Section D: Wetland Assessment

NATURAL SCIENTIFIC SERVICES

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SECTION D: WETLAND ASSESSMENT

1. Introduction

Section D of this report details the Baseline Wetland Assessment, which involved desktop- and field-based investigations of the major wetland systems within the three mine sections at Beatrix. The aim of the assessment was to classify the wetlands on site and to provide a better understanding of the importance, sensitivity, health and functionality of the major systems identified. No-in-field wetland delineations were performed.

Wetlands, as defined by the National Water Act, (Act 36 of 1998), include:
"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

Under Articles 1.1 and 2.1 of the Ramsar Convention wetlands are defined as:
"*areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres*" and "*may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands.*"

This wetland assessment utilises the Ramsar definition, as is done by the "Classification system for Wetlands and other Aquatic Ecosystems in South Africa" by Ollis *et al*. (2013), hereafter referred to as "the Classification System."

2. Methodology

The methodologies for the wetland assessment are detailed below. Although largely desktop based, a brief site visit was undertaken from 25-27 January 2016 to assess the main wetland systems in terms of health, functionality, importance and sensitivity.

2.1. Wetland Identification

Prior to any field investigations being undertaken, the area was surveyed at a desktop level using 1:50 000 topographical maps, Google Earth™ and Bing satellite imagery, historical aerial imagery (1952) and available contour data to determine the layout of potential wetlands within the three mine sections. The presence of wetland habitat was ground-truthed during the field investigation, although not delineated. The wetland sampling points are highlighted in **Figure 2-1**, **Figure 2-2**, and **Figure 2-3**.

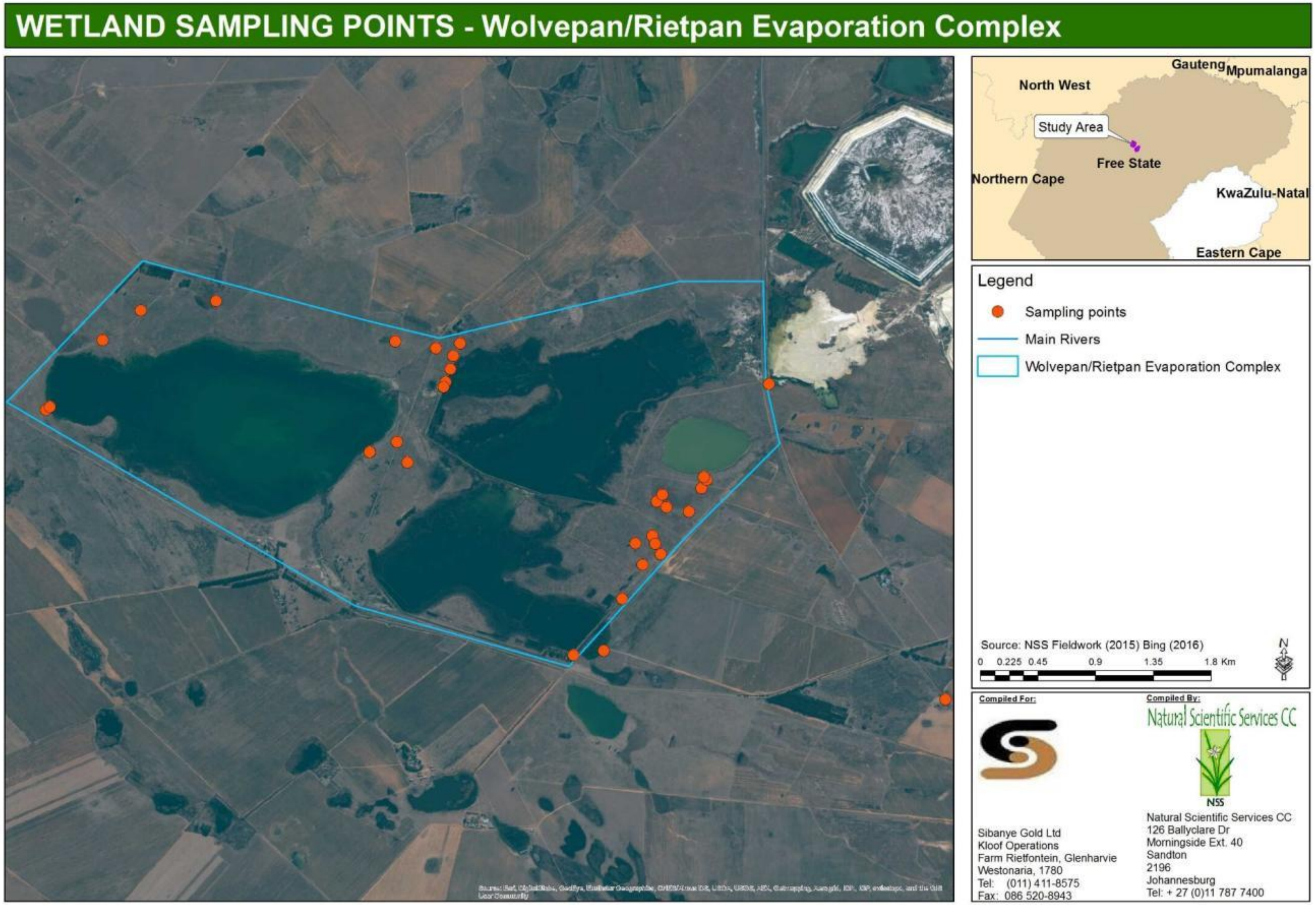


Figure 2-1 Sampling points – Wolvepan/Rietpan Evaporation Complex

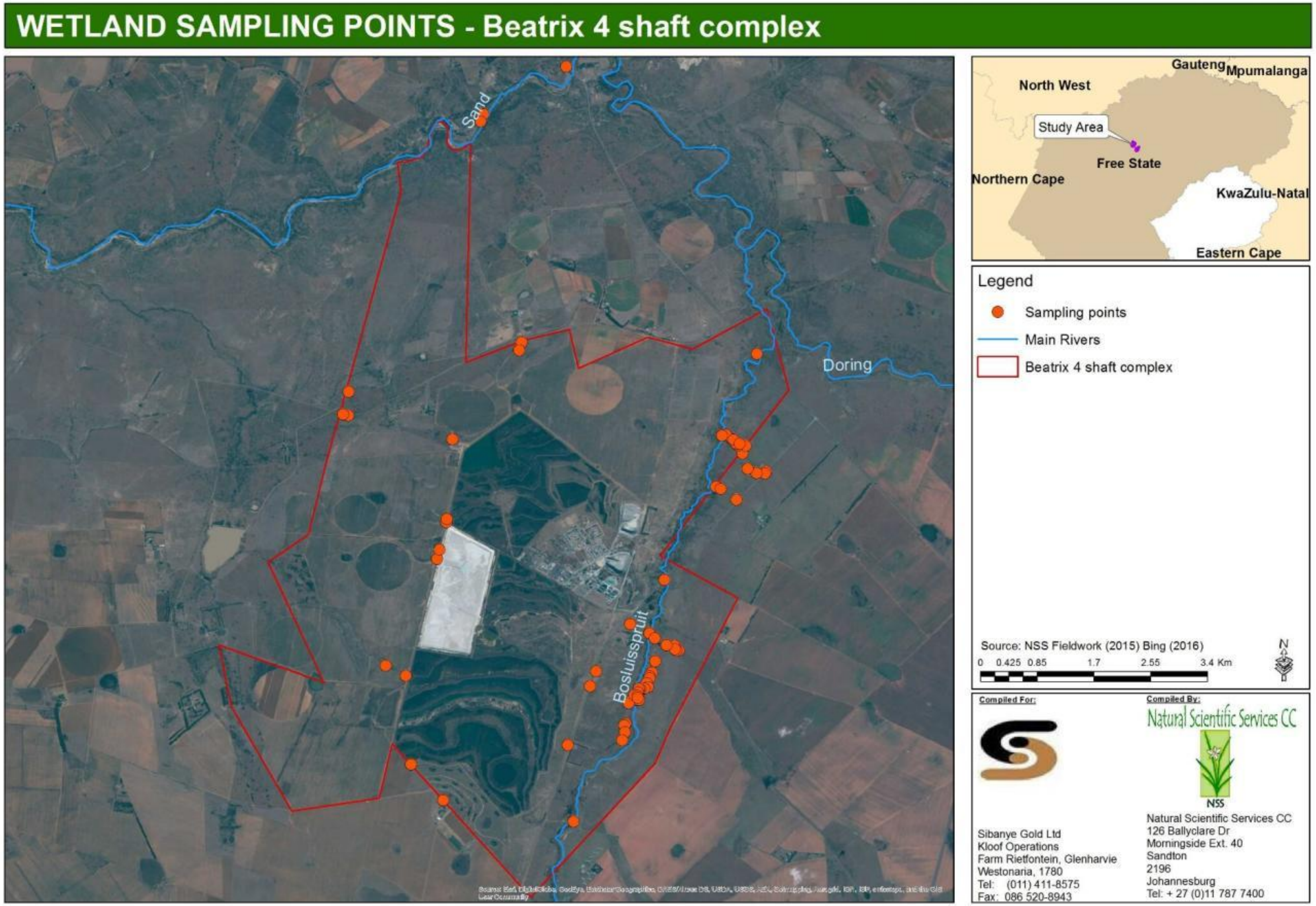


Figure 2-2 Sampling points – Beatrix 4 Shaft

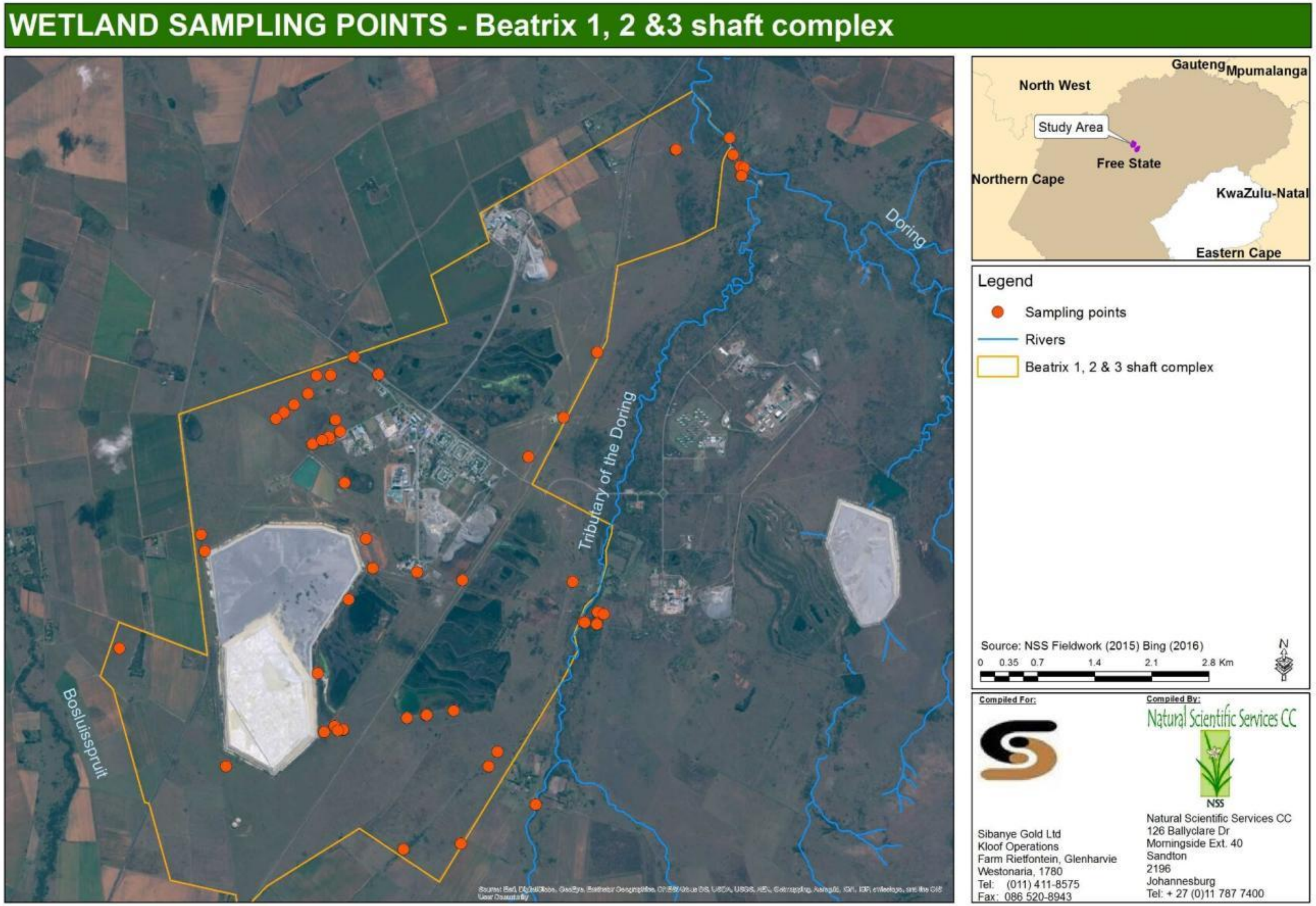


Figure 2-3 Sampling points – Beatrix 1, 2, 3 Shaft

2.2. Wetland Classification

As previously mentioned, wetlands were defined using the “Classification system” by Ollis *et al*. (2013).” Ecosystems included by the Classification System encompass all those that are listed under the Ramsar Convention as “wetlands,” and include all freshwater (non-marine) systems. The Classification System recognizes three broad inland systems: rivers, wetlands and open waterbodies. Like Kotze *et al*’s (2008) classification of wetlands based on hydro-geomorphic (HGM) units, the Ollis *et al*. (2013) Classification System asserts that the functioning of an inland aquatic ecosystem is determined fundamentally by hydrology and geomorphology.

The Classification System has a six-tiered structure where under the determination of a system’s HGM unit (Level 4) is the most fundamental (**Figure 2-4**):
Level 1 – Type of Systems (Marine, estuarine or Inland)
Level 2 – Regional Setting (Level 1 Ecoregions; NFEPA WetVeg units etc)
Level 3 – Landscape Unit (Valley Floor, Slope, Plain, Bench)
Level 4 – Hydrogeomorphic (HGM) Unit
Level 5 – Hydrological Regime
Level 6 – Descriptors (e.g. Natural vs Artificial; Salinity; pH etc)

2.3. Wetland Extent

The wetland assessment was undertaken as part of the Baseline Biodiversity Assessment for Beatrix and not for any specific future development. Wetland extent was, therefore, determined from a **desktop perspective only**, and only included the major wetland systems in the three mine sections. Any future proposed developments within the Beatrix mine sections would, however, require in-field wetland delineations. Wetland extent was determined using 1:50,000 topographical maps, Google Earth™ imagery, historical aerial imagery (1952) and contour data supplied by Sibanye Gold.

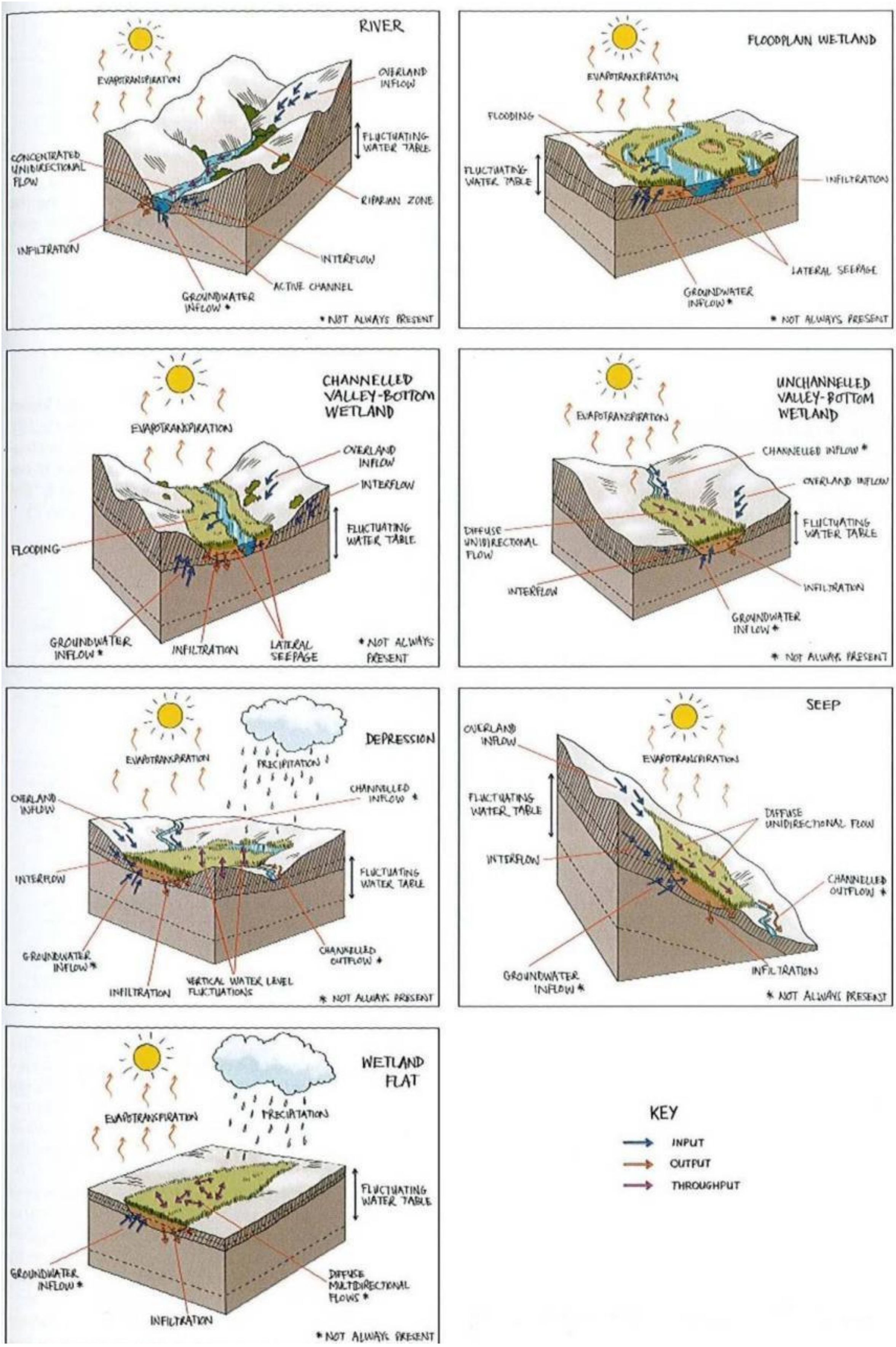


Figure 2-4 Primary HGM types, highlighting dominant water inputs, throughputs & outputs (Ollis *et al*. 2013)

2.4. Present Ecological State

The main channelled valley bottom and seep wetland systems identified on site were assessed using the Level 1 WET-HEALTH tool of Macfarlane *et al.* (2008). The ephemeral pan systems were qualitatively assessed. The DWS (2014) PES ratings were used for the river systems that border the mine property, as this rating takes into consideration the greater system. Methodologies used are discussed in more detail below.

2.4.1. Wet-Health – channelled valley bottom and seep wetland systems

The main channelled valley bottom and seep wetland systems (natural systems only) identified on site were assessed using the Level 1 WET-HEALTH tool of Macfarlane *et al.* (2008). The WET-HEALTH tool is designed to assess the health or integrity of a wetland. To assess wetland health, the tool uses indicators based on the main wetland drivers: geomorphology, hydrology and vegetation. The overall wetland PES for each driver is then expressed on a scale of A-F (**Table 2-1**).

In addition, the threat and/or vulnerability of a wetland must be assessed to determine its likely "trajectory of change" (**Table 2-2**). Overall wetland health is then jointly represented by the wetland's PES and trajectory of change. The factors contributing to the wetland's PES are discussed below per wetland driver.

Table 2-1 Impact scores and Present Ecological State categories

ECOLOGICAL CATEGORY	DESCRIPTION	COMBINED IMPACT SCORE
A	**Unmodified, natural**	0-0.9
B	**Largely natural with few modifications**. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9
C	**Moderately modified**. A moderate change in ecosystem processes and loss of natural habitat has taken place but the natural habitat remains predominantly intact.	2-3.9
D	**Largely modified**. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9
E	**Seriously modified**. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9
F	**Critically modified**. Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10

Source: Modified from Macfarlane *et al.* (2008)

Table 2-2 Trajectory of change classes, scores and symbols

TRAJECTORY CLASS	DESCRIPTION	CHANGE SCORE	CLASSRANGE	SYMBOL
Improve markedly	Condition is likely to improve substantially over the next five years	2	1.1 to 2	↑↑
Improve	Condition is likely to improve over the next five years	1	.3 to 1	↑
Remains stable	Condition is likely to remain stable over the next five years	0	-0.2 to +0.2	→
Deterioration slight	Condition is likely to deteriorate slightly over the next five years	-1	-0.3 to -1	↓
Deterioration substantial	Condition is likely to deteriorate substantially over the next five years	-2	-1.1 to 2	↓↓

Source: Modified from Macfarlane *et al.* (2008)

2.4.2. <u>Qualitative Assessment – Ephemeral Pans</u>

Historically there has been little research done in South Africa on pans, especially when compared to palustrine[1] wetlands (Ferreira, 2012). In terms of assessing the functioning and ecosystem services supplied by the ephemeral pans, the standard methods used in South Africa are not applicable as these focus on palustrine systems. Ferreira (2012) undertook his PhD on developing a methodology for determining the ecological integrity of *perennial* endorheic pans within South Africa. Unfortunately this methodology is not applicable to the ephemeral pan systems identified within the three mine sections, and no method is available in South Africa to assess the habitat integrity of such systems. The main impacts have therefore been listed in the relevant fact sheets (**Section 3.5**).

2.5. Wetland Functionality

The WET-EcoServices tool of Kotze *et al.* (2008) provides a means for rapidly assessing ecosystem services supplied by wetlands. The wetland benefits included in the WET-EcoServices model are selected based on their importance for South African wetlands, and how readily these can be assessed. Benefits such as groundwater recharge or discharge and biomass export may be important but are difficult to characterise at a rapid assessment level, and have thus been excluded. Detailed in **Table 2-3** are the ecosystem services that are assessed during a rapid field assessment. The outcome is an eco-system significance scoring for each service (**Table 2-4**).

[1] Palustrine: All non-tidal wetlands dominated by persistent emergent plants, emergent mosses or lichens, or shrubs or trees (Kotze *et al*, 2008)

Table 2-3 WET-EcoServices model of wetland ecosystem services (Kotze *et al.* 2008).

Ecosystem Services supplied by Wetlands	Indirect Benefits	Regulating & supporting benefits	Flood attenuation		The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream
			Streamflow regulation		Sustaining streamflow during low flow periods
			Water quality enhancements	Sediment trapping	The trapping and retention in the wetland of sediment carried by runoff waters
				Phosphate assimilation	Removal by the wetland of phosphates carried by runoff waters
				Nitrate assimilation	Removal by the wetland of nitrates carried by runoff waters
				Toxicant assimilation	Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff water
				Erosion control	Controlling of erosion at the wetland site, principally through the protection provided by vegetation
			Carbon storage		The trapping of carbon by the wetland, principally as soil organic matter
	Direct Benefits	**Biodiversity maintenance**			Through the provision of habitat and maintenance of natural process by the wetland, a contribution is made to maintaining biodiversity
		Biodiversity maintenance is not an ecosystem service as such, but encompasses attributes widely acknowledged as having potentially high value to society			
		Provisioning benefits	Provision of water for human use		The provision of water extracted directly from the wetland for domestic, agriculture or other purposes
			Provision of harvestable resources		The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.
			Provision of cultivated foods		The provision of areas in the wetland favourable for the cultivation of foods
		Cultural benefits	Cultural heritage		Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants
			Tourism and recreation		Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife
			Education and research		Sites of value in the wetland for education or research

Table 2-4 Eco-system Significance Scoring (Kotze *et al*, 2008)

Score	< 0.5	0.5 – 1.2	1.3 - 2	2.1 –2.8	>2.8
Likely extent to which an eco-system service is being supplied	Low	Moderately Low	Intermediate	Moderately High	High

2.6. Ecological Importance and Sensitivity

The assessment of wetland EIS was based on the EIS tool developed by Rountree and Kotze (2012). The purpose of assessing importance and sensitivity of water resources is to be able to identify those systems that provide higher than average ecosystem services, biodiversity support functions or are especially sensitive to impacts.

The Importance and Sensitivity tool for wetlands thus proposed three suites of importance criteria, namely:

- Ecological Importance and Sensitivity, incorporating the traditionally examined criteria used in EIS assessments of other water resources by DWS and thus enabling consistent assessment approaches across water resource types;
- Hydro-functional importance, which considers water quality, flood attenuation and sediment trapping ecosystem services that the wetland may provide; and
- Importance in terms of basic human benefits - this suite of criteria consider the subsistence uses and cultural benefits of the wetland system.

It is recommended that the highest of these three suites of scores be used to determine the overall Importance and Sensitivity category (**Table 2-5**) of the wetland system.

Table 2-5 Ecological importance and sensitivity categories – Interpretation of median scores for biotic and habitat determinants

RANGE OF MEDIAN	ECOLOGICAL IMPORTANCE & SENSITIVITY (EIS)	RECOMMENDED EMC
>3 and <=4	**Very high** Wetlands that are considered ecologically important and sensitive on a national / international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	A
>2 and <=3	**High** Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	B
>1 and <=2	**Moderate** Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	C
>0 and <=1	**Low/Marginal** Wetlands which are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	D

3. Results

The results of the wetland assessment are summarised below, with a more detailed description of the main wetland HGM units found, within each of the three mine sections, provided in separate wetland Fact Sheets (**Section 3.5**).

3.1. Wetland Classification

Two broad types of inland systems were identified within Beatrix Mine, rivers[2], and wetlands (both natural and artificial). The main wetlands identified from a desk-top level, in each of the mines sections, are shown in **Figure 3-1**, **Figure 3-2**, and **Figure 3-3**. Ollis *et al*. (2013) describes the HGM units identified on site as:

- Rivers: A linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water. Three main perennial river systems were identified within the study area:
  - The Sand River, classified as a Lowland River, borders the northern boundary of the Beatrix 4 Shaft Complex. A Lowland River is a system with a low-gradient, alluvial sand-bed channel.
  - The Bosluisspruit runs along the south eastern boundary of the Beatrix 4 Shaft Complex and is classified as a Lower Foothill system: lower gradient, mixed-bed alluvial channel with sand and gravel dominating the bed.
  - The Doring River and the tributary of the Doring River, touches the north eastern boundary of the Beatrix 1, 2 & 3 Shaft Complex and are also classified as Lower Foothill Systems.

  There are no major rivers within a 5km radius of the Wolvepan/Rietpan Evaporation Complex.

- Wetlands. Within each mining complex there are a number of natural and artificial wetlands. In accordance with the Classification system (Ollis *et al*, 2013), wetlands not naturally occurring, for example dams, canals, excavations, etc. are classified as artificial wetlands. Ollis *et al*. (2013) describes the HGM units identified on site as:
  - Channelled Valley Bottom systems associated with the above-mentioned rivers. Dominant water inputs to these wetlands are from the river channel flowing through the wetland, either as surface flow resulting from flooding or as sub-surface flow and/or from adjacent valley-side slopes (as overland flow or interflow).
  - Seep. A wetland area located on gently to steeply sloping land and dominated by colluvial (i.e. gravity driven), unidirectional movement of water and material

[2] The Ramsar definition of 'wetland' encompasses both types of Inland Systems, whereas rivers are not wetlands according to the narrower definition of the South African National Water Act

down-slope. Both natural and artificial seeps were present within the study area. The artificial seeps were mainly associated with seepage, for example from the tailings facilities, reservoirs and dirty water dams.

- Depression. Both natural and artificial depressions were identified within the study area.
  - The artificial depressions consisted of both in-channel and off-channel dams, and evaporation facilities. All dams are classified as depressions according to Ollis *et al* (2013). This rule is based on the fact that the landform characteristics of such systems fit the definition of a depression in that they typically have closed (or near closed) elevation contours and increase in depth from the perimeter to a central area of greatest depth (Ollis *et al*, 2013).
  - A number of natural pan systems (flat bottomed) were also identified within all three mine sections. Pans (depressions) within South Africa are characteristic of the drier parts of the country and are concentrated in the Northern Cape, Western Free State and North West Province (Allan *et al*, 1995). Many of the natural pan systems have however been incorporated into the artificial evaporation facilities of the mine and are now perennial in nature. It is assumed that in their natural state these pans would have been ephemeral in nature.

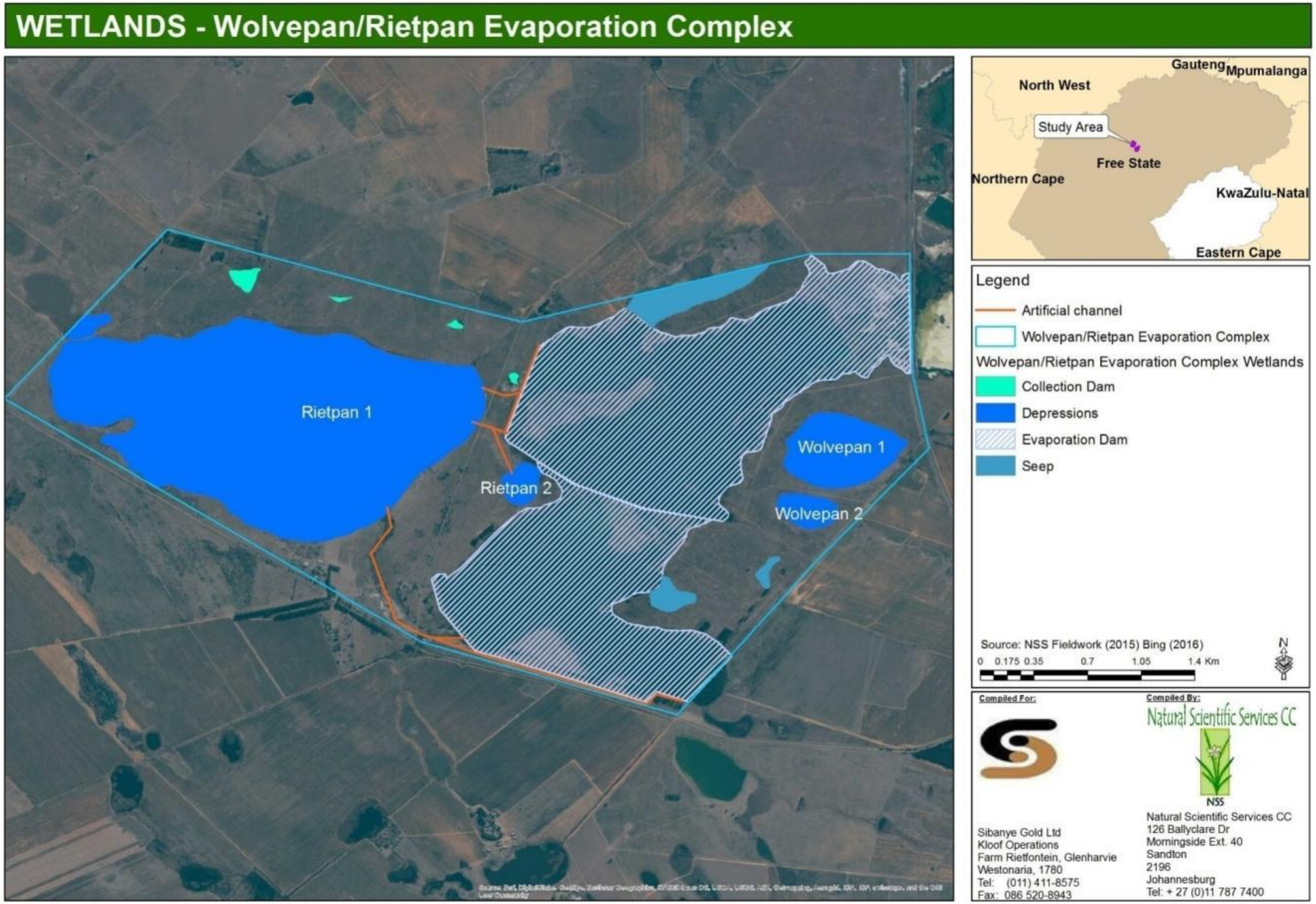


Figure 3-1 Wetland Systems – Wolvepan/Rietpan Evaporation Complex (desktop delineated)

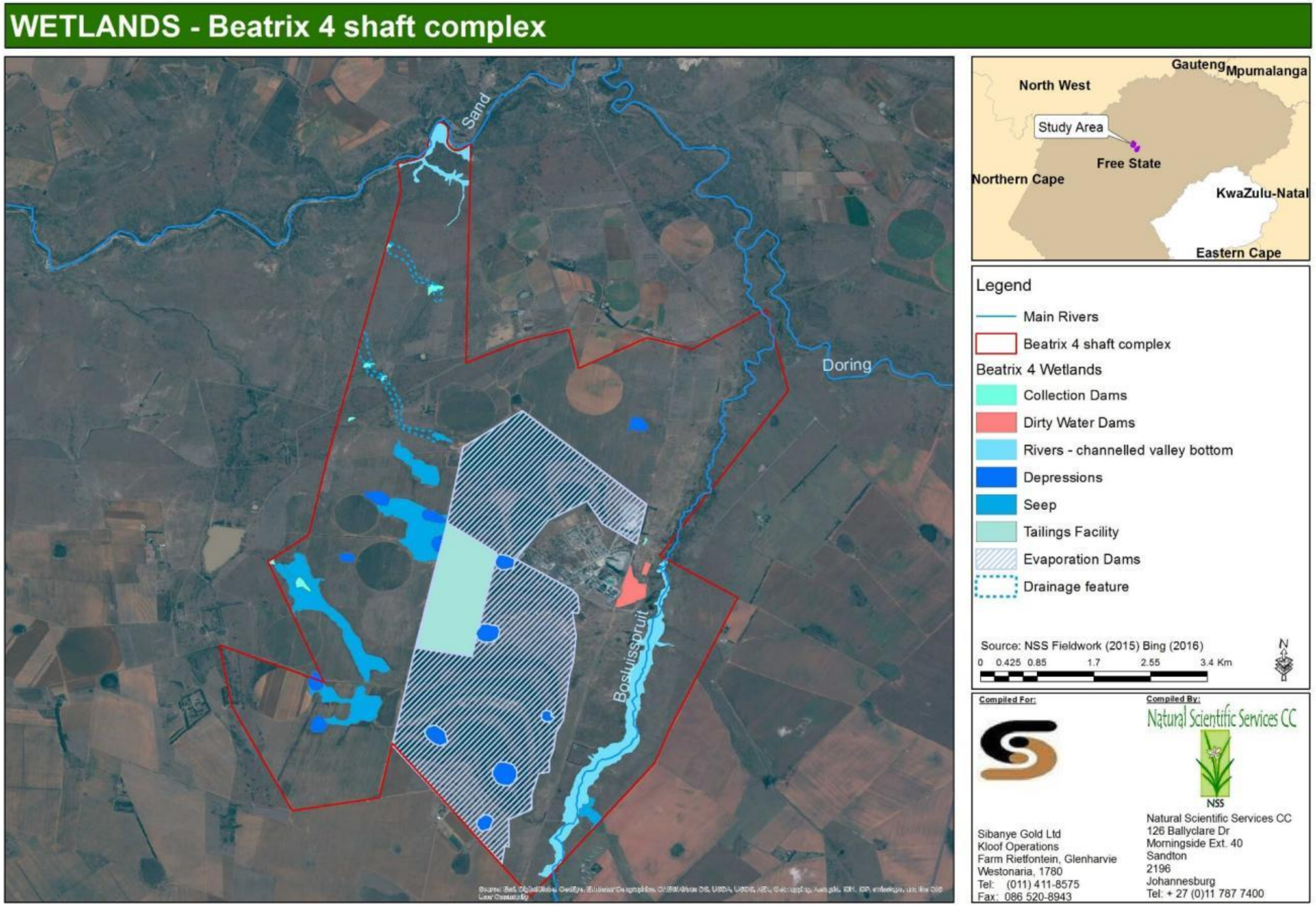


Figure 3-2 Wetland Systems – Beatrix 4 Shaft (desktop delineated)

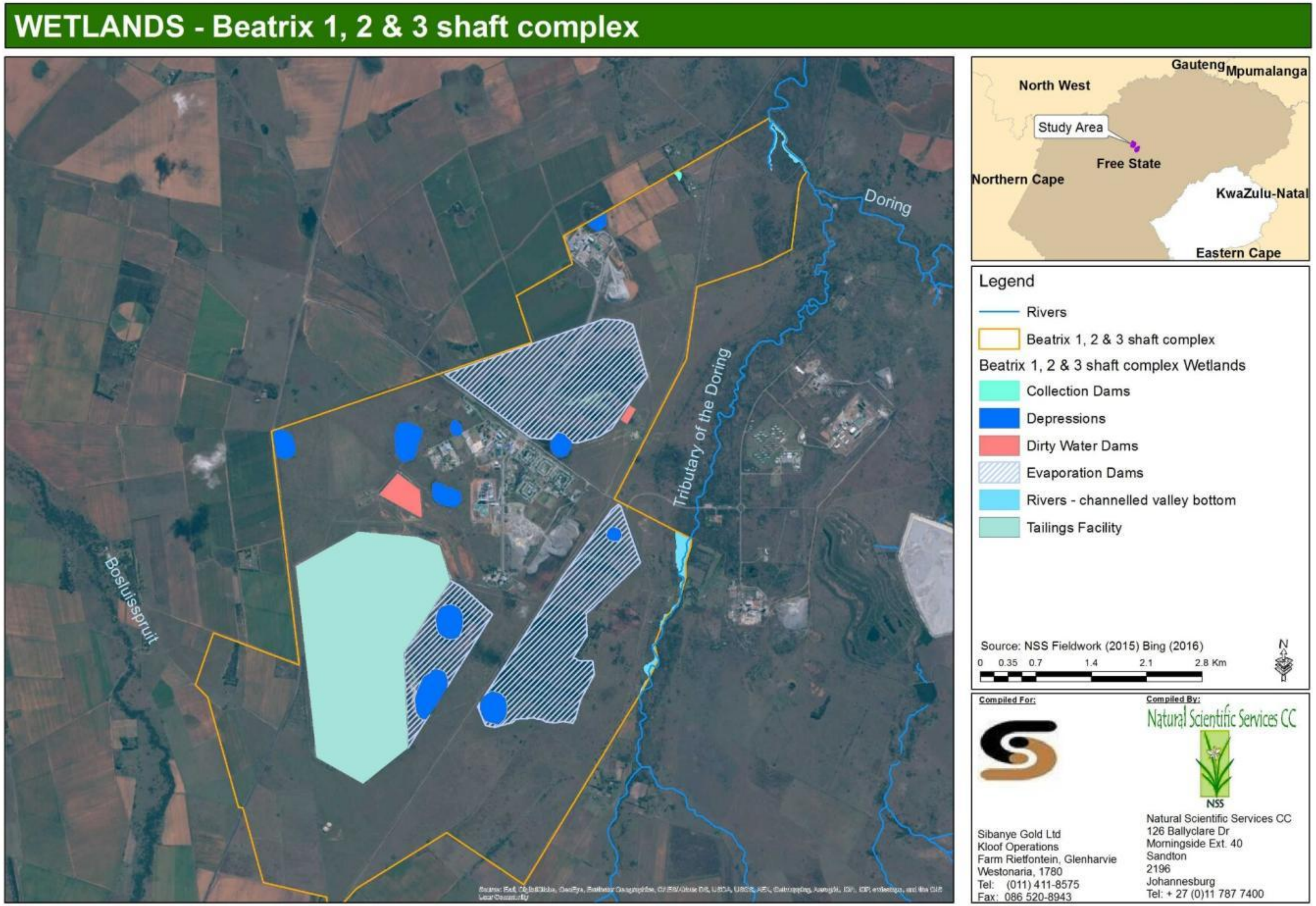


Figure 3-3 **Wetland Systems – Beatrix 1, 2, 3 Shaft (desktop delineated)**

3.2. Present Ecological State

3.2.1. Rivers and Associated Unchannelled Valley Bottom Wetlands

A summary of the (desktop-based) PES and current impacts on the surrounding rivers, as reported by the DWS (2014), are discussed in the relevant fact sheets (**Section 3.5**). The PES of the Doring River is largely natural (B) with only a small change in natural habitats and biota, and with ecosystem functions essentially unchanged. The Bosluisspruit and Sand River are moderately modified (C) due to loss and change of natural habitats and biota, but basic ecosystem functions are still predominately unchanged. Some of the impacts identified by NSS on the three river systems included heavily eroded banks, specifically along the Bosluisspruit downstream of the mining activities, a number of alien and invasive species along the banks of the river systems, evidence of discharge into the river (along the Bosluisspruit and the tributary of the Doring), and a number of bridges along the systems impeding flow.

3.2.2. Depressions

As mentioned previously, in terms of assessing the functioning and ecosystem services supplied by the ephemeral pans, the standard methods used in South Africa are not applicable, with the only available methodology being applicable to perennial systems and not the ephemeral systems found within the three mine sections. The main impacts for the various pans identified have been summarised below, with more detail and photographs in the relevant fact sheets (**Section 3.5**):

- Pans within agricultural fields. A large number of the pans identified within Beatrix 4 Shaft and Beatrix 1, 2, and 3 shaft Complexes are located within agricultural fields. These agricultural activities will more than likely impact volume of water entering the pan by altering the surface roughness of the catchment of the pan and increased water usage (crops have a higher water usage than the natural grasslands of the area). In terms of biodiversity, the agricultural fields will impact on the ecological corridor between pans, specifically for terrestrial species. During times when the field are fallow, an increase in sediment will be expected within the pan due to a reduced surface roughness of the catchment. The use of fertilizers and herbicides will also impact the water quality in these pans, when there is water.
- Pans acting as evaporation facilities or dirty water collection dams. A number of pans are utilised within the mines evaporation complexes, collecting dirty water or in the case of Rietpan, dirty water and tailings. Many of these pans were only detected with the use of historical aerial imagery. The hydrology of these pans is completely altered, with these systems now being permanent in nature. Although no water quality data was available, it is expected that the water quality is very poor in these systems, impacting on the biodiversity that would utilise them as a water source.

3.2.3. Seeps

The seeps identified, off the desktop-level investigation, were located within agricultural fields. The impacts on these seeps include an impact on all of the wetland drivers:

hydrology, geomorphology, vegetation and water quality. The hydrology for example will be impacted due to a change in surface roughness affecting the water retention of the seep and contour berms and furrows impacting the distribution of water. The geomorphology will be impacted due to the field lying fallow for a large part of the year, therefore increasing surface run-off and the chance of erosion. The natural vegetation has been either partially or completely removed. In areas were crops have not been planted a number of alien and invasive species and pioneer species are present. The use of fertilizers and herbicides will also impact the water quality within these seep zones.

3.3. Ecosystem Services

3.3.1. Rivers and Associated Unchannelled Valley Bottom Wetlands

Channelled valley bottom wetlands are generally known for nitrate and toxicant removal, specifically if the water being delivered to the system provides that opportunity, as is the case for the rivers associated with Beatrix mine and the surrounding agricultural activities. In terms of maintenance of biodiversity, these systems provide an important ecological corridor for the movement of species as well as suitable habitat for CIS.

3.3.2. Depressions

Despite their recognised importance, the scientific understanding of the functioning of wetlands in arid environments and their associated ecosystem services is incomplete (Tooth, 2015). The presence of pans within the moisture stressed environment of the study area means that the natural pans are key providers (‘hotspots’) of ecosystem services, including water and food supply (Tooth, 2015). The Millennium Ecosystem Assessment (2005) and the UNEP’s Global Deserts Outlook (Ezcurra, 2006) both highlighted that in moisture stressed environments such as the study area wetland ecosystem services are unbalanced and may provide the only supply of fundamental water and food resources. The concern with pans is that they perform few of the functions normally associated with wetlands and could therefore be seen as less important systems (Ferreira, 2012), which is not the case. In addition to the provision of water, these depressions provide a unique habitat in terms of biodiversity maintenance, precipitation of minerals and the distribution of accumulated salts and nutrients during the dry months. As mentioned previously, unfortunately a number of pans have been incorporated into the mines dirty water systems and are serving an evaporation function for the mines dirty water or as an effluent storage facility. The specific ecosystem services provided by the various pans assessed on site have been summarised in the fact sheets in **Section 3.5**. Maintenance of biodiversity in many cases would have scored a High, due to the large congregations of waterbirds, many of which are Conservation Important Species, however the scores were lowered either due to the integrity of the pans, for example Rietpan, or the fact that pans within the Dry Highveld Grassland Group 3 vegetation type are classified as Least Threatened.

3.3.3. Seeps

Seeps are expected to contribute to some surface flow attenuation early in the season (until soils are saturated). This 'plugging' effect increases the storage capacity of the slope above the wetland, and prolongs the contribution of water to the downstream wetlands during low flow periods. Seepage wetlands generally supply a number of water quality enhancement benefits, e.g.: removal of excess nutrients and organic pollutants, removal of nitrogen, etc. These services are all supplied on a Moderately High level (**Table 3-6**) by the seep wetlands at Beatrix Shaft 4 complex, mainly due to the opportunity to supply these services due to the locatio of the seeps within the agricultural fields.

3.4. Ecological Importance and Sensitivity

3.4.1. Rivers and Associated Unchannelled Valley Bottom Wetlands

The Bosluisspruit and Doring River represent **Endangered**[3] (EN) Lower Foothill systems whilst the Sand River represents a **Critically Endangered**[4] (CR) Lowland River. None of these rivers are protected (Nel& Driver 2012). The channelled bottom wetlands associated with the Sand River, Bosluisspruit and Doring River were classified as having an ecological threat status of Least Threatened[5] (LT). The tributary of the Doring River however falls within the Dry Highveld Grassland Group 4 wetland vegetation type, and is classified as CR.

A summary of the (desktop-based) Ecological Importance (EI), Ecological Sensitivity (ES) and current impacts on the surrounding rivers, as reported by the DWS (2014), are discussed in the relevant fact sheets (**Section 3.5**). The high EI of the Doring and Sand rivers is due to the presence of protected species in these sub-quaternary catchments. ES is dependent on stream size, morphology and geomorphic habitat diversity. All three local rivers are moderately sensitive to modified flow conditions and water level changes. The degree of flow change will elicit a particular level of response and the smaller streams are usually more sensitive i.e. rapid loss of useable habitats as flows decrease (DWS 2014). The NSS ratings found the EIS and Hydrological/Functional Importance of the Bosluisspruit to be a Moderate/High, whilst the Direct Human benefits a Low/Moderate. The Doring and Sand Rivers each scored a High for EIS and Hydrological/Functional Importance and a Moderate for Direct Human Benefits (whereas the Doring, is more important than the Sand in terms of harvestable resources and cultivated crops within the HGM unit, the Sand is more important from a water use and tourism/recreation perspective).

3.4.2. Depressions

Due to the large number of pans found within the Dry Highveld Grassland Group 3 wetland vegetation Group (Nel and Driver, 2012) the depressions were classified by the National Biodiversity Assessment 2011: Freshwater Component (Nel& Driver, 2012) as Least

[3] EN = Endangered ecosystem type in good condition ≤ 35% of its original area

[4] CR = Critically Endangered ecosystem type in good (A or B) condition ≤ 20% of total extent of ecosystem type

[5] LT = Least Threatened ecosystem type has > 60% of its total extent in a good or Moderately-modified (A, B or C ecological category)

Threatened and yet not protected. The EIS for Rietpan and Wolvepan scored a Very High mainly due to the large congregations of water birds attracted to the area due to the evaporation complex, with some of these species being Conservation Important Species. The pans within the agricultural fields at both the Beatrix 4 Shaft and Beatrix 1, 2, 3 Shaft scored a Moderate High for EIS, with the main difference being the smaller size of the pans, the more natural ephemeral nature of the pans and the location of the pans within the agricultural fields, and therefore less likely to attract the same large congregations of water birds. In terms of Hydrological/Functional Importance the pan within the mining complex scored higher than those within the agricultural fields due to the artificial function the pans are serving in storing dirty water for the mines.

3.4.3. <u>Seeps</u>

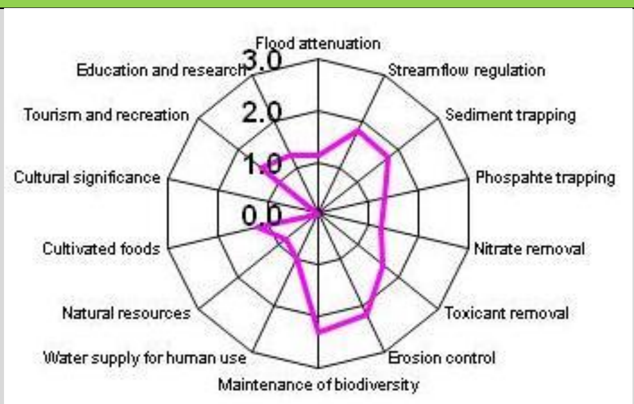
Nel and Driver (2012) classified the seeps within the Dry Highveld Grassland Group 3 wetland vegetation type as EN and also not protected. Seep wetlands were identified within the agricultural areas in the Beatrix 4 Shaft Complex. The EIS of these seep wetlands scored a Low/Moderate rating with the potential for CIS, however a low integrity of the wetland (**Table 3-6**). The Hydrological/Functional Importance scored the highest, a Moderate/High rating, mainly due to the opportunity provided by the agricultural activities surrounding the seep to supply these services.

3.5. Wetland Fact Sheets

3.5.1. <u>Wolvepan/Rietpan Evaporation Complex</u>

Table 3-1 Wolvepan 1 and 2 Fact Sheet

Wolvepan/Rietpan Evaporation Complex	
WOLVEPAN 1 AND 2	
Wetland Area	Wolvepan 1 – 25.5 ha Wolvepan 2 – 6.35 ha
	

Wolvepan/Rietpan Evaporation Complex			
WOLVEPAN 1 AND 2			
 Wolvepan 1		 Wolvepan 2	
LEVEL 1 TO 4 CLASSIFICATION (Ollis *et al*, 2013)			
Level 1: System	Inland	Level 3: Landscape Unit	Plain
Level 2: Ecoregion Level 2: NFEPA – WetVeg (WVG) and Threat Status	11.08 (Highveld) Dry Highveld Grassland Group 3 (Vulnerable)	Level 4: Wetland HGM Type (WT) and Ecological Threat Status	Pan – Least Threatened (An ecosystem type had to have > 60% of its total extent in a good OR moderately-modified (A, B or C ecological category))
CONSERVATION STATUS			
Protection Level WT	Not Protected (< 5% of their target in protected areas and in good condition)	FEPA	Pans immediately downstream classified as FEPA
Mining & Biodiversity Guidelines	Partially within Highest Biodiversity Importance	Free State C-Plan	Ecological Support Area 1
SETTING			
Quaternary catchment	C43B	Hydrology	Pans are usually fed by surface water; however some are fed by sub-surface water.
Slope	Endorheic		
Geology & Soils (Mucina& Rutherford, 2006; AGIS, 2014)	Ecca sandstone, mudstone and shale with occasional dolerite sills. There's a sporadic occurrence of calcrete in bottomlands, while aeolian sand overlies uplands between pans.		
ECOLOGICAL IMPORTANCE & SENSITIVITY			
<u>Ecological Importance & Sensitivity</u> - Very High (mainly due to the large congregations of waterbirds attracted to the pan, including birds of Conservation Importance) <u>Hydrological/Functional Importance</u> - Moderate <u>Direct Human Benefits</u> - Low			
MAIN ECOSYSTEM FUNCTIONS			
		- The highest scoring ecosystem service, scoring a Moderate High was the maintenance of biodiversity. This was due to the large congregations of water birds, many of which were Conservation Important Species - Erosion control also scored a Moderately High - Although not directly assessed by WET-EcoServices, the following services are also supplied by ephemeral pans: o Provision of water, mainly after rainfall events, in an otherwise arid environment o Temporary wetlands allow for the precipitation of	

Wolvepan/Rietpan Evaporation Complex	
WOLVEPAN 1 AND 2	
	minerals, including phosphate minerals due to the concentrating effects of evaporation. ○ In temporary wetlands some of the accumulated salts and nutrients can be transported out of the system by wind and deposited in surrounding landscape
CURRENT IMPACTS	
Current Impacts: • Altered surface roughness due to the pans being overgrazed • Wolvepan 1 surrounded by alien invasive species, mainly *Tamarix spp* • Areas excavated around Wolvepan 2	
	
Wolvepan 1 – *Tamarix spp*	Wolvepan 2 - overgrazed

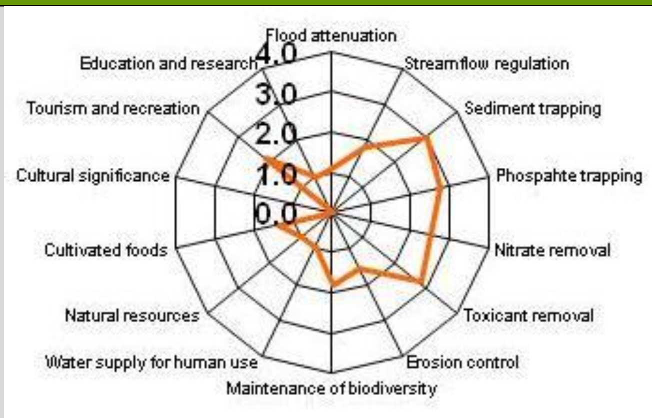
Table 3-2 Rietpan 1 and 2 Fact Sheet

Wolvepan/Rietpan Evaporation Complex	
RIETPAN 1 AND 2	
Wetland Area	Rietpan 1 – 239 ha Rietpan 2 – 4.80 ha

<table>
<tr><td colspan="4">Wolvepan/Rietpan Evaporation Complex</td></tr>
<tr><td colspan="4">RIETPAN 1 AND 2</td></tr>
<tr><td colspan="2">
Rietpan 1</td><td colspan="2">
Rietpan 2</td></tr>
<tr><td colspan="4">LEVEL 1 TO 4 CLASSIFICATION (Ollis et al, 2013)</td></tr>
<tr><td>Level 1: System</td><td>Inland</td><td>Level 3: Landscape Unit</td><td>Plain</td></tr>
<tr><td>Level 2: Ecoregion
Level 2: NFEPA – WetVeg (WVG) and Threat Status</td><td>11.08 (Highveld)
Dry Highveld Grassland Group 3 (Vulnerable)</td><td>Level 4: Wetland HGM Type (WT) and Ecological Threat Status</td><td>Pan – Least Threatened (An ecosystem type had to have > 60% of its total extent in a good OR moderately-modified (A, B or C category))</td></tr>
<tr><td colspan="4">CONSERVATION STATUS</td></tr>
<tr><td>Protection Level WT</td><td>Not Protected (< 5% of their target in protected areas and in good condition)</td><td>FEPA</td><td>Pans immediately downstream classified as FEPA</td></tr>
<tr><td>Mining & Biodiversity Guidelines</td><td>Partially within Highest Biodiversity Importance</td><td>Free State C-Plan</td><td>Critical Biodiversity Area 1
Ecological Support Area 1</td></tr>
<tr><td colspan="4">SETTING</td></tr>
<tr><td>Quaternary catchment</td><td>C43B</td><td rowspan="2">Hydrology</td><td rowspan="2">Pans are usually fed by surface water; however some are fed by sub-surface water. Both Rietpan 1 and 2 have been artificially fed by mine effluent.</td></tr>
<tr><td>Slope</td><td>Endorheic</td></tr>
<tr><td>Geology & Soils (Mucina& Rutherford, 2006; AGIS, 2014)</td><td colspan="3">Ecca sandstone, mudstone and shale with occasional dolerite sills. There's a sporadic occurrence of calcrete in bottomlands, while aeolian sand overlies uplands between pans.</td></tr>
<tr><td colspan="4">ECOLOGICAL IMPORTANCE & SENSITIVITY</td></tr>
<tr><td colspan="4"><u>Ecological Importance & Sensitivity</u> - Very High (mainly due to the large congregations of waterbirds attracted to the pan, including birds of Conservation Importance)
<u>Hydrological/Functional Importance</u> - Moderate/High. The hydrological and functional importance scored a High due to the artificial function the pans are serving in storing dirty water for the mines.
<u>Direct Human Benefits</u> - Low</td></tr>
<tr><td colspan="4">MAIN ECOSYSTEM FUNCTIONS</td></tr>
</table>

Wolvepan/Rietpan Evaporation Complex

RIETPAN 1 AND 2



Ecosystems services that scored a high included sediment trapping, toxicant removal and phosphate trapping. All of these services scored a High for opportunity to provide the service due to the pans being used for the disposal of mine effluent/tailings and as an evaporation facility for the mines dirty water make. Maintenance of biodiversity scored an overall Intermediate, however scored a Moderately High for noteworthiness due to the congregations of large numbers of water birds, many of which were Conservation Important Species. The integrity however scored a Moderately Low resulting in the overall Intermediate score.

CURRENT IMPACTS

Current Impacts:

- Surrounded by alien invasive species – dominant species *Tamarix spp*
- Pans fed artificially by mine effluent and/or dirty water resulting in deep tailings deposits, with high salts, within the pans and likely other toxicants, for example cyanide
- Pans used as evaporation facilities for mines dirty water make, changing the hydrology of the pans from ephemeral/temporary systems to a system more permanent in nature
- Numerous artificial channels entering the pans

Tamarix spp

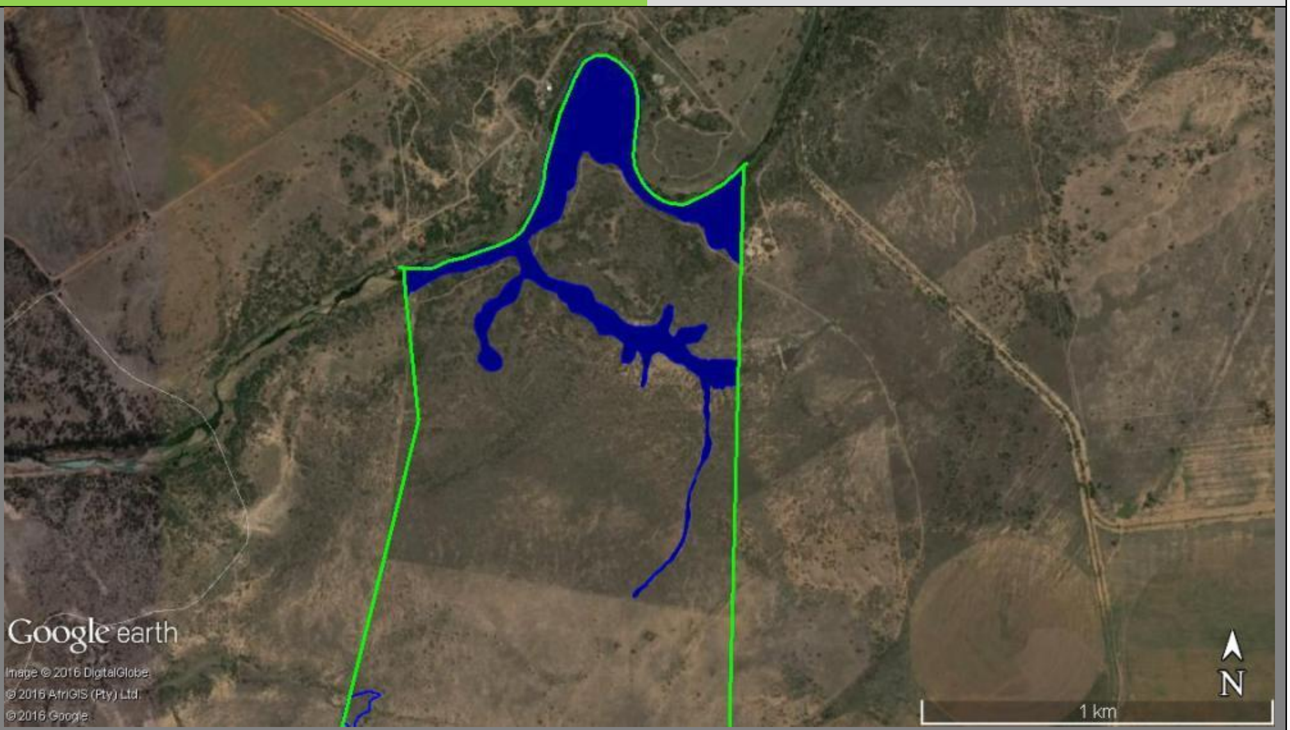
Effluent (tailings) entering the pan

Artificial inlet channels

3.5.2. Beatrix 4 Shaft

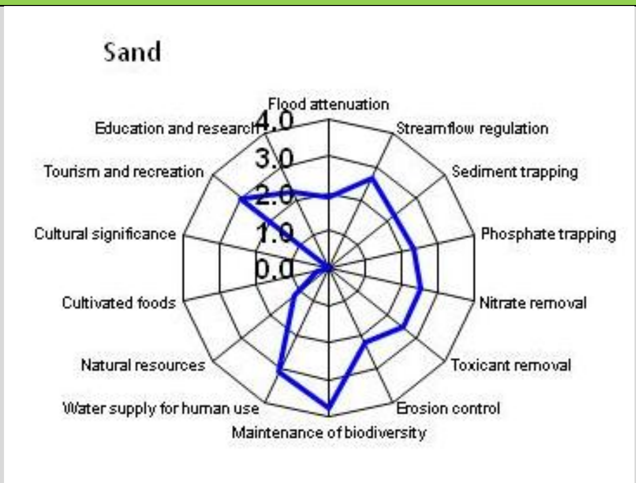
Table 3-3 Beatrix 4 Shaft – Sand River – Fact Sheet

Beatrix 4 Shaft Complex	
Sand River and tributary	
River - riparian zone and channelled valley bottom wetlands (within study area)	Sand River& tributary – 20.3 ha (desktop)



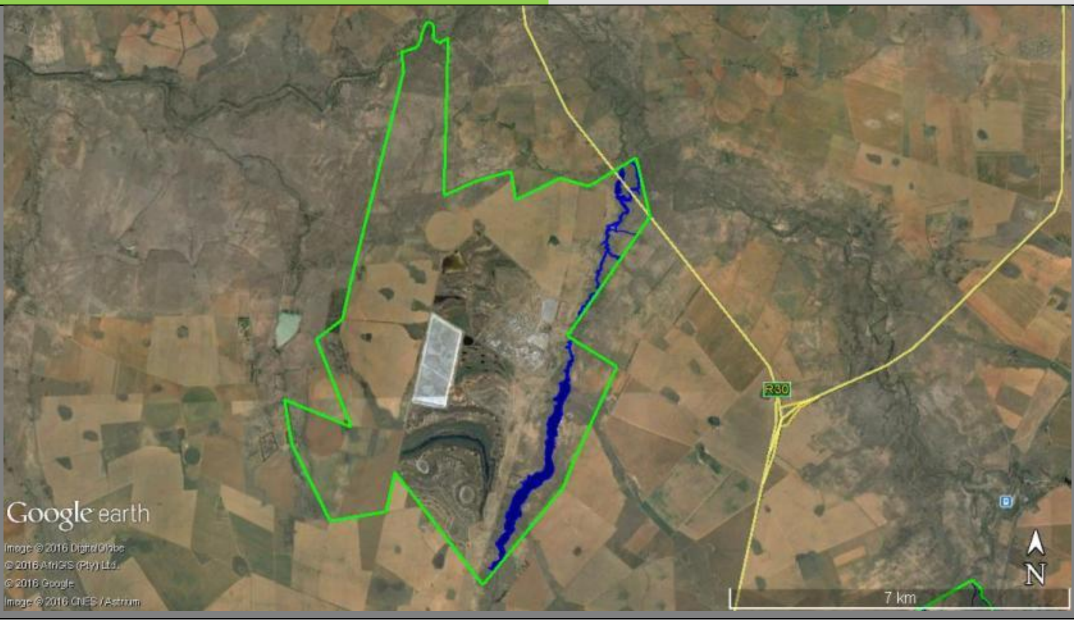
Sand River

LEVEL 1 TO 4 CLASSIFICATION (Ollis *et al*, 2013)			
Level 1: System	Inland	Level 3: Landscape Unit	Valley Floor
Level 2: Ecoregion Level 2: NFEPA – WetVeg (WVG) and Threat Status	11.08 (Highveld) Dry Highveld Grassland Group 3 (Vulnerable)	Level 4: Wetland HGM Type (WT) and Ecological Threat Status	1) Channelled Valley Bottom – Least Threatened (An ecosystem type had to have > 60% of its total extent in a good OR moderately-modified (A, B or C ecological category)) 2) River (Perennial Lowland River) –Critically Endangered (river ecosystem with <20% of their total extent in a good condition (A or B)

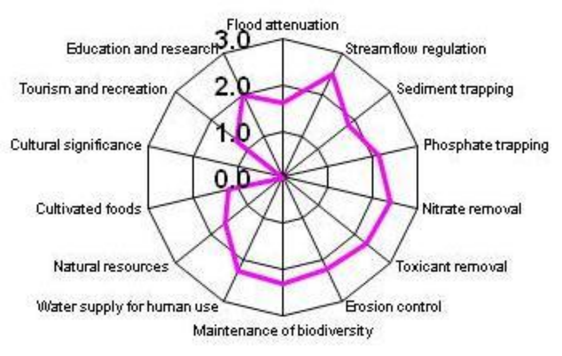
Beatrix 4 Shaft Complex			
Sand River and tributary			
CONSERVATION STATUS			
Protection Level WT	Not Protected (< 5% of their target in protected areas and in good condition)	FEPA	No FEPA wetlands
Mining & Biodiversity Guidelines	No rating	Free State C-Plan	Ecological Support Area 1
SETTING			
Quaternary catchment	C42L	Hydrology	Channelled valley bottom wetlands – water inputs from main channel (when channel banks overspill) and from adjacent slopes)
Slope	Lowland River		
Geology & Soils (Mucina & Rutherford, 2006; AGIS, 2014)	Deep sandy to clayey (but mostly coarse sand) alluvial soils developed over Quaternary alluvial (fluviatile) sediments. “The rivers are perennial, often in flood in summer. Erosion of banks and deposition of new fine soil on alluvium can be of considerable extent.		
PRESENT ECOLOGICAL STATE		**DWS (2014) Rating**: PES of Moderately Modified (C)	
ECOLOGICAL IMPORTANCE & SENSITIVITY		**DWS (2014) Rating:** Ecological Importance: High Ecological Sensitivity: Moderate **NSS Rating** <u>Ecological Importance & Sensitivity</u> – High <u>Hydrological/Functional Importance</u> –High <u>Direct Human Benefits</u> – Moderate	
MAIN ECOSYSTEM FUNCTIONS			
		The following ecosystem services scored a High likelihood of being supplied: • Streamflow regulation • Maintenance of biodiversity • Water supply for human use • Tourism and recreation The following ecosystem services scored a Moderate High likelihood of being supplied: • Sediment trapping • Phosphate trapping • Nitrate removal • Toxicant removal • Education and research	
CURRENT IMPACTS			
Current Impacts: • Eroded banks • Extensive agriculture within the catchment • Numerous bridges impeding flow • DWS (2014) impacts for the greater system include: Roads, in stream weirs, agriculture and erosion. After merging with the Palmietkuilspruit, the Sand River is also impacted by irrigation from channel (Allemanskraal dam), return flows and alien invasive plants.			

Beatrix 4 Shaft Complex	
Sand River and tributary	
	

Table 3-4 Beatrix 4 Shaft – Bosluisspruit – Fact Sheet

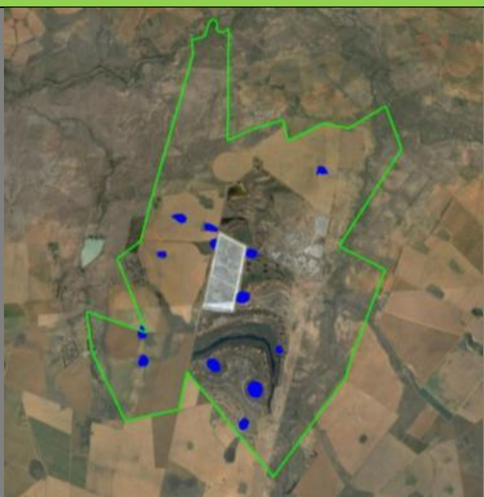
Beatrix 4 Shaft Complex	
Bosluisspruit & Associated Channelled Valley Bottom Wetlands	
River - riparian zone and channelled valley bottom wetlands (within study area)	Bosluisspruit& tributaries – 112 ha (desktop)
	

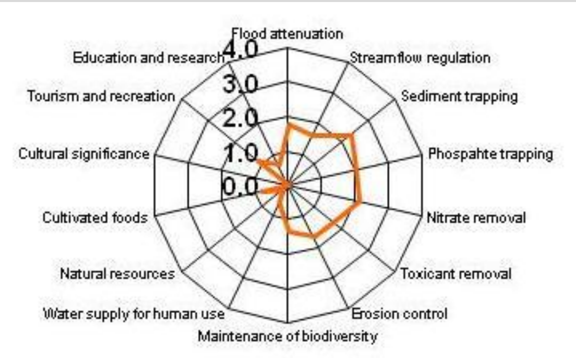
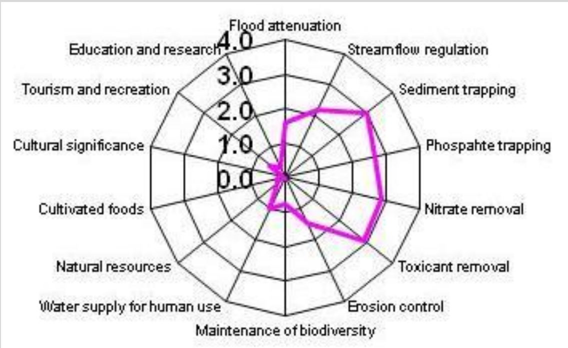
Beatrix 4 Shaft Complex			
Bosluisspruit & Associated Channelled Valley Bottom Wetlands			
			
			
LEVEL 1 TO 4 CLASSIFICATION (Ollis *et al*, 2013)			
Level 1: System	Inland	Level 3: Landscape Unit	Valley Floor
Level 2: Ecoregion Level 2: NFEPA – WetVeg (WVG) and Threat Status	11.08 (Highveld) Dry Highveld Grassland Group 3 (Vulnerable)	Level 4: Wetland HGM Type (WT) and Ecological Threat Status	3) Channelled Valley Bottom – Least Threatened (An ecosystem type had to have > 60% of its total extent in a good OR moderately-modified (A, B or C ecological category)) 4) River (Perennial Lower Foothill) –Endangered (river ecosystem with <35% of their total extent in a good condition (A or B ecological category))
CONSERVATION STATUS			
Protection Level WT	Not Protected (< 5% of their target in protected areas and in good condition)	FEPA	FEPA wetlands immediately downstream of site
Mining & Biodiversity Guidelines	Some stretches intersect areas of Highest Biodiversity Importance	Free State C-Plan	Ecological Support Area 1 Critical Biodiversity Area 1
SETTING			
Quaternary catchment	C42L	Hydrology	Channelled valley bottom wetlands – water inputs from main channel (when channel banks overspill) and from adjacent slopes)
Slope	Lower foothill		

Beatrix 4 Shaft Complex	
Bosluisspruit & Associated Channelled Valley Bottom Wetlands	
Geology & Soils (Mucina & Rutherford, 2006; AGIS, 2014)	Deep sandy to clayey (but mostly coarse sand) alluvial soils developed over Quaternary alluvial (fluviatile) sediments. "The rivers are perennial, often in flood in summer. Erosion of banks and deposition of new fine soil on alluvium can be of considerable extent.
PRESENT ECOLOGICAL STATE	**DWS (2014) Rating**: PES of Moderately Modified (C)
ECOLOGICAL IMPORTANCE & SENSITIVITY	**DWS (2014) Rating:** Ecological Importance: Moderate Ecological Sensitivity: Moderate **NSS Rating** Ecological Importance & Sensitivity – Moderate/High Hydrological/Functional Importance – Moderate/High Direct Human Benefits – Low/Moderate
MAIN ECOSYSTEM FUNCTIONS	
	No ecosystem services scored a High for the likely extent of the service being supplied. The following ecosystem services scored Moderately High: • Maintenance of biodiversity, with the system serving as an important ecological corridor • Streamflow regulation • Phosphate trapping • Nitrate removal • Toxicant removal • Water supply for human use
CURRENT IMPACTS	
• Eroded banks and tributaries, specifically downstream of the mining industry • Dumping of building rubble in tributaries • Discharge of effluent into the system • Intensive agricultural activities within the catchment	• Alien and invasive species • Numerous bridges impeding flow • DWS (2014) impacts for the greater system include: Roads, agriculture, trampling, erosion, chicken farming and mining.
 Discharge from mine into river	 Tributaries entering the Bosluisspruit heavily eroded

Beatrix 4 Shaft Complex	
Bosluisspruit & Associated Channelled Valley Bottom Wetlands	
	
Opuntia spp (CARA Category 1)	Eroded banks

Table 3-5 Beatrix 4 Shaft Depressions - agricultural fields & mining operation – Fact Sheet

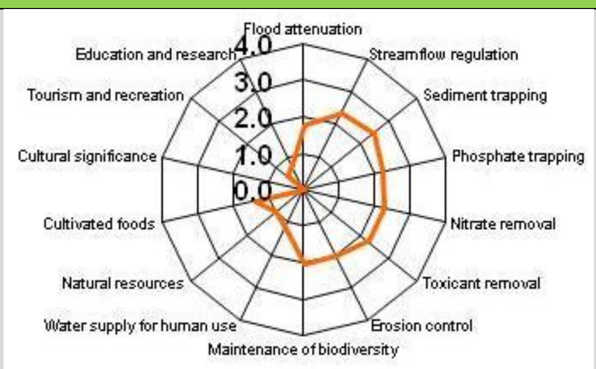
Beatrix Shaft4 Complex			
Depression			
Depression		60 ha (desktop)	
			
LEVEL 1 TO 4 CLASSIFICATION (Ollis *et al*, 2013)			
Level 1: System	Inland	Level 3: Landscape Unit	Plain
Level 2: Ecoregion Level 2: NFEPA – WetVeg (WVG) and Threat Status	11.08 (Highveld) Dry Highveld Grassland Group 3 (Vulnerable)	Level 4: Wetland HGM Type (WT) and Ecological Threat Status	Depression – Least Threatened (An ecosystem type that has >60% of its total area in good or Moderately Modified condition (A, B or C)
CONSERVATION STATUS			
Protection Level WT	Not Protected (< 5% of their target in protected areas and in good condition)	FEPA	Most southern depression classified as a FEPA(although situated within Evaporation Complex)
Mining & Biodiversity Guidelines	Most southern depression classified as Highest Biodiversity Risk for Mining (although situated within Evaporation Complex)	Free State C-Plan	Majority degraded Some pans situated within Critical Biodiversity Area 1 (although situated within

<table>
<tr><td colspan="4">Beatrix Shaft4 Complex</td></tr>
<tr><td colspan="4">Depression</td></tr>
<tr><td></td><td></td><td></td><td>Evaporation Complex)</td></tr>
<tr><td colspan="4">SETTING</td></tr>
<tr><td>Quaternary catchment</td><td>Western depressions - C42L
Eastern depressions – C42K</td><td>Hydrology</td><td>Pans are usually fed by surface water; however some are fed by sub-surface water. A number of pans are situated within the mining evaporation complex and are likely used for disposal of effluent</td></tr>
<tr><td>Geology & Soils (Mucina & Rutherford, 2006; AGIS, 2014)</td><td colspan="3">Aeolian and colluvial sands overly sandstone, mudstone and shale of the Karoo Supergroup, as well as the older Ventersdorp Supergroup.</td></tr>
<tr><td colspan="4">ECOLOGICAL IMPORTANCE AND SENSITIVITY</td></tr>
<tr><td colspan="2">Pans within agricultural fields
<u>Ecological Importance & Sensitivity</u> - Moderate
<u>Hydrological/Functional Importance</u> – Moderate
<u>Direct Human Benefits</u> – Low
The Ecological Importance & Sensitivity scored a Moderate due to these pans being ephemeral in nature and located within agricultural fields, and therefore unlikely to attract large congregations of water birds.</td><td colspan="2">Pans used as mines dirty water/evaporation facilities
<u>Ecological Importance & Sensitivity</u> – Low
<u>Hydrological/Functional Importance</u> – High
<u>Direct Human Benefits</u> – Low
The hydrological and functional importance scored a High due to the artificial function the pans are serving in storing dirty water for the mines.</td></tr>
<tr><td colspan="4">MAIN ECOSYSTEM FUNCTIONS</td></tr>
<tr><td colspan="2">Pans within agricultural fields

</td><td colspan="2">Pans used as mines dirty water/evaporation facilities

</td></tr>
<tr><td colspan="2">No ecosystem services scored a High for likely extent to which benefit is being supplied. Sediment trapping and nitrate removal both scored a Moderately High, with the opportunity to supply these benefits being higher than the effectiveness.</td><td colspan="2">Toxicant, nitrate and sediment trapping all scored a High due to the opportunity to supply these services, with dirty water and / or tailings stored within these facilities.</td></tr>
<tr><td colspan="4">CURRENT IMPACTS</td></tr>
<tr><td colspan="4">Current Impacts:
• Pans are either situated within agricultural fields or as the mines dirty water/evaporation facilities</td></tr>
<tr><td colspan="2"><u>Pans within agricultural fields:</u>
- Altered surface roughness of catchment
- Increased water usage by crops
- Fields fragmenting the ecological corridor between pans for terrestrial species
- Increase in sediment when fields are fallow
- Deterioration of water quality due to herbicides and fertilizers</td><td colspan="2"><u>Pans used as dirty water/evaporation facilities:</u>
- Hydrology completely altered from ephemeral systems to permanent systems
- Poor water quality
- Increased sediment load
- Hazardous to biodiversity</td></tr>
</table>

Beatrix Shaft4 Complex	
Depression	
	

Table 3-6 Beatrix 4 Shaft Seep – Fact Sheet

Beatrix 4 Shaft Complex			
Seep			
Seep		144 ha (desktop)	
			
			
LEVEL 1 TO 4 CLASSIFICATION (Ollis *et al*, 2013)			
Level 1: System	Inland	Level 3: Landscape Unit	Slope

Beatrix 4 Shaft Complex			
Seep			
Level 2: Ecoregion Level 2: NFEPA – WetVeg (WVG) and Threat Status	11.08 (Highveld) Dry Highveld Grassland Group 3 (Vulnerable)	Level 4: Wetland HGM Type (WT) and Ecological Threat Status	Seep – Endangered (An ecosystem type that has< 35% of its total area in good condition
CONSERVATION STATUS			
Protection Level WT	Not Protected (< 5% of their target in protected areas and in good condition)	FEPA	No FEPA wetlands
Mining & Biodiversity Guidelines	Northern seeps – Highest Biodiversity Risk for Mining	Free State C-Plan	Majority degraded Most Northerly section Critical Biodiversity Area 1
SETTING			
Quaternary catchment	Western Seeps - C42L Eastern Seeps – C42K	Hydrology	Water inputs are mainly from sub-surface flow
Geology & Soils (Mucina & Rutherford, 2006; AGIS, 2014)	Aeolian and colluvial sands overly sandstone, mudstone and shale of the Karoo Supergroup, as well as the older Ventersdorp Supergroup.		
PRESENT ECOLOGICAL STATE		ECOLOGICAL IMPORTANCE AND SENSITIVITY	
Hydrology – Moderately Modified Geomorphology – Moderately Natural Vegetation – Seriously Modified		Ecological Importance & Sensitivity – Low/Moderate Hydrological/Functional Importance – Moderate/High Direct Human Benefits – Low The Moderate to High Functional rating is mainly due to the opportunity provided by the agricultural activities surrounding the seep to supply these services.	
MAIN ECOSYSTEM FUNCTIONS			
		No ecosystem services scored a High for the likely extent to which a benefit is being supplied; however a number of services scored a Moderately High. These included: • Streamflow regulation • Sediment trapping • Phosphate trapping • Nitrate removal • Toxicant removal • Maintenance of biodiversity, including supplying an important ecological corridor.	
CURRENT IMPACTS			

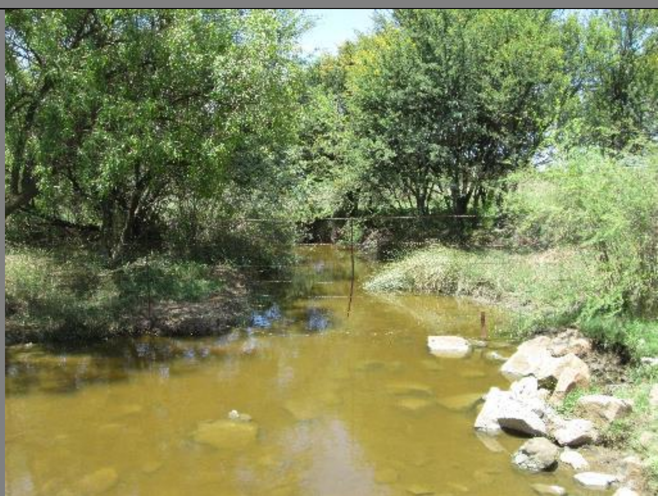
Current Impacts:

- Seeps located within agricultural areas which will impact on all wetland drivers, for example:
  - A change in surface roughness of the catchment, especially during periods when fields are fallow
  - Contour berms and furrows affecting the water distribution patterns of the wetland
  - Increase in sedimentation during periods when fields are fallow
  - Removal of natural vegetation, to be replaced by crops, invasive and pioneer species
  - Likely decline in water quality due to the use of fertilizers and herbicides and the upstream tailings facilities

Beatrix 4 Shaft Complex	
Seep	
	

3.5.3. ***Beatrix 1, 2, 3 Shaft***

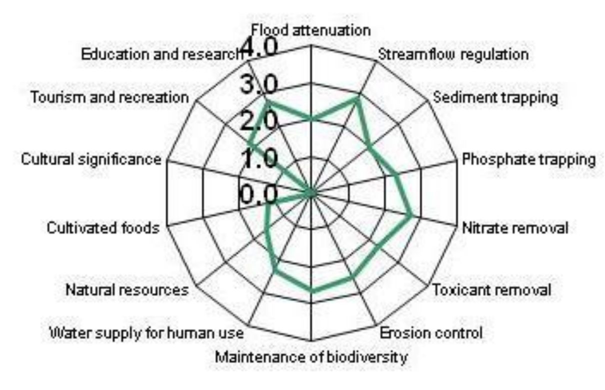
Table 3-7 Beatrix 1, 2, 3 Shaft – Doring River & Associated Tributary – Fact Sheet

Beatrix 1, 2, and 3 Shaft Complex	
Doring River and tributary	
River - riparian zone and channelled valley bottom wetlands (within study area)	Doring River – 3.3 ha (desktop) Tributary of the Doring River – 10.3 ha (desktop)
 Doring River	 Tributary of the Doring River
 Doring River	 Tributary of the Doring River (upstream of the mining activities)

Beatrix 1, 2, and 3 Shaft Complex			
Doring River and tributary			
LEVEL 1 TO 4 CLASSIFICATION (Ollis *et al*, 2013)			
Doring River		**Tributary of the Doring River**	
Level 1: System	Inland	Level 1: System	Inland
Level 2: Ecoregion Level 2: NFEPA – WetVeg (WVG) and Threat Status	11.08 (Highveld) Dry Highveld Grassland Group 3 (Vulnerable)	Level 2: Ecoregion Level 2: NFEPA – WetVeg (WVG) and Threat Status	11.08 (Highveld) Dry Highveld Grassland Group 4 (Endangered)
Level 3: Landscape Unit	Valley Floor	Level 3: Landscape Unit	Valley Floor
Level 4: Wetland HGM Type (WT) and Ecological Threat Status	5) Channelled Valley Bottom – Least Threatened (An ecosystem type that has> 60% of its total extent in a good OR moderately-modified (A, B or C ecological category)) 6) River (Perennial - Lower foothill) – Endangered (river ecosystem with 20-35% of their total extent in a good condition (A or B ecological category))	Level 4: Wetland HGM Type (WT) and Ecological Threat Status	1) Channelled Valley Bottom – Critically Endangered (An ecosystem type that has< 20% of its total area in good condition) 2) River (Perennial - Lower foothill) – Endangered(river ecosystem with 20-35% of their total extent in a good condition (A or B ecological category))
CONSERVATION STATUS			
Protection Level WT	Not Protected (< 5% of their target in protected areas and in good condition)	FEPA	FEPA Wetlands
Mining & Biodiversity Guidelines	Highest Biodiversity Importance	Free State C-Plan	Doring River: Ecological Support Area 1 Tributary of the Doring River: Critical Biodiversity Area 1
SETTING			
Quaternary catchment	C42K	Hydrology	Channelled valley bottom wetlands – water inputs from main channel (when channel banks overspill) and from adjacent slopes)
Slope	Lower Foothill		
Geology & Soils (Mucina& Rutherford, 2006; AGIS, 2014)	Doring River: Deep sandy to clayey (but mostly coarse sand) alluvial soils developed over Quaternary alluvial (fluviatile) sediments. “The rivers are perennial, often in flood in summer. Erosion of banks and deposition of new fine soil on alluvium can be of considerable extent.		
PRESENT ECOLOGICAL STATE		**DWS (2014) Rating**: PES of Largely Natural (B)	
ECOLOGICAL IMPORTANCE & SENSITIVITY		**DWS (2014) Rating:** Ecological Importance: High Ecological Sensitivity: Moderate **NSS Rating** Ecological Importance & Sensitivity – High Hydrological/Functional Importance – High Direct Human Benefits – Moderate	
MAIN ECOSYSTEM FUNCTIONS			

Beatrix 1, 2, and 3 Shaft Complex

Doring River and tributary



The following ecosystem services scored a High likelihood of being supplied:

- Nitrate removal
- Streamflow regulation
- Education and Research

The following ecosystem services scored a Moderate High likelihood of being supplied:

- Phosphate trapping
- Toxicant removal
- Erosion Control
- Maintenance of Biodiversity
- Water supply for human use

CURRENT IMPACTS

Current Impacts:

- Numerous bridges: impeding flow, debris build up
- Extensive agriculture within the catchment
- Eroded banks
- Discharge from mine into river
- Alien invasive species, for example *Tamarix spp.*
- DWS (2014) impacts for the greater system include: Roads, mining with small dams, slime dams, agriculture and erosion.

Bridge impeding flow and debris build up

Inlet channels from the mine

Beatrix 1, 2, and 3 Shaft Complex	
Doring River and tributary	
Eroded banks and alien invasive species	*Tamarix spp*
	
Eroded banks	Discharge from mine workings

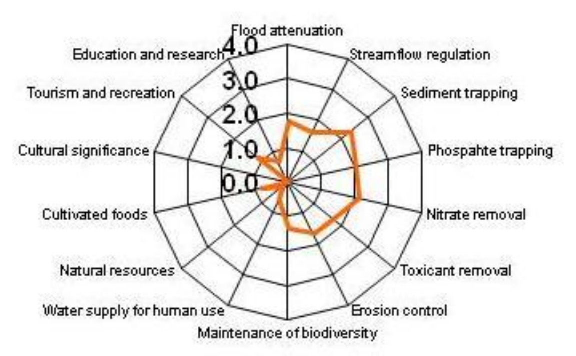
Table 3-8 Beatrix 1, 2, 3 Shaft Depressions - agricultural fields & mining operation – Fact Sheet

Beatrix 1, 2, 3 Shaft Complex	
Depression	
Depression	65 ha (desktop)
	
	

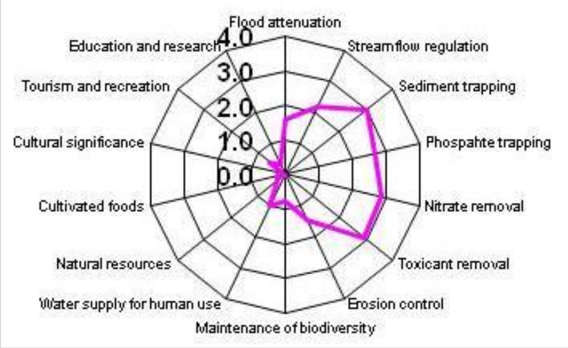
Beatrix 1, 2, 3 Shaft Complex			
Depression			
			
LEVEL 1 TO 4 CLASSIFICATION (Ollis *et al*, 2013)			
Level 1: System	Inland	Level 3: Landscape Unit	Plain
Level 2: Ecoregion Level 2: NFEPA – WetVeg (WVG) and Threat Status	11.08 (Highveld) Dry Highveld Grassland Group 3 (Vulnerable)	Level 4: Wetland HGM Type (WT) and Ecological Threat Status	Depression – Least Threatened (An ecosystem type that has >60% of its total area in good or Moderately Modified condition (A, B or C)
CONSERVATION STATUS			
Protection Level WT	Not Protected (< 5% of their target in protected areas and in good condition)	FEPA	Some pans classified as FEPA – (although situated within Evaporation Complex)
Mining & Biodiversity Guidelines	Highest Biodiversity Risk for Mining (although situated within Evaporation Complex)	Free State C-Plan	Ecological Support Area 2 Critical Biodiversity Area 1(although situated within Evaporation Complex)
SETTING			
Quaternary catchment	C42K	Hydrology	Pans are usually fed by surface water; however some are fed by sub-surface water. A number of pans are situated within the mining evaporation complex and are used for disposal of effluent
Geology & Soils (Mucina & Rutherford, 2006; AGIS, 2014)	Aeolian and colluvial sands overly sandstone, mudstone and shale of the Karoo Supergroup, as well as the older Ventersdorp Supergroup.		
ECOLOGICAL IMPORTANCE AND SENSITIVITY			
Pans within agricultural fields Ecological Importance & Sensitivity - Moderate Hydrological/Functional Importance – Moderate Direct Human Benefits – Low The Ecological Importance & Sensitivity scored a Moderate due to these pans being ephemeral in nature and located within agricultural fields, and therefore unlikely to attract large congregations of water birds.		**Pans used as mines dirty water/evaporation facilities** Ecological Importance & Sensitivity – Low Hydrological/Functional Importance – High Direct Human Benefits – Low The hydrological and functional importance scored a High due to the artificial function the pans are serving in storing dirty water for the mines.	
MAIN ECOSYSTEM FUNCTIONS			
Pans within agricultural fields		**Pans used as mines dirty water/evaporation facilities**	

Beatrix 1, 2, 3 Shaft Complex

Depression



No ecosystem services scored a High for likely extent to which benefit is being supplied. Sediment trapping and nitrate removal both scored a Moderately High, with the opportunity to supply these benefits being higher than the effectiveness.



Toxicant, nitrate and sediment trapping all scored a High due to the opportunity to supply these services, with dirty water and / or tailings stored within these facilities.

CURRENT IMPACTS

Current Impacts:

- Pans are either situated within agricultural fields or as the mines dirty water/evaporation facilities

Pans within agricultural fields:

- Altered surface roughness of catchment
- Increased water usage by crops
- Fields fragmenting the ecological corridor between pans for terrestrial species
- Increase in sediment when fields are fallow
- Deterioration of water quality due to herbicides and fertilizers

Pans used as dirty water/evaporation facilities:

- Hydrology completely altered from ephemeral systems to permanent systems
- Poor water quality
- Increased sediment load
- Hazardous to biodiversity

4. Summary & Conclusion

The wetland assessment involved desktop- and field-based investigations of the type, extent, Present Ecological State (PES), functionality, and Ecological Importance and Sensitivity (EIS) of the major wetland systems in Beatrix. The Bosluisspruit and Doring River represent Endangered Lower Foothill systems whilst the Sand River represents a Critically Endangered Lowland River, none of which are protected. The PES of the Doring River is largely natural (B) with only a small change in natural habitats and biota, and with ecosystem functions essentially unchanged. The Bosluisspruit and Sand River are moderately modified (C) due to loss and change of natural habitats and biota, but basic ecosystem functions are still predominately unchanged. Observed impacts on these river systems included bank erosion, invasive alien flora, artificial discharges, and flow impediment from bridges, among other things. In addition, within the mining complexes a large number of pans and seeps occur, mainly in agricultural fields where they have been impacted by agricultural activities. Other pans have been utilised to collect dirty mine water or to contain tailings, and have been highly transformed as a result.

Key findings in terms of Wetland Importance and Sensitivity included; (a) The Wolvepan and Rietpan pan complex which were assigned an EIS of Very High, mainly due to the large waterbird congregations they support of which many species are of conservation importance; (b) The Sand River which was rated with a High EIS on account of its role in stream flow regulation, maintenance of biodiversity, and water supply; (c) The Doring and Sand Rivers which were rated with a High EIS and Hydro-functional Importance due to their importance in providing largely natural habitat and corridors and for conservation important species but also the services they provide in terms of nitrate removal, stream flow regulation and education/research. The results of this wetland assessment represent an important component of the sensitivity assessment that is presented in report **Section E**.