REPORT N° 31102_W

FRESHWATER HABITAT IMPACT ASSESSMENT - POLOKWANE SMELTER SO2 ABATEMENT

ANGLO AMERICAN

CONFIDENTIAL

MAY 2017

WSP | PARSONS BRINCKERHOFF

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Anglo American

DRAFT
Confidential

Project no: 31102_W
Date: May 2017

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QUALITY MANAGEMENT

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1 INTRODUCTION

1.1 BACKGROUND

Anglo American Platinum (Anglo American) propose to install and operate a Wet gas Sulphuric Acid (WSA) Plant and associated sulphur dioxide (SO_2) abatement equipment (the 'SO_2 system') within their existing Polokwane Smelter Complex (PSC), located within the Limpopo Province.

The installation of the WSA Plant will convert the SO_2 by-product into commercial-grade concentrated sulphuric acid (H_2SO_4). The resultant emissions from the WSA plant (containing reduced SO_2 concentrations) will be released into the atmosphere, and the commercial grade sulphuric acid will be temporarily stored before distribution. A new temporary access road is required during construction to link the new SO_2 system and the Kopermyn Road located to the east of the Smelter.

WSP | Parsons Brinckerhoff (WSP) was commissioned by Anglo American to conduct a Freshwater Habitat Assessment to determine whether the proposed SO_2 system and associated infrastructure will have an impact on any freshwater habitats and to determine the applicability of Section 21(c) and (i) of the National Water Act (Act No. 36 of 1998) (NWA) and its associated Government Notices, to the proposed system.

1.2 TERMS OF REFERENCE

The aim of the assessment is to determine the extent, health and functionality of freshwater habitats within 500m of the proposed SO_2 system and associated infrastructure, which have a potential risk of being impacted by the construction and operation of the proposed system. The assessment was guided by the following objectives:

- Desktop delineation of all watercourses within a 500m radius of the proposed SO_2 system and associated infrastructure utilising available site-specific data;
- A risk/impact probability screening of the identified watercourses to determine which have any risk of being impacted upon by the construction and operation of the proposed SO_2 system;
- Infield delineation and classification of all identified freshwater habitats;
- Determination of the freshwater habitats which have potential to be impacted by the construction and operational activities;
- Assessment of the Present Ecological State (PES), Ecological Importance and Sensitivity (EIS) and functional importance (wetland only) of the delineated wetland and river/riparian habitats;
- Buffer determination of freshwater systems that may potentially be impacted upon;
- Identification, prediction, description, significance rating and associated mitigative measures of the potential impacts associated with the proposed construction and operation of the proposed SO_2 system on the delineated freshwater habitats; and,
- Determination of the applicability of Section 21 (c) and (i) of the National Water Act (NWA) and associated Government Notice (GN) 509 of 2016.

1.3 ASSUMPTIONS AND LIMITATIONS

Key assumptions limitations and/or knowledge gaps relevant to the assessment included:

- Wetlands identified for delineation were based on a desktop review of available information. This is reliant on various published data sources (e.g. aerial imagery and mapping) which have been assumed by WSP to be representative of site conditions.
- Whilst the desktop review and site investigation aimed to identify and assess all wetlands within the study area, wetlands not identified during this process did not form part of this study. Access was hampered by the fencing of various areas onsite and access control at the Smelter.
- The proposed SO_2 system and access road locations was determined from data provided by Anglo American.
- The wetland boundary comprises a gradually changing gradient of wetland indicators and varies both temporally and spatially; therefore the wetland delineation occurs within a certain degree of tolerance.
- It should be recognised that there are several confounding effects on the interpretation of the historic and current extent and functioning of the respective systems, such as the presence of roads and fencing.
- The wetland/riparian boundaries within a specific study area in relation to the proposed SO_2 system and access road were accurately delineated infield, based on the initial desktop review. The remaining watercourses were delineated at a desktop level and broadly verified in the field to obtain an extent of the wetland/riparian areas.
- The findings, results, observations, conclusions and recommendations given in this report are based on WSP's best scientific and professional knowledge as well as available information.

1.4 EXPERTISE OF THE SPECIALIST

The assessment was conducted by Colin Holmes with support from various specialists as summarised in **Table 1**. CVs can be provided on request.

Table 1: Expertise of the specialists

NAME	QUALIFICATION	PROFESSIONAL REGISTRATION	EXPERIENCE
Colin Holmes	Environmental Scientist	*Pr.Sci.Nat.*	Colin is a Senior Environmental Consultant at WSP | PB with an MSc in Applied Environmental Science. He has also completed wetland management courses with the University of Free State. Colin has completed and managed numerous projects relating to wetland and riparian delineations, Present Ecological State and Ecological Importance and Sensitivity assessments, risk matrix assessments and the compilation of IWWMPs. He is registered as a Professional Natural Scientist (*Pr.Sci.Nat*) and SETA accredited Carbon Footprint Analyst.
Karen King	Soil Scientist	*Pr.Sci.Nat.*	Karen King is a professionally registered hydrologist and soil scientist with an MSc from the University of KwaZulu-Natal. She has over 12 years' experience in the academic and consulting fields. She has co-authored a number of publications covering a diverse range of topics including land use changes, rainfall patterns, wetlands, gravity waves, soils applications and trans-boundary water. Karen specialises in hydrology and soils assessments for environmental and engineering purposes and has managed a number of such projects.

NAME	QUALIFICATION	PROFESSIONAL REGISTRATION	EXPERIENCE
Greg Matthews	Hydrologist	*Pr.Sci.Nat.*	Greg Matthews has over 17 years' experience in surface water, groundwater and contaminated land related projects. He has managed and implemented a number of turnkey projects in the industrial, mining and governmental sectors. His specialities include surface and groundwater assessments and modelling, stormwater management plans, flood risk assessments, industrial and mine water and effluent management and contaminated land risk assessment and remediation. Greg has been involved in numerous water related projects where he has used his hydrological background successfully in the assessment of environmental related impacts to the hydrological environment and recommendations on mitigation requirements.

2 SITE AND ENVIRONMENTAL SETTING

2.1 STUDY SITE

The Polokwane Smelter is located on Portion 49 of the Palmietfontein Farm 24KS approximately 12km to the south of the city of Polokwane, adjacent to the Regional Route R37 to Burgersfort and east of the Kopermyn Road. The proposed system and access road is located within the current smelter boundary (**Table 2**; **Figure 1**).

Table 2: Location of the Smelter and proposed SO_2 system

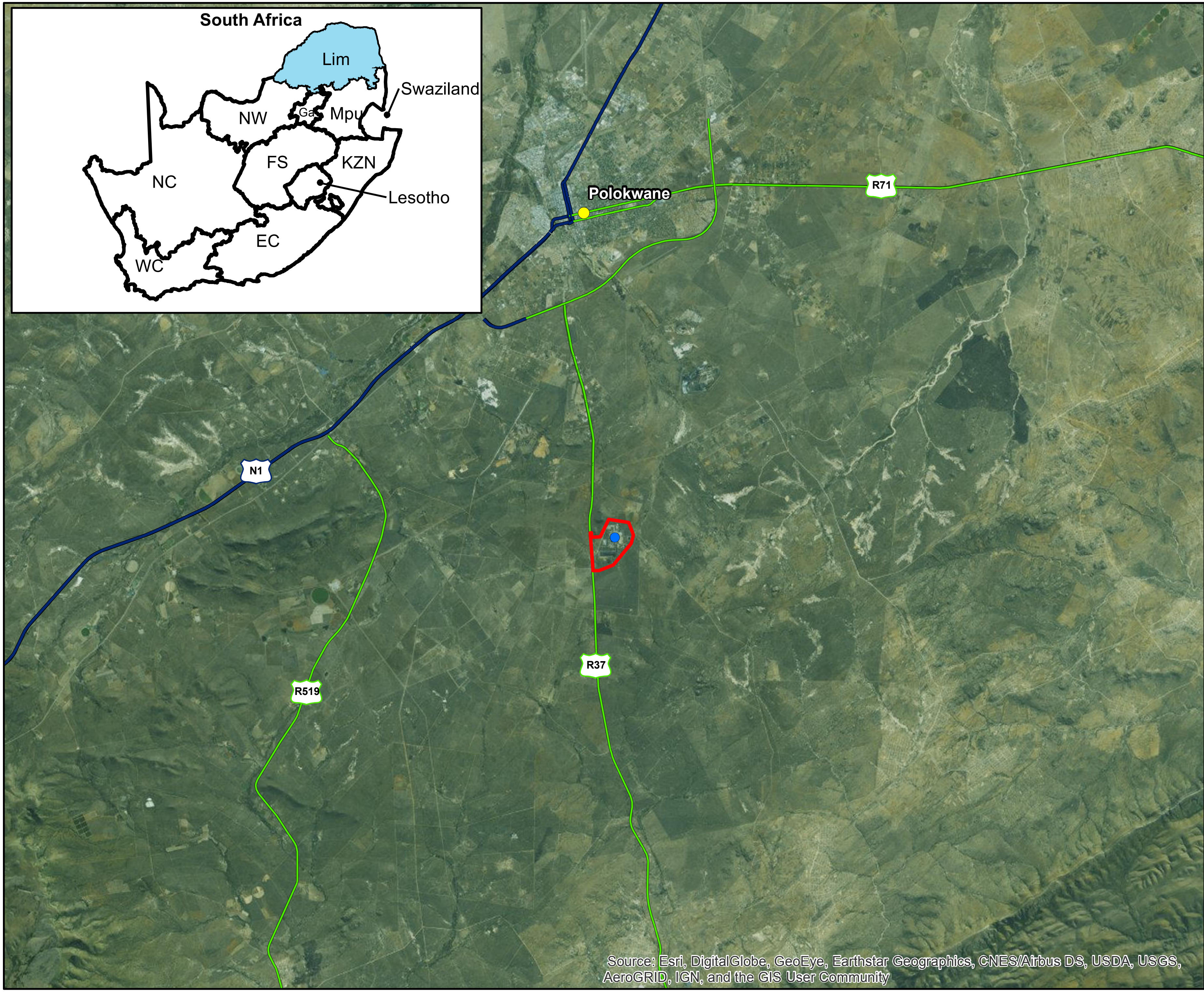
LOCATION	LATITUDE	LONGITUDE
Smelter	-24.027541°S	29.468369°E
Proposed SO_2 System	-24.030592°S	29.469808°E

2.2 SUMMARISED ENVIRONMENTAL SETTING

As per the South Africa Weather Service (SAWS) weather station at the Polokwane Hospital (No. 677834) the mean annual precipitation (MAP) in the Polokwane region is 455 mm, with annual minimum and maximum average temperatures of 12°C and 25°C respectively, determined over a 104 year period. The adopted mean annual evaporation is considerably higher than the MAP at 1513 mm, making this a dry area.

The Smelter is located within the quaternary catchment A71A, (Water Management Area 1: Limpopo), forming part of the major drainage from the Polokwane Plateau to the Limpopo River. The major river in the region is the Sand River with the proposed SO_2 site is located within the headwaters of the Sterkloopspruit, a tributary of the Sand River. The Sterkloopspruit flows in a north-easterly direction, from the Smelter towards Polokwane. It passes through the Polokwane Nature Reserve, Polokwane Golf Club and Polokwane itself before its confluence with the Sand River, over 18km downstream of the Smelter.

The floodlines for the Sterkloopspruit were determined for the Stormwater Management Plan study compiled by SRK (2012), which are indicated in **Figure 2**. The peak discharge values for the Sterkloopspruit River catchment were 28.5m^3/s and 38.2m^3/s for the 1:50 and 1:100 year events respectively (SRK 2012).



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REGIONAL SETTING OF THE POLOKWANE SMELTER

Legend

Polokwane Smelter Site Boundary

N

0 990 1,980 2,970 3,960 4,950

Metres

DATA SOURCE:

SOUTH AFRICAN DEPARTMENT OF RURAL DEVELOPMENT ANDLAND REFORM- CHIEF DIRECTORATE: NATIONAL GEO-SPATIAL INFORMATION

PROJECTION: WGS 29 HARTEBEESHOEK 94

PROJECT TITLE:

SO2 ABATEMENT PROJECT FOR POLOKWANE SMELTER.

PROJECT NO: 31102_7

SCALE: 1:200,000 AT A4	DATE: 2017/05/15
DRAWN BY: SABELO DUBE	FIGURE NO: 1

REVIEWED BY: ZAKARIYA NAKHOODA

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There were no wetland and/or river systems identified as NFEPA wetlands or rivers within a 500m radius from the boundary of the site.

According to the geohydrological report compiled by Wates Meiring & Barnard (WMB) for the Smelter, the underlying geology of the study area consists of medium to coarse-grained grey and pink biotite granite of the Turfloop Granite suite, of the early Vaalium erathem. There is the possibility of remnants of the older Mothiba Formation of the Pietersburg Group of the Murchison Sequence of the Swazian erathem. The formation comprises talc-chlorite and amphibole-chlorite schist and amphibolite, serpentinite and iron formations. Dykes were also identified within the area with the regional trends of jointing are present, i.e. lineaments with a north-easterly orientation (Geohydrology of the Anglo Platinum Smelter Sites, Pietersburg Report No: 4541-2465-14-G).

Due to the insufficient water supply obtained from surface water resources, the Polokwane area is reliant on groundwater through tapping into shallow perched water aquifers and fractured rock aquifers that are typical of the area.

The site is characterised by a shallow, perched aquifer and a deeper fractured rock aquifer. The perched aquifer is developed within the upper 5m of the weathered zone. The aquifer, comprising transported, pedogenic and residual soils is unconfined and transient in nature, and usually exists only during the rainy season. The fractured rock aquifer occurs in the deeper fractured bedrock and tend to be confined to semi-confined.

Depth to groundwater varies from approximately 2 m below ground level to the south of the smelter, to 20 meters below ground level to the north of the smelter. Groundwater levels typically mimic topography in the region, and groundwater flow is in a north easterly direction.
The site is intersected by a number of south west-north east trending dykes, which cross cut both the upper perched and lower fractured aquifers. The dykes appear to act as hydraulic barriers, causing damming of groundwater on the upstream side.

Transmissivities are relatively low in both aquifer units, with minor increases in transmissivity along the fractured contact zones caused by the dyke intrusion. Aqufier testing has indicated transmissivities of 1×10^{-6} – $1x 10^{-7}$ m^2/d in the host rock and $1x 10^{-1}$ m^2/d in the fractured dolerite contact zones.

The Pietersburg Plateau consists of mainly grey iron-containing lateritic soil types forming over the granite. The soils on which the Smelter is located contain a surface layer with humic characteristics (presence of accumulated organic material). There are Hutton and predominantly red Avalon soils and Clovelly subsurface layer. The dominant soils include the largely deep, well-drained and apedal (devoid of macro-structure) Hutton, Clovelly and Avalon soil forms outside of wetland/riparian areas with clay-rich Arcadia soils being present within the wetland areas . There is evidence of historic arable land activities on the Hutton, Clovelly and Avalon soils.

The Avalon soil is susceptible to erosion due to the high concentration of sodium which results in the dispersion of clay particles, and a consequent reduction in infiltration capacity and permeability which subsequently results in soil erosion.

The vegetation unit within which the proposed system is located is classified as Polokwane Plateau Bushveld, which can be described as sweet veld open savanna with a conservation status of 'Least Concern'. The woody community consists of dominant species such as *Acacia tortillis, A. caffra*, and *A. rehmanniana*, with the grass community dominated by *Digiaria eriantha, Heteropogon contortus, Themeda triandra*, *Antephora pubescens* and *Eragrostis chloromelas*. There are populations of alien invasive *Melia azeda-rach, Opuntia ficus-indica* and *Ricinus communis* species which are of concern. The biodiversity of the area is classified as 'High Biodiversity Importance', according to the Mining and Biodiversity Guideline (2012).

3 METHODOLOGY OVERVIEW

The methods used for the Freshwater Habitat Assessment follow a serial approach as outlined below:

- Desktop identification of watercourses within a 500m radius of the proposed SO_2 system;
- Infield delineation and classification of all watercourses within the 500m study area;
- Functional assessments of the potentially impacted watercourses (i.e. PES, EIS, EcoServices);
- Buffer determination; and,
- Completion of the Risk Matrix Assessment (Impacts, mitigative measures, significance rating).

The methods and tools utilised to conduct the freshwater habitat assessments within the study area were determined utilising the desktop and infield assessments and professional opinion (**Table 3**).

Table 3: Methods utilised during the freshwater habitat assessment

METHOD/TOOL	SOURCE	APPENDIX
Delineation of Wetland Areas	A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas (DWAF 2005a).	A1
Classification of aquatic ecosystems	National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis *et al*., 2013).	A1
Impact/Risk Probability Assessment	Internal risk screening tool (WSP)	A2
Present Ecological State (PES) Assessment	Level 1 WET-Health Assessment (McFarlane *et al*. 2009)	A3
Functional Importance Assessment	Level 2 WET-Ecoservices Assessment (Kotze *et al*., 2009)	A4
Ecological Importance & Sensitivity (EIS) Assessment	DWAF Wetland EIS Tool (Duthie, 1999)	A5
Risk Matrix Assessment	Department of Water and Sanitations (DWS) Risk Matrix Assessment Protocol	A6
Buffer Determination	Site-based tool for the determination of buffer zone requirements for wetland ecosystems	A7

Additional in-depth descriptions on each individual method or tool can be found in **Appendix A1** through to **A7**. Desktop national and provincial datasets were utilised to supplement the information gathered onsite, for the accurate assessment of the proposed development site and associated infrastructure.

4 RESULTS

4.1 DESKTOP AND INFIELD FINDINGS

The desktop review and subsequent site assessment identified the following systems within the site and 500m radius of the site (**Figure 2**, **Table 4**):

- A channelled valley-bottom wetland (CVB);
- An artificial system (NFEPA dataset); and
- The Sterkloopspruit River

The impact probability assessment determined that, of these, only the CVB unit required further assessment in terms of Section 21(c) and (i) of NWA as the proposed SO_2 system may potentially impact the habitat, biota, water quality and/or flow regime (i.e. characteristics) of this unit (**Table 4**).

Table 4: Initial Risk Assessment of the watercourses located within 500m of the proposed development (Figure 1)

IDENTIFIED SYSTEM CLASSIFICATION	PROJECT CODE	WATER USE	FURTHER ASSESSMENT	SECTION
Channelled valley-bottom	CVB	**Yes**	**Yes**	4.2
NFEPA (Artificial)	Dam	No	No	-
Sterkloopspruit	Rip	No	No	-

If the proposed SO_2 system were to be developed, it is assessed to not have any potential to impact the remaining systems and even though the remaining systems are within 500m of the proposed site, it is not considered a water use and therefore will not be assessed further (**Table 4**).

4.2 CHANNELLED VALLEY-BOTTOM

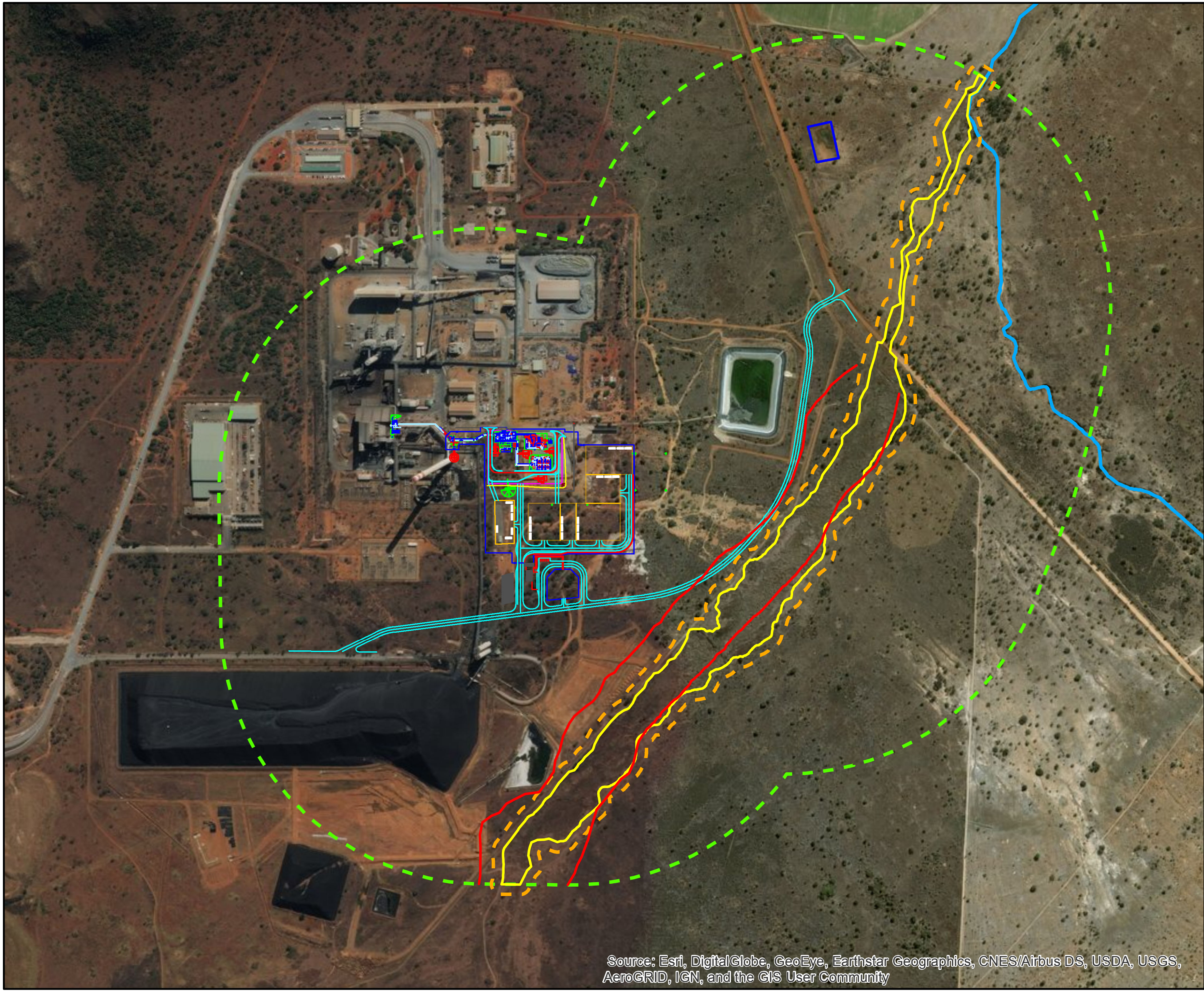
The CVB's catchment has been transformed due to the presence of the Smelter, informal roads and the alteration of the natural fire regime resulting in the establishment of alien invasive plant species. The Smelter resulted in a large area being transformed into completely hardened surfaces however the runoff from these surfaces entered the Smelter's dirty water closed system (inclusive of a Pollution Control Dam (PCD)) and therefore would not result in increased floodpeaks into the CVB system. If the Smelter receives significant rainfall there is potential for the PCD (located approximately 90m from the CVB) to spill into the degraded bushveld surrounding the CVB, which would eventually enter the CVB itself.

The CVB system is located within a relatively flat valley, receiving water inputs from the adjacent slopes (i.e. runoff and interflow). It initially showed characteristics of an unchannelled valley-bottom however, following the infield investigations, it was determined to be weakly channelled with a number of depressions along the channel which are assumed to be artificial in nature. These depressions are fully vegetated and result in small open-water areas during the wet periods (i.e. summer season). There is an excessive level of moribund material due to fires being actively prevented by the Smelter as a safety measure. There is a dilapidated dam wall further upstream from the study site indicating that the system was previously dammed possibly when the land was still an active farm. The system has experienced infilling of material for the construction of the Kopermyn Road, altering the natural flow paths and extent of the system.

The channel was dominated by dense stands of *Typha capensis and Cyperus sexangularis* fringed by *Schoenoplectus corymbosus*. The secondary species located within the seasonal and temporary zones included *Imperata cylindrica, Chloris virgate, Hypoxis hemerocallidea* and *Juncus punctorius, Setaria spp.* Alien invasive species located within the terrestrial environment surrounding the system included *Verbena bonariensis, Bidens pilosa, Opuntia ficus indica* and *Ricinus communis.*

DELINEATION AND IDENTIFICATION

Although rainfall was received the day before the field assessment, the time of year (dry season) has an impact on the accuracy of the delineated boundary. The data collected infield along with historic imagery was utilised to delineate the system as accurately as feasibly possible.



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FRESHWATER ECOSYSTEMS WITHIN 500M OF THE PROPOSED SO_2 SYSTEM

Legend

- Sterkloopspruit
- Floodlines from SRK 2012 Stormwater Management Plan
- Channelled valley-bottom wetland (CVB)
- Artificial excavation
- 500m Buffer
- 19m CVB Buffer

N

0 40 80 120 160 200

Metres

DATA SOURCE:

SOUTH AFRICAN DEPARTMENT OF RURAL DEVELOPMENT ANDLAND REFORM-CHIEF DIRECTORATE: NATIONAL GEO-SPATIAL INFORMATION
NFEPA

PROJECTION: WGS 29 HARTEBEESHOEK 94

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SCALE: 1:9,300 AT A4	DATE: 2017/05/15
DRAWN BY: SABELO DUBE	FIGURE NO: 2

REVIEWED BY: ZAKARIYA NAKHOODA

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The vegetation and soil wetness indicators were the primary indicators utilised to delineate the wetland boundary. This is due to the distinct change in vegetation communities between that of terrestrial and wetland systems and the gleyed and mottled soils located within the channel (permanent) and temporary/ seasonal zones respectively (**Figure 3**).

The wetland unit is located within the Limpopo Plain Aquatic Ecoregion and the Central Bushveld Group 6 WetVeg group. According to Ollis *et al* (2013)'s classification system the wetland unit is classified as an Inland Valley Floor Landscape Unit (Level 3) and as a Channelled Valley-Bottom Hydrogeomorphic Unit (Level 4).

PRESENT ECOLOGICAL STATE

The PES assessment of a wetland system is based on an understanding of both catchment and on-site impacts and the impact that these aspects have on system hydrology, geomorphology and vegetation. The level 1 WET-Health assessment determined the overall PES for CVB as being Moderately Modified ('C' Class) (**Table 5**). As the resultant score is only just within the 'C' Class range, it must be noted that the system is more suitably described as being 'B/C' Class system.

Table 5: PES Assessment for the CVB System

ASPECT	PES SCORE	CLASS	JUSTIFICATION (IMPACT DESCRIPTION)
Hydrology	3.0	C: Moderately Modified	The system is affected by reduced water inputs from alien infestation within the system and the capture of rainfall that falls within the 'dirty' area of the Smelter. Historic alterations to the channel through excavations have resulted in vegetated 'gullies' within the channel. There is increased water use due to established alien invasive species resulting in minor desiccation within the system. The deposition/infilling associated with existing informal roads has resulted in minor habitat loss and altered the movement and retention of flows. There was no flowing water during the time of the assessment however the water quality is assumed to be impacted upon due to the previous water quality sampling that has been conducted along the system. The hydrological integrity of the system is assessed to remain constant over the next 5 years.
Geomorphology	0.3	A: 'Unmodified', Natural	The geomorphology of the system has been impacted upon through the infilling of material from the construction of the Kopermyn Road. This is, however, limited in extent. Although there is deposition of material and minor historical excavations, there is no evidence of major erosional features within the system. The geomorphological integrity of the system is assessed to remain constant over the next 5 years.
Vegetation	2.4	C: Moderately Modified	The establishment of the Kopermyn Road (infilling/deposition) has resulted in a minor portion of complete removal of the natural vegetation. The major impact on the natural vegetation is the removal of fire from the natural functioning. This has resulted in high levels of moribund material and allowed the established of alien invasive plant species. These species are capable of outcompeting indigenous species. The vegetation community of the system is assessed to decrease over the next 5 years.
Overall	**2.07**	**C: Moderately Modified**	**Moderately modified**. A moderate change in ecosystem processes and loss of natural habitat and biota and has occurred.

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EXAMPLES OF SOIL SAMPLES WITHIN STUDY AREA

Legend

Roads

Channelled valley-bottom wetland (CVB)

N

0 10 20 30 40 50

Metres

DATA SOURCE:

SOUTH AFRICAN DEPARTMENT OF RURAL DEVELOPMENT ANDLAND REFORM-
CHIEF DIRECTORATE: NATIONAL GEO-SPATIAL INFORMATION

PROJECTION: WGS 29 HARTEBEESHOEK 94

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WETLAND FUNCTIONAL IMPORTANCE (ECOSERVICES)

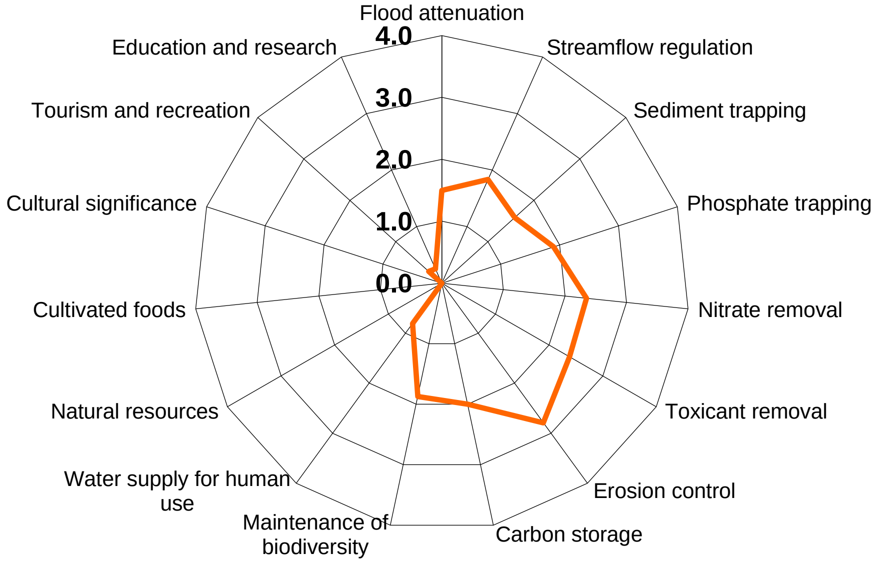
The typical functionality of channelled valley-bottom wetlands tend to contribute less towards flood attenuation and sediment trapping compared to that of typical floodplain wetland types, but would supply these benefits to a certain extent. The potential for removal of nutrients and toxicants would generally be expected to some degree, particularly from diffuse water inputs from adjacent hillslopes (Kotze *et al.* 2009).

The overall goods and services provided by the CVB unit were assessed as being very low to moderate as the system has been impacted upon by anthropogenic activities (**Table 6**). The noteworthy regulating services are erosion control and nitrate and toxicant removal, which are all rated as moderate to moderately-high, however these scores are inflated by the effectiveness to provide these services (i.e. rated moderately-high to high) with the associated opportunity to provide these services being rated as low to moderately-low. Maintenance of biodiversity is rated as moderate as the system provides potential habitat for red data/endangered species.

There is no to minimal provision in terms of cultivated foods, tourism/recreation, education/research and/or socio-cultural aspects. This is mostly due to no natural resources being utilised from the system, no known traditional practices, the inaccessibility and the present state of the system. No water is utilised for human use.

Table 6: Results of the Functional Importance Assessment for the Wet01 System

Ecosystem Goods & Services	Overall Score (out of 4)	Importance Class
Flood attenuation	1.5	Moderately-Low
Streamflow regulation	1.8	Moderate
Sediment trapping	1.6	Moderately-Low
Phosphate trapping	1.9	Moderate
Nitrate removal	2.4	Moderate
Toxicant removal	2.4	Moderate
Erosion control	2.8	Moderately-High
Carbon storage	2.0	Moderate
Maintenance of biodiversity	1.9	Moderate
Water supply for human use	0.8	Low
Natural resources	0.0	None
Cultivated foods	0.0	None
Cultural significance	0.0	None
Tourism and recreation	0.3	Low
Education and research	0.3	Low



ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS)

The CVB Unit was assessed as having an overall Moderate EIS (**Table 7**) driven by the hydrological functional importance (i.e. nitrate and toxicant assimilation and erosion control). This is due to the current state of the system, associated lack of reference habitat representation, the lack of important biodiversity features, no presence of red data or unique species and the unit not being considered important in any conservation plans.

Table 7: The EIS Assessment for the CVB System

UNIT	ECOLOGICAL IMPORTANCE	FUNCTIONAL/HYDROLOGICAL IMPORTANCE	DIRECT BENEFITS TO SOCIETY	*OVERALL IMPORTANCE (/4)*	
Wet01	1.67	2.05	0.23	**2.05**	**Moderate**

The CVB Unit is not classified as 'Wetland FEPA' (CSIR, 2011) and is thus not considered important in meeting national wetland conservation targets. The system has low direct benefits to society mainly due to the lack of harvestable resources and the lack of direct water use.

RECOMMENDED ECOLOGICAL CATEGORY (REC)

The Recommended Ecological Category (REC) (i.e. management objectives) is a recommendation from an ecological viewpoint which is considered within the decision-making process in the National Water Resource Classification System (NWRCS). This recommendation is based on either maintenance of the PES or an improvement thereof.

According to DWAF (2007), the PES and EIS of water resources must drive management objectives when there is no water resource classification available. Therefore, for water resources that do not have a REC allocated for the system, information contained in **Table 8** may be utilised, indicating that the management objective for the CVB system is to '**Maintain**' the present state.

Table 8: Management objectives for the assessed water resources (DWAF 2007).

PES	ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS)			
	Very High	**High**	**Moderate**	**Low**
A	Maintain	Maintain	Maintain	Maintain
B	Improve	Improve	Maintain	Maintain
C	Improve	Improve	**Maintain**	Maintain
D	Improve	Improve	Maintain	Maintain
E/F	Improve	Improve	Maintain	Maintain

4.3 BUFFER DETERMINATION

The Buffer Zone Guidelines for Rivers, Wetlands and Estuaries (buffer tool) was utilised to determine the buffer zone requirements for the aquatic systems located within the study site that may potentially be impacted upon by the proposed development. The objective of the buffer zone is to identify the exclusion area and thereby limit/prevent any further degradation of the existing system. A buffer can potentially reduce the impacts to aquatic resources and, in so doing, protect the range of goods and services that these resources provide to society (MacFarlane 2016).

The DWS and Water Research Commission developed buffer tool was utilised to determine the appropriate width of the buffer for the CVB system as it is the main system within the study area and is in close proximity to the proposed access road. The tool determined that the minimum of **18 metre** buffer from the delineated edge of the system, during both the construction and operation phases. This buffer is required to be extended around the CVB system due to its proximity to the proposed site.

To further define an area of exclusion the flood risk assessment that was previously undertaken to calculate the 100 year floodline should be incorporated with the buffer zone. The extent of the exclusion area, which factors in both the buffer tool and 100 year floodline, is depicted in **Figure 2**. The buffer zone is required to be demarcated as a no-go zone to ensure the risk ratings of the impacts remain low. Ideally the 1:100 floodline should also be demarcated as a No-Go zone however as currently depicted, the proposed road infrastructure is located within this floodline.

5 IMPACT ASSESSMENT AND MITIGATIVE MEASURES

The proposed development may potentially impact the CVB system. The majority of the potential impacts will occur during the construction phase, especially relating to the construction of the access road. There are no foreseen long term impacts associated with the operational activities of the proposed development.

There is no foreseen direct loss of wetland habitat or biota relating to the construction and operational activities, this under the assumption that the determined buffer will be demarcated as a 'No-Go' area and adhered to. There will be temporary intrusion into sections of the 1:100 floodline for the construction and utilisation of the access road, with the appropriate rehabilitation this impact would not be significant long term.

The significant hardening of surfaces associated with the development footprint would decrease infiltration, alter flow patterns and increase concentration runoff, however the surface water entering the hardened surface of the SO2 system will be directed to the dirty water system of the Smelter.

Therefore not resulting in increased floodpeaks and the potential for erosion. Effective stormwater management would allow for the release of the surface water runoff associated with the access road in a controlled manner, with minimal impact on the CVB system.

The quality of the surface water runoff from the proposed development may result in the degradation of water quality within the buffer zone of the CVB system and downstream. The runoff, containing hydrocarbons, from minor leaks associated with construction vehicles, is the main contaminant source. Again an effective maintenance and stormwater management plan for the proposed development would provide mitigative measures to ensure this is a low impact.

5.1 RISK MATRIX ASSESSMENT

The risk-based management approach developed by the DWS is required to be undertaken to determine whether a proposed development would require a Water Use License Application or whether it would fall within the ambit of the appropriate **General Authorisation** (GA).

The approach was utilised to assess potential impacts of the proposed development on associated freshwater habitats. The mitigation measures are considered during scoring, scores are thus based on residual impacts after mitigation. If any of the impacts receive a Moderate score (56 – 80) then additional control measures may be implemented to potentially decrease the score to Low.

The mitigation of negative impacts on biodiversity and ecosystem goods and services is a legal requirement for authorisation purposes. It requires proactive planning that is enabled through a mitigation hierarchy, which strive to first avoid disturbance of ecosystems and loss of biodiversity, then, to minimise, rehabilitate and finally offset any remaining significant residual negative impacts on biodiversity (DEA 2013).

There are generic best practice mitigative measures that are required to be implemented with every potential development to ensure the application of the most appropriate combination of environmental control measures and strategies, to protect water resources and the surrounding environment. These measures are generally defined within a project-specific Environmental Management Programme (EMPr), however in the absence of an EMPr, the best practice specifications within the DWAF '*Integrated Environmental Management Series – Environmental Best Practice Specifications*': '*Construction*' (DWAF 2005b) & '*Operation*' (DWAF 2005c) guidelines should be implemented, along with the project-specific mitigative measures.

A summary of the assessment is provided in **Table 9,** with the full Risk Matrix available in **Appendix B**. All risk ratings associated with the assessment were low. It must be noted that it is assumed that standard accepted management and operational practices will be implemented and the below suggested control measures are implemented over and above these standard practices. It is also assumed that:

- The determined buffer will be demarcated as a No-Go area.
- Effective stormwater management will be implemented for the proposed site and access road;
- The SO_2 system is located within the Dirty Water Stormwater System; and,
- The PCD contains sufficient capacity to accommodate the additional runoff volumes generated from the proposed SO_2 system area.

5.2 RECOMMENDATIONS

There following are additional recommendations, which should be considered during the design and construction phases to further limit the potential of impacting any water resource:

- The design for the proposed access road should be slightly realigned to ensure it is not located within the 1:100 floodline of the CVB system.

Table 9: Summary of DWS Risk Matrix Assessment for activities that may potentially impact the CVB wetland system

Activity		Aspect	Impact	Consequence	Likelihood	Risk Score	Risk Rating	Control Measures
Proposed SO_2 System	Construction	→ Clearing of significantly degraded vegetation and excavations, infilling associated with the construction activities within the 'dirty' area of the Smelter	→ Increase runoff sediment input that may potentially enter the CVB unit.	2	8	16	L	→ Implementation of the recommended buffer zone for the wetland. → The construction footprint should be kept to a minimum with no construction activities to occur within the delineated boundary of the CVB system. → The access road should be positioned outside the 1:100 year floodline of the CVB system. → Implementation of a no-go buffer zone for the wetland. → The site should contoured to allow for surface water to readily drain away and to prevent ponding of water anywhere within the site. → A stormwater management plan must be implemented for the temporary access road to prevent erosion/scouring and subsequent sedimentation of the CVB unit. → The onsite operational storm water management plan must be updated by a qualified engineer. The runoff regimes post-construction activities matches that regimes pre-construction (i.e. without resulting in increased peak discharge to water resources, soil saturation in non-wetland areas and erosion/ sedimentation). → The development and implementation of a wetland rehabilitation and management plan. The plan should be completed prior to construction commencing. → The use of sediment curtains to prevent sediment entering the CVB system. → The use of multiple temporary outlets must be considered over one/few larger stormwater outlets along the temporary access road. This will result in diffuse surface flow and minimise flow concentration and erosion. All stormwater detention and attenuation and outlet structures must be located outside of the CVB unit and buffer/exclusion zones with some allowance for outlet protection e.g. reno-mattresses, rock packs, filter strips). → All outlets must be designed to dissipate the energy of outgoing flows to levels that present a low erosion risk. → All stormwater generated by the medium to high risk contamination 'dirty' areas must not be allowed to discharge into the surrounding environment. → Dirty water generated from the SO_2 system site must enter the 'dirty' water system of the Smelter. → Construction vehicles utilising the access road must be continuously maintained to ensure the number of hydrocarbon leaks is kept to a bare minimum. → Any contaminant spill (e.g. hydrocarbons) must be addressed immediately in line with a project specific Environmental Management Programme. → The access road must be rehabilitated to represent the natural vegetation type/unit of the area upon completion of construction activities. Continued monitoring of the rehabilitated site must occur in accordance with a rehabilitation and monitoring programme.
		→ Stormwater management	→ Alterations of flow patterns	2.75	10	27.5	L	
	Operational	→ Stormwater management	→ Hardened surfaces resulting in concentrated flows (potentially containing contaminants) leading to scouring/erosion	2	9	18	L	
Construction of road infrastructure	Construction	→ Clearing of vegetation and infilling associated with the construction of the road.	→ Decreased roughness → Increased runoff (volume and velocity) → Increased sediment input → Soil compaction → Potential oil spills and waste entering the surrounding environment and potentially the CVB Unit as well	5.25	9	47.25	L	
		→ Hydrocarbons emanating from construction vehicles	→ Hydrocarbons entering the natural system	4	13	52	L	
	Decommissioned	→ Stormwater management	→ Scouring/erosion due to increased volumes and patterns of flow (increased floodpeaks) → Soil compaction	3	9	27	L	

- A site layout plan must be compiled indicating the limits of disturbance associated with the proposed development in relation to the identified sensitive areas (i.e. wetland and floodlines). No-go areas and any stormwater infrastructure must be indicated on this plan along with environmental management measures, particularly erosion and sediment controls and measures.
- Where feasibly possible, construction activities should be limited to the drier months of the year.
- Temporary erosion prevention berms should be installed along the length of the access road to decrease the concentration and velocity of runoff. This will aid in the prevention of gully formation and sedimentation. The following guidelines should be utilised for the placement of these berms:
  - Where the longitudinal slope is:
    - less than 2%, berms should be installed every 50 m;
    - between 2% and 10%, berms should be installed every 25 m;
    - between 10%-15%, berms should be installed every 20 m;
    - greater than 15%, berms should be installed every 10 m.
  - Berms shall be suitably compacted to a minimum height of 350mm.
  - Berms should extend beyond the width of the road.
  - Berms are to be constructed so that a canal is formed at the upslope side.
  - Installed at approximately a 30-degree angle down slope. Ensure adequate drainage at the outflow, protected with stone, grass, sod, or anything that will reduce velocity of water.
  - Inspected regularly and rebuilt periodically.
- An embankment/berm must be place along the road portion closest to the delineated edge of the wetland. The area would receive runoff from the road originating upslope at the propose SO_2 system site. This will allow for the discharge of stormwater further along the road, preventing direct concentrated water input into the wetland.
- The use of the graminoid species, *Cynodon dactylon*, at the outflows of these berms would be beneficial as this species prevents soil erosion and is recommended for the protection of waterways. This will create filter strips which intercept and spread out stormwater runoff thus helping to attenuate flood peaks. The species is indigenous to the area and according to a study conducted by Basumatary and Bordoloi (2016), contains phytoremediation properties, with the ability to decrease the quantity of oil and grease in soil. As the construction vehicles are assumed to be kept in perfect working order and the number of vehicles to utilise the road to be approximately 10 per day, the above mitigative measures should suffice in mitigating the minor hydrocarbon leaks that may occur. During the rehabilitation phase these *C. dactylon* filter strips must be removed and appropriately disposed of as a precautionary principle to prevent the continued movement of hydrocarbons through the natural system.
- An alien invasive management plan must be compiled and implemented to prevent further encroachment of these alien species into the disturbed areas cause by construction activities.
- The existing water quality monitoring at the Smelter must continue in accordance with the water quality monitoring programme established for the site.
- Dust suppression measures (e.g. water cart) must be implemented during construction along the access road to prevent sediment particles being deposited within the CVB unit.
- A Work Method Statement must be compiled by the client and/or responsible contractor and should include aspects such as:
  - Proposed construction works;
  - Materials and equipment to be utilised;
  - Procedures for transporting materials to/from site (entry/exit points and turning areas would be indicated on the site plan);

- Method and location of storage of material (this would be required to be indicated on a site plan);
- Procedures for containment of leaks/spills as well as associated emergency response plan/Spill Contingency Plan;
- Establishment and management of construction camps including location and extent (this would be indicated on a site plan);
- Management of stormwater;
- Recommendations outlined within this wetland assessment report;
- Sensitive area demarcation (this would be indicated on the site plan in agreeance with the wetland specialist);
- Management of construction materials (movement, storage, preparation/handling);
- Waste management;
- Erosion control/s;
- Equipment maintenance; and,
- Responsibilities of key personnel, e.g. project manager, contractor/site manager, ECO

5.3 REHABILITATION GUIDELINES

Rehabilitation requires that there is an attempt to imitate natural processes and reinstate natural ecological driving forces in such a way that it aids the recovery (or maintenance) of dynamic systems so that, although they are unlikely to be identical to their natural counterparts, they will be comparable in critical ways so as to function similarly (Jordan *et al.* 1987). Rehabilitation should be based on an understanding of both the ecological starting point and on a defined goal endpoint, and should accept that it is not possible to predict exactly how the wetland is likely to respond to the rehabilitation interventions.

The most typical rehabilitation interventions designed to assist in the recovery of degraded wetland ecosystems are 'plugs' constructed within artificial drainage channels. The 'plugs' are placed with the intention of reinstating a more natural hydrology. Typical interventions for maintaining the health of wetland ecosystems that are in the process of degrading are the placement of erosion control structures which assist in halting the advancement through a wetland of an erosion headcut.

Rehabilitation is not confined to physical structures, however, and rehabilitation may include interventions such as reducing livestock grazing-pressure or reducing the frequency of burning. Refer to the generic wetland rehabilitation methods in **Appendix A8**.

If any of the identified watercourses are impacted on by the construction and/or operation of the proposed SO_2 system, a suitably experienced specialist, who has sound knowledge of the receiving environment, will be required to implement an approved Wetland/Riparian Rehabilitation Plan. The plan shall include, but not be limited to:

- → Detailed rehabilitation methodology;
- → Details for potential structures proposed within existing systems to assist with the prevention of further erosion and improve flooding of wetland systems;
- → Methods for the removal and control of alien invasive plant species within the wetland and riparian areas;
- → Assessment of current vegetation species within the study site;
- → Proposed plant species to be utilised for rehabilitating in the wetland and/or riparian areas; and,

- Monitoring requirements to assess how successful the rehabilitation techniques are within the systems.

6 DISCUSSION AND CONCLUSION

The Freshwater Habitat Assessment determined that the CVB system may potentially be impacted upon by the proposed SO_2 development. This unit underwent further assessments to determine the recommended buffer of the system and a risk assessment to determine the need for a Water Use Licence Application (WULA) in terms of Section 21 (c) and (i) of NWA.

The potential impacts to the identified systems by the proposed development would be from inefficient stormwater management resulting in potential erosion and sedimentation of the CVB impacting the flow regime, habitat, biota and water quality of the CVB system. However, if the stipulated mitigative measures, including adhering to the DWS' environmental best practice guidelines; implementing the determined buffer zones; the construction and operational activities are outside the delineated boundary of the wetland and the 1:100 year floodline; and the development and implementation of a site-specific Monitoring Programme, Stormwater Management Plan and Work Method Statement, then the impacts are deemed to be of low significance.

On this basis it is the specialist opinion that the proposed development may then be registered with the DWS under a General Authorisation (GA). However it is understood that the Smelter already has a Water Use Licence and therefore the GA may then not be applicable, as per section 3(c) of **GN509 of 2016**. It has been evident that GA's have been issued despite this and therefore the DWS will have to be engaged to confirm the applicability of either the GA or WULA.

It must be noted that a GA is not a licence but a registration with DWS. There are still conditions associated with the GA that need to be met to fall within the ambit of **GN509 of 2016: Section 9-12**. These include, but are not limited to:

- Inductions;
- Conditions on site camp locations;
- Erosion control measures;
- Pollution control measures;
- water quality measurements;
- monitoring and reporting (including monitoring programmes);
- rehabilitation; and
- proof of budgetary provisions.

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Appendix A

METHODOLOGY (ASSESSMENT TOOL DESCRIPTIONS)

APPENDIX A-1

DELINEATION AND CLASSIFCATION

Wetland delineation includes the confirmation of the occurrence of wetland and a determination of the outermost edge of the wetland. The outer boundary of wetlands was identified and delineated according to the Department of Water Affairs wetland delineation manual 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005a). Wetland indicators were used in the field delineation of the wetlands: position in landscape, vegetation and soil wetness (determined through soil sampling with a soil auger and the examining the degree of mottling).

Four specific wetland indicators were used in the detailed field delineation of wetlands, which include:

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur.
- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation.
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

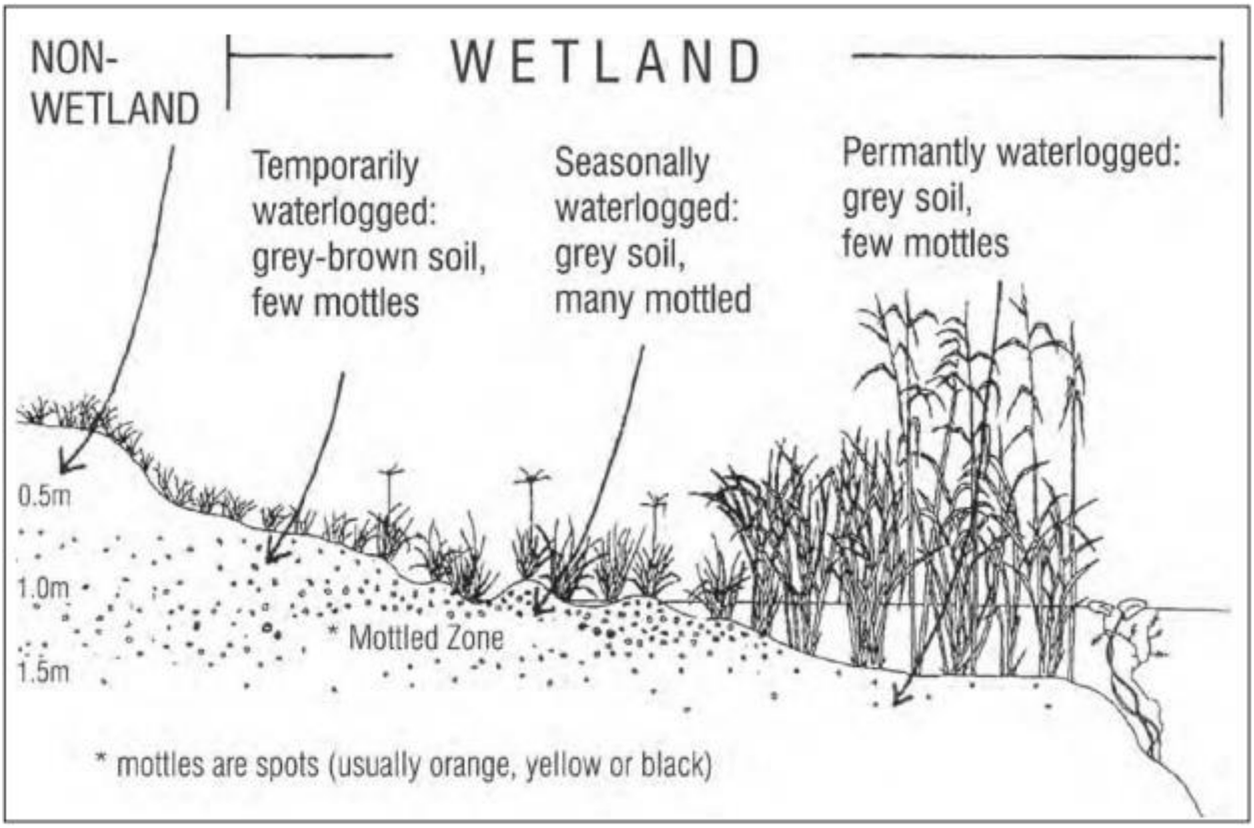


Figure A1a: ***Cross section through a wetland, indicating how the soil wetness and vegetation indicators change as one moves along a gradient of decreasing wetness, from the middle to the edge of the wetland. Source: Donovan Kotze, University of KwaZulu-Natal.***

According to the wetland definition used in the National Water Act, vegetation is the primary indicator, which must be present under normal circumstances. However, in practise the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role. The reason for this is that vegetation responds relatively quickly to changes in the soil moisture regime or management and may be transformed; whereas the morphological indicators in the soil are far more permanent and will hold the signs of frequent saturation long after a wetland has been drained (perhaps for several centuries). The permanent, seasonal and temporary wetness zones can be characterised to some extent by the soil wetness indicators that they display (Table A1a & A1b)

Table A1a: Soil Wetness Indicators in the various wetland zones

TEMPORARY ZONE	SEASONAL ZONE	PERMANENT ZONE
Minimal grey matrix (<10%)	Grey matrix (<10%)	Prominent grey matrix
Few high chroma mottles	Many low chroma mottles present	Few to no high chroma mottles
Short periods of saturation (less than three months per annum)	Significant periods of wetness (at least three months per annum)	Wetness all year round (possible sulphuric odour)

Table A1b: Relationship between wetness zones and vegetation types and classification of plants according to occurrence in wetlands

VEGETATION	TEMPORARY WETNESS ZONE	SEASONAL WETNESS ZONE	PERMANENT WETNESS ZONE
Herbaceous	Predominantly grass species; mixture of species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas	Hydrophilic sedges and grasses restricted to wetland areas	Dominated by: (1) emergent plants, including reeds (*Phragmites australis*), a mixture of sedges and bulrushes (Typha capensis), usually >1m tall; or (2) floating or submerged aquatic plants.
Woody	Mixture of woody species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas.	Hydrophilic woody species restricted to wetland areas	Hydrophilic woody species, which are restricted to wetland areas. Morphological adaptations to prolonged wetness (e.g. prop roots).
SYMBOL	**HYDRIC STATUS**	**DESCRIPTION/OCCURRENCE**	
Ow	Obligate wetland species	Almost always grow in wetlands (>90% occurrence)	
Fw/F+	Facultative wetland species	Usually grow in wetlands (67-99% occurrence) but occasionally found in non-wetland areas	
F	Facultative species	Equally likely to grow in wetlands (34-66% occurrence) and non-wetland areas	
Fd/F-	Facultative dryland species	Usually grow in non-wetland areas but sometimes grow in wetlands (1-34% occurrence)	
D	Dryland species	Almost always grow in drylands	

In order to identify the wetland types, using Kotze et al. (2009) and Ollie et al. (2013), a characterisation of hydrogeomorphic (HGM) types was conducted. These have been defined based on the geomorphic setting of the wetland in the landscape (e.g. hillslope or valley bottom, whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated), how water flows through the wetland (diffusely or channelled) and how water exits the wetland (Figure A1b).

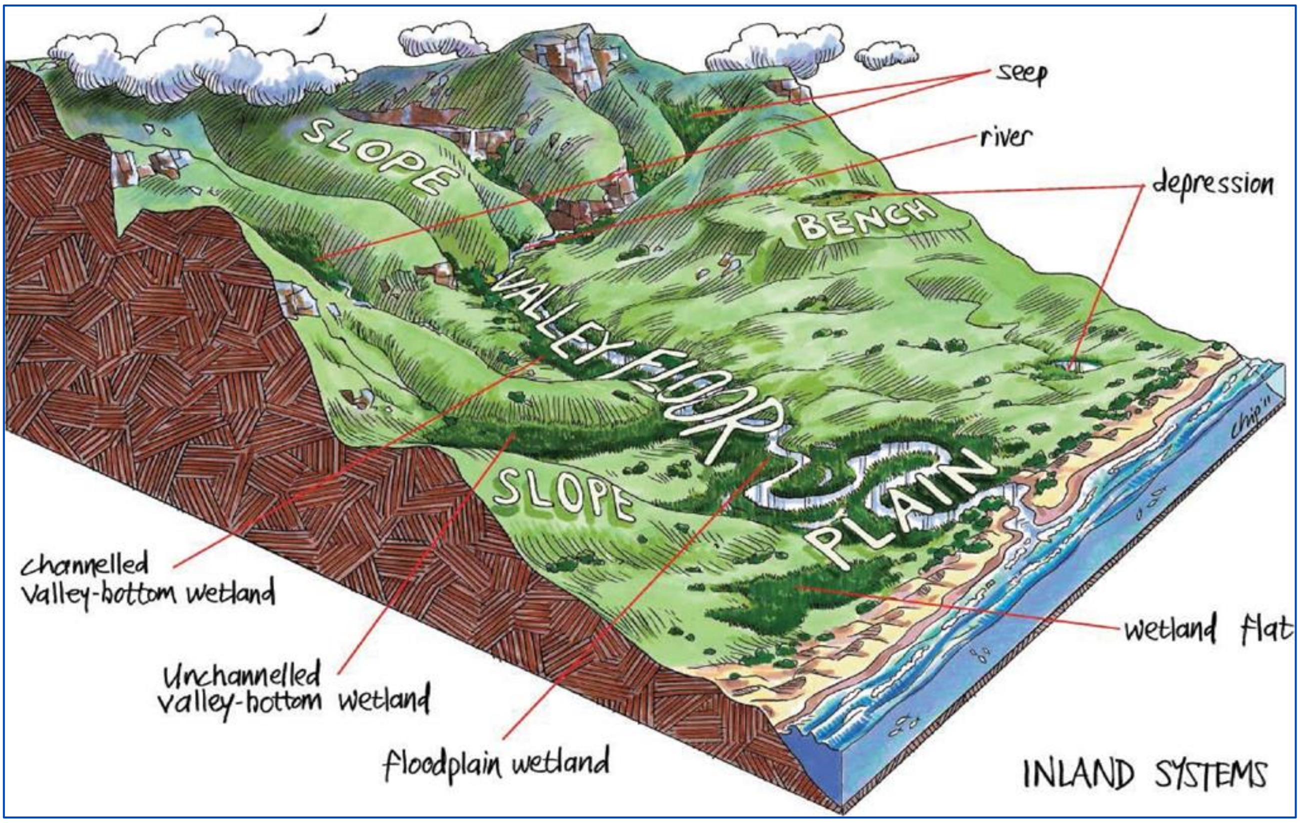


Figure A1b: Illustration of wetland types and their typical landscape setting (From Ollis *et al*. 2013)

APPENDIX A-2

IMPACT/RISK PROBABILITY ASSESSMENT

An initial assessment is required to determine whether the proposed development and associated infrastructure infringe on the regulated boundary of a watercourse. The identified watercourses undergo an impact probability assessment to determine whether there is potential of the proposed development impacting each specific watercourse. This is a qualitative rapid risk screening exercise to determine where a watercourse would potentially be impacted upon by the proposed development, based on professional scientific judgement. The risk ratings utilised are described in **Table A2a** below.

Table A2a: Risk ratings assigned to watercourses identified within the study area

RISK CATEGORY	JUSTIFICATION (POTENTIAL IMPACTS ON HABITAT, BIOTA, WATER QUALITY, FLOW REGIME)
No Risk	There is no potential risk (direct or indirect) to any of the identified watercourse's characteristics as a result on the proposed development. Factors such as the position of the watercourse in relation to the proposed development are considered, i.e. watercourse located within a different micro-catchment.
Low	There is an unlikely possibility that the proposed development will have an indirect impact on any of the watercourse characteristics, if the development is constructed and operated under a 'best-practice scenario'. However, through experience, it is evident that best-practice is not always implemented through there is still a risk that the watercourse could be impacted. These systems will be assessed further.
Moderate	There is a possibility that the proposed development will have an indirect or cumulative impact on at least one of the watercourse characteristics. This may be due to the proposed development being located within close proximity to the boundary of a watercourse. These systems will be assessed further.
High	There is a definite possibility of the proposed development having a direct impact on at least one of the watercourse characteristics. This may be due to the proposed development being located within the boundary of a watercourse. These systems will be assessed further.

APPENDIX A-3

PRESENT ECOLOGICAL STATE (PES) – WETLANDS

WET-Health assists in assessing the health of wetlands using indicators based on geomorphology, hydrology and vegetation. For the purposes of rehabilitation planning and assessment, WET-Health helps users understand the condition of the wetland in order to determine whether it is beyond repair, whether it requires rehabilitation intervention, or whether, despite damage, it is perhaps healthy enough not to require intervention. It also helps diagnose the cause of wetland degradation so that rehabilitation workers can design appropriate interventions that treat both the symptoms and causes of degradation. WET-Health is tailored specifically for South African conditions and has wide application, including assessing the Present Ecological State of a wetland. There are two levels of complexity: Level 1 is used for assessment at a broad catchment level and Level 2 provides detail and confidence for individual wetlands based on field assessment of indicators of degradation (e.g. presence of alien plants). A basic tertiary education in agriculture and/or environmental sciences is required to use it effectively. Level 1 was utilised for the assessment of the wetlands impacted upon.

WET-Health is a tool designed to assess the health or integrity of a wetland. Wetland health is defined as a measure of the deviation of wetland structure and function from the wetland's natural reference condition. This technique attempts to assess hydrological, geomorphological and vegetation health in three separate modules.

Hydrology is defined in this context as the distribution and movement of water through a wetland and its soils. This module focuses on changes in water inputs as a result of changes in catchment activities and characteristics that affect water supply and its timing, as well as on modifications within the wetland that alter the water distribution and retention patterns within the wetland.

Geomorphology is defined in this context as the distribution and retention patterns of sediment within the wetland. This module focuses on evaluating current geomorphic health through the presence of indicators of excessive sediment inputs and/or losses for clastic (minerogenic) and organic sediment (peat).

Vegetation is defined in this context as the vegetation structural and compositional state. This module evaluates changes in vegetation composition and structure as a consequence of current and historic onsite transformation and/or disturbance.

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. The tool attempts to standardise the way that impacts are calculated and presented across each of the modules. This takes the form of assessing the spatial extent of impact of individual activities and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact (**Table A3a**).

Table A3a: Guideline for interpreting the magnitude of impacts on wetland integrity (Macfarlane *et al.*, 2008).

IMPACT CATEGORY	DESCRIPTION	SCORE
None	No discernible modification or the modification is such that it has no impact on this component of wetland integrity	0 – 0.9
Small	Although identifiable, the impact of this modification on this component of wetland integrity is small	1 – 1.9
Moderate	The impact of this modification on this component of wetland integrity is clearly identifiable, but limited.	2 – 3.9
Large	The modification has a clearly detrimental impact on this component of wetland integrity. Approximately 50% of wetland integrity has been lost.	4 – 5.9
Serious	The modification has a highly detrimental effect on this component of wetland integrity. Much of the wetland integrity has been lost but remaining integrity is still clearly identifiable.	6 – 7.9
Critical	The modification is so great that the ecosystem processes of this component of wetland integrity are almost totally destroyed, and 80% or more of the integrity has been lost.	8 – 10

Impact scores obtained for each of the modules reflect the degree of change from natural reference conditions. Resultant health scores fall into one of six health categories (A-F) on a gradient from "unmodified/natural" (Category A) to "severe/complete deviation from natural" (Category F) as depicted in **Table A3b**, below. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic systems.

Table A3b: Health categories used by WET-Health for describing the integrity of wetlands (after Macfarlane *et al.*, 2008).

IMPACT CATEGORY	DESCRIPTION	RANGE	PES CATEGORY
None	Unmodified, natural.	0 – 0.9	**A**
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1 – 1.9	**B**
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2 – 3.9	**C**
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4 – 5.9	**D**
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6 – 7.9	**E**
Critical	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8 – 10	**F**

An overall wetland health score was calculated by weighting the scores obtained for each module and combining them to give an overall combined score using the following formula:

Overall health rating = [(Hydrology*3) + (Geomorphology*2) + (Vegetation*2)] / 7

This overall score assists in providing an overall indication of wetland health/functionality which can in turn be used for recommending appropriate management measures.

APPENDIX A-4

WETLAND FUNCTIONAL IMPORTANCE (GOODS AND SERVICES)

WET-EcoServices is used to assess the goods and services that individual wetlands provide, thereby aiding informed planning and decision making. It is designed for a class of wetlands known as palustrine wetlands (i.e. marshes, floodplains, vleis or seeps). The tool provides guidelines for scoring the importance of a wetland in delivering each of 15 different ecosystem services (including flood attenuation, sediment trapping and provision of livestock grazing). The first step is to characterise wetlands according to their hydro-geomorphic setting (e.g. floodplain). Ecosystem service delivery is then assessed either at Level 1, based on existing knowledge or at Level 2, based on a field assessment of key descriptors (e.g. flow pattern through the wetland).

The overall goal of WET-EcoServices is to assist decision makers, government officials, planners, consultants and educators in undertaking quick assessments of wetlands, specifically in order to reveal the ecosystem services that they supply. This allows for more informed planning and decision making. WET-EcoServices includes the assessment of several ecosystem services (listed in **Table A4a**) - that is, the benefits provided to people by the ecosystem.

Table A4a: Ecosystem services assessed by WET-Ecoservices

Ecosystem services supplied by wetlands	Indirect benefits	Regulating and 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 enhancement benefits	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 waters
				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**[2]			Through the provision of habitat and maintenance of natural process by the wetland, a contribution is made to maintaining biodiversity
		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

The steps involved in applying WET-EcoServices can be summarised as follows (**Figure A4a**).

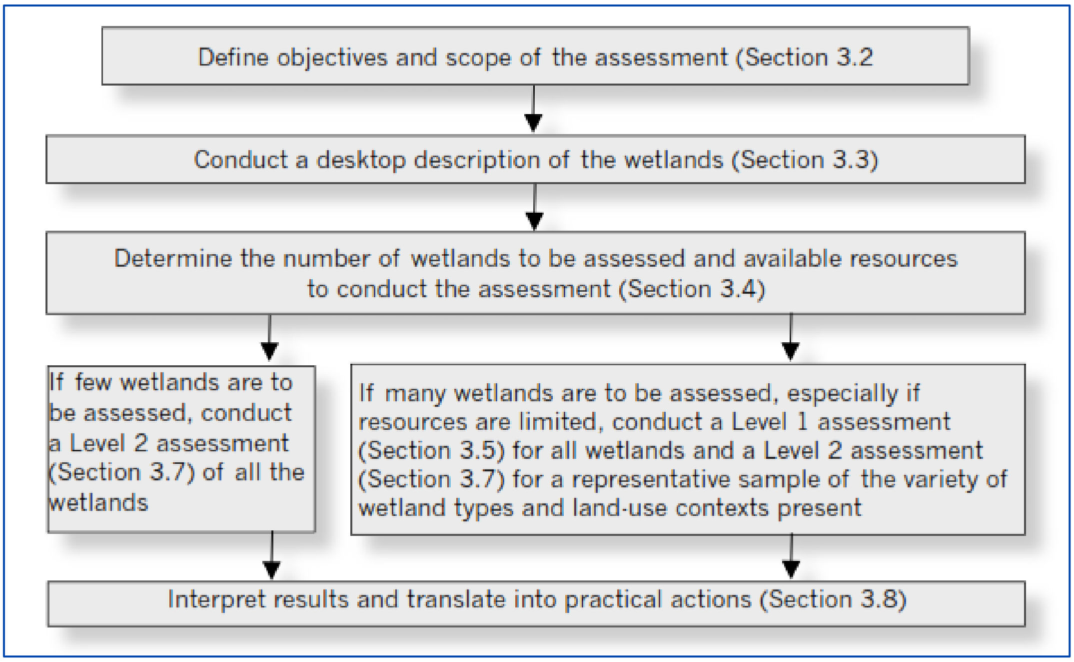


Figure A4a: Steps required for Wet-EcoServices. The sections referred to within this figure relate back to the Wetland Management Series: Wet-Ecoservices. WRC Report TT 339/08

APPENDIX A-5

ECOLOGICAL IMPORTANCE & SENSITIVITY (EIS) - WETLANDS

The Ecological Importance and Sensitivity was determined by utilising a rapid scoring system. The system has been developed to provide a scoring approach for assessing the Ecological, Hydrological Functions; and Direct Human Benefits of importance and sensitivity of wetlands. The scoring assessments for these three aspects of wetland importance and sensitivity have been based on the requirements of the NWA, the original Ecological Importance and Sensitivity assessments developed for riverine assessments (DWAF, 1999), and the work conducted by Kotze *et al.* (2008) on the assessment of wetland ecological goods and services from the WET-EcoServices tool (Rountree, 2010). An example of the scoring sheet is attached as **Table A5a**. The scores are then placed into a category of very low, low, moderate, high and very high as shown in **Table A5b**.

Table A5a: Example of scoring sheet for Ecological Importance and sensitivity

ECOLOGICAL IMPORTANCE AND SENSITIVITY			
Ecological IMPORTANCE	SCORE (0-4)	CONFIDENCE (1-5)	MOTIVATION FOR SITE
Biodiversity support			
Presence of Red Data species			
Populations of unique species			
Migration/breeding/feeding sites			
Landscape scale			
Protection status of the wetland			
Protection status of the vegetation type			
Regional context of the ecological integrity			
Size and rarity of the wetland type/s present			
Diversity of habitat types			
Sensitivity of the wetland			
Sensitivity to changes in floods			
Sensitivity to changes in low flows/dry season			
Sensitivity to changes in water quality			
ECOLOGICAL IMPORTANCE & SENSITIVITY			
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	*Input from different scoring sheet*		
IMPORTANCE OF DIRECT HUMAN BENEFITS	*Input from different scoring sheet*		
OVERALL IMPORTANCE			

Table A5b: Category of score for the Ecological Importance and Sensitivity

RATING	EXPLANATION
None, Rating = 0	Rarely sensitive to changes in water quality/hydrological regime
Low, Rating =1	One or a few elements sensitive to changes in water quality/hydrological regime
Moderate, Rating =2	Some elements sensitive to changes in water quality/hydrological regime
High, Rating =3	Many elements sensitive to changes in water quality/ hydrological regime
Very high, Rating =4	Very many elements sensitive to changes in water quality/ hydrological regime

APPENDIX A-6

RISK MATRIX ASSESSMENT

The Integrated Water Resource Management (IWRM) is an internationally-accepted approach to sustainable Water Resource Management. It recognises the inter-relatedness and relationship between watercourse level processes and components (resource quality characteristics). An activity associated with the proposed development can impact any of the resource ecosystem drivers (flow regime, water quality, geomorphological) or responses (habitat, biota) and this will have a knock-on effect on potentially all the other drivers and or responses. Therefore, any activity that has the potential to pose a **RISK** to the resource quality characteristics constitutes a water use in terms of Section 21(c) and (i).

The inter-related resource quality characteristics of watercourse, according to DWS, are:

- Flow regime (quantity, pattern, timing, water level and assurance of instream flow);
- Habitat (character and condition of the instream and riparian habitat);
- *Geomorphology (incorporated within flow regime and habitat)*;
- Water quality (physical, chemical and biological characteristics of the water), and;
- Biota (characteristics, condition and distribution of the aquatic biota).

The initial risk screening assessment was a qualitative assessment to determine whether a watercourse (resource) would potentially be impacted by the proposed development. This impact significance rating is a quantitative risk assessment to determine the significance of the identified impacts on the watercourses identified in the initial risk screening assessment.

The impact significance rating is utilised when an impact is identified that could potentially affect the integrity of a watercourse characteristics (i.e. flow regime, water quality, geomorphological processes creating habitat and biota as response). These threats must be managed in accordance with the likelihood (i.e. chances of the impact occurrence) and consequence (i.e. severity) of the threat.

APPENDIX A-7

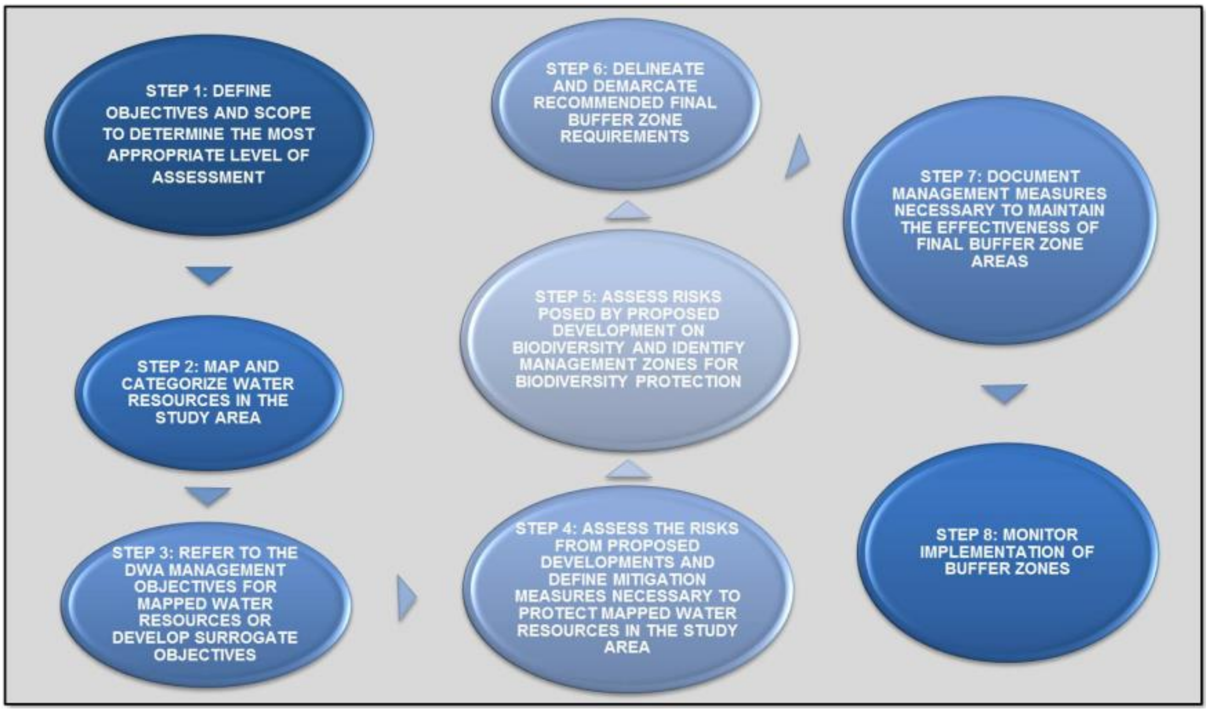
BUFFER DETERMINATION

Macfarlane and Bredin (2016) developed an approach for determining buffer zones, and the current Water Research Commission guideline document that is available is "*Buffer zone guidelines for rivers, wetlands and estuaries. Part 1: Technical Manual*" and "*Part 2: Practical Guide*". This approach has been identified by the DWS as a preferred method for determining buffer zones. It supports the assessment of key attributes rather than the use of a standard distance buffer zone. The following criteria are considered for determining buffer zones:

- Threats associated with the development;
- Climatic conditions in the region (i.e. mean annual precipitation and rainfall intensity);
- Sensitivity of the wetland, riparian areas and drainage lines (i.e. in terms of the water resource and biodiversity); and
- Site specific characteristics of the proposed buffer zone (i.e. slope, vegetation density (during construction and operational phases of the development), soil characteristics, etc.).

The buffer zones of the wetlands were assessed using the technical and practical manuals (Macfarlane and Bredin 2016).

An eight-step assessment procedure (as below) provides the user with a step-by-step approach to determine appropriate buffer zones. The assessment procedure, as well as the management practices that need to be taken into consideration, provide the guidelines for determining and managing appropriate buffer zones. Developed in conjunction with this report, Buffer Zone Tools on spreadsheets provide the user with the primary tools for determining appropriate buffer zones in connection with rivers, wetlands and estuaries.



APPENDIX A-8

GENERIC WETLAND REHABILITATION METHODS (WATER WISE & RAND WATER: WETLAND REHABILITATION)

Methods of rehabilitating wetlands:

- Blocking drainage channels that drain water from or divert polluted water to the wetland, with gabions or earthen plugs; Placing plugs in gullies, to help with bank and soil stabilisation;
- Fencing off sensitive areas to keep grazers out and fence off areas that have been disturbed and need time for vegetation to re-establish;
- Planting of vegetation to stabilise the soil;
- Filling in and compacting gullies with soil from other areas;
- Plug channels to restore or create wetlands. These can also be used to stabilise and raise the channel floors, thereby reducing velocity;
- Cement structures such as a cement head cut repair. This assists in reducing water velocity and helps reduce erosion and contain the headcut. Another option is a cement head-cut repair this creates a type of settling pond which reduces the speed at which the water flows through the wetland. It also creates an area where settlement can occur.
- Gabion structures which assist in bank and soil stabilisation, reducing erosion and decreasing the speed of water flow. They also provide an area for vegetation to establish.
- Insertion of grass bales, these help bind soil and slow the rate at which water travels. The slower the water flow, the lower the erosive power of water. Binding and stabilising soil prevents the soil from being washed downstream. The insertion of grass bales creates a backflow of water back into the wetland, pushing the water outwards to create a marshy area. Protect them from veld fires. They will degrade over time.
- These methods will help wetland plants re-establish themselves. Wetland and riverbank plants are vital for preventing erosion; they play a crucial role in the purification of water, reduce the severity of floods and regulate water especially during droughts.

The following are a set of general rehabilitation ideas that can be used in stabilising the soil and restoring the water flow of the wetland:

- **Drain reclamation**: Drains and gullies lower the water table and dry out the wetland. They produce excess sediment that affects the wetland below. It is important to stabilise gully sides and also to stop the vertical erosion in the gully. This prevents the further lowering of the water table. Materials that can be used are herbaceous or woody plants, hay bales, clay plugs, gabions filled with rock, a geo-textile lining`, soil, or even just packing loose rock against head-cut faces.
- **Stabilise the river banks**: Plants are the best and cheapest solution to solving riverbank erosion. For shallow slopes a large variety of herbaceous plants with a dense surface root mat and ground cover are effective for stabilising the soil that can erode rapidly. Examples include papyrus, bulrushes, reeds, sedges and couch grass. Herbaceous plants protect against scouring of riverbeds and wetlands increasing soil stabilisation. Herbaceous plants absorb the energy of fast flowing water rather than reflecting it, slowing it down so it does not cause erosion. Other erosion control measures include mesh mats made of either coir or sisal. These mats help stabilise banks and help vegetation to establish. In approved areas Vetiver grass can also be used. Plants or grass used to stabilise banks must be planted in rows along the contour lines in order for them to be effective in

reducing soil erosion. Herbaceous cover plants are ideal for shallow banks and gentle slopes but for steeper slopes indigenous trees (suitable for riparian zones) are a better option as their roots reach deep down and stabilise the soil. For rehabilitation it is important to select and correctly place plants with vigorous rooting growth characteristics that will accelerate natural plant succession and deal directly with the problem on site. Look around and see what indigenous species are growing in the area you are about to rehabilitate; it is always best to use local plant species.

Appendix B

RISK MATRIX ASSESSMENT

RISK MATRIX (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocol)

NAME and REGISTRATION No of SACNASP Professional member: Colin Holmes Reg no. 400384/14

Risk to be scored for construction and operational phases of the project. MUST BE COMPLETED BY SACNASP PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE.

					Severity																			
No.	**Phases**	**Activity**	**Aspect**	**Impact**	**Flow Regime**	**Physico & Chemical (Water Quality)**	**Habitat (Geomorph + Vegetation)**	**Biota**	**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Frequency of activity**	**Frequency of impact**	**Legal Issues**	**Detection**	**Likelihood**	**Significance**	**Risk Rating**	**Confidence level**	**Control Measures**	**Borderline LOW MODERATE Rating Classes**	**PES AND EIS OF WATERCOURSE**
1	Construction	Proposed SO2 System	Clearing of significantly degraded vegetation and excavations, infilling associated with the construction activities within the 'dirty' area of the Smelter	Increase runoff sediment input that may potentially enter the CVB unit.	0	0	0	0	0	1	1	2	1	1	5	1	8	16	L	80	Please refer to Table 9 within the Report: *31102_Anglo American Polokwane Smelters SO2 Abatement_Freshwater Habitat Impact Assessment_Draft Report_20170518*	-	PES = C; EIS = Moderate
			Stormwater management	Alterations of flow patterns	3	0	0	0	0.75	1	1	2.75	3	1	5	1	10	27.5	L	90		-	
	Operation		Stormwater management	Scouring/erosion due to concentrated flows	0	0	0	0	0	1	1	2	1	2	5	1	9	18	L	80		-	
																						-	
2	Construction	Construction of road infrastructure	Clearing of vegetation and excavations, infilling associated with the construction activities.	Decreased roughness, Increased runoff (volume and velocity), Increased sediment input, Soil compaction, Potential oil spills and waste entering the CVB	3	3	2	1	2.25	1	2	5.25	1	2	5	1	9	47.25	L	90		-	
			Hydrocarbons emanating from construction vehicles	Hydrocarbons entering the natural system	0	2	0	2	1	1	2	4	3	2	5	3	13	52	L	90		-	
	Operation		Stormwater management	Scouring/erosion due to concentrated flows	1	1	1	1	1	1	1	3	1	1	5	2	9	27	L	90		-	
																						-	