far as possible.
- The development footprint area must be limited to what is absolutely essential in order to minimise environmental damage.
- All demarcated sensitive zones outside of the construction area must be kept off limits during any development and closure phases of the mine.
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas.
- Development impacts on the affected low significance wetland features should be managed to minimise impacts on adjacent wetland features.
- Edge effects of activities including erosion and alien/ weed control need to be strictly managed in these areas.
- Access into adjacent wetland areas, particularly by vehicles, is to be strictly controlled.
- All vehicles should remain on designated roads with no indiscriminate driving through adjacent wetland areas.
- Run-off from dirty water areas entering low significance wetland habitats must be prevented and clear separation of clean and dirty water in the vicinity of the proposed shaft must take place. Oil must be prevented from entering the clean water system.
- Ensure that seepage from dirty water systems is prevented as far as possible.

- It must be ensured that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage. All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil.
- All spills should be immediately cleaned up and treated accordingly.
- Appropriate sanitary facilities must be provided for the life of the mine and all waste removed to an appropriate waste facility.
- Effective waste management must be implemented in order to prevent construction related waste from entering the wetland environment.
- All adjacent wetland systems must be monitored for erosion and incision.
- Edge effects of activities including erosion and alien/ weed control need to be strictly managed in wetland areas.
- All affected wetland areas must be rehabilitated upon decommissioning to ensure that wetland functions are re-instated during decommissioning and all disturbed wetland areas adjacent to the mining development must be revegetated with indigenous wetland species.
- As much vegetation growth as possible should be promoted within the proposed development area in order to protect soils. In this regard special mention is made of the need to use indigenous vegetation species where hydroseeding, wetland and rehabilitation planting (where applicable) are to be implemented.
- It must be ensured that all activities potentially impacting on geohydrological resources are managed according to the relevant DWA Licensing regulations and groundwater monitoring requirements.
- Post closure groundwater management will need to be very carefully managed to ensure that no impact on the wetland areas and riparian resources in the area takes place after mine closure has taken place.
- Future mine planning should ensure that mining activities does not lead to a reduction of stream flow or dewatering of any wetland areas and connectivity of the wetland features in the vicinity of ventilation shafts should be maintained.

# 6 REFERENCES

**Bromilow, C.** 2001. Revised Edition, First Impression. *Problem Plants of South Africa.* Briza Publications, Pretoria, RSA.

**Davis, B. and Day, J**. (1998). Vanishing waters. University of Cape Town Press, Cape Town, South Africa.\

**Department of Water Affairs**, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999* [Appendix W1

**Germishuizen, G & Clarke, B.** 2003. First Edition, First Impression. *Illustrated guide to the Wildflowers of Northern South Africa.* Briza Publications, Pretoria, RSA.

**Henderson, L.** 2001. *Alien Weeds and Invasive Plants*. Agricultural Research Council, RSA.

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

**Mucina, L. & Rutherford, M.C.** (Eds). 2006. *The Vegetation of South Africa, Lesotho and Swaziland.* Strelitzia 19. South African National Biodiversity Institute, Pretoria, RSA.

**Van Oudtshoorn, F.** 2004. Second Edition, Third Print. *Guide to Grasses of South Africa.* Briza Publications, Pretoria, RSA.