Wetland Assessment of the Tweefontein Optimisation Project Amendment (TOPA)

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INDEMNITY AND CONDITIONS RELATING TO THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and Wetland Consulting Services (Pty.) Ltd. and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

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1. BACKGROUND INFORMATION

Wetland Consulting Services (Pty.) Ltd. (WCS) was appointed by Clean Stream Environmental Consultants (CSEC) to compile a specialist wetland assessment report for the proposed Tweefontein Optimisation Project Amendment application. The proposed amendment includes expansions to both underground and opencast mining within the Tweefontein Mineral Rights Area (MRA), as well as changes and additions to the associated infrastructure.

WCS has previously undertaken a number of wetland studies for Tweefontein, including most recently the following:

- 2012 – Ecological assessment of the Tweefonteinspruit for the proposed Tweefonteinspruit Clean-up Project
- 2012 – Specialist wetland delineation and assessment for the proposed Tweefontein Water Treatment Plant
- 2009 - Specialist wetland delineation and assessment for the Tweefontein Optimisation Project

The purpose of this document is to describe the wetlands within the study area, to identify expected impacts on the wetlands due to the proposed TOPA and to provide recommendations regarding appropriate mitigation and/or management measures to be implemented should the proposed activities be authorised.

Use was made of existing information from the above mentioned reports, though additional field work was undertaken to ensure improved accuracy of the wetland delineation and that all assessments reflect the current conditions on site.

2. SCOPE OF WORK

The following tasks formed part of the agreed upon scope of work:

Baseline Assessment:

- Review of existing available data;
- Verify and improve the delineation and classification of all the wetlands within the study area;
- Functional Assessment of all the wetlands identified;
- Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of wetland ecosystems on site using WET-Health (Macfarlane et al, 2009) and the DWA scoring system (DWAF, 1999) respectively; and
- Compilation of all the findings in a specialist report.

Impact Assessment:

- Identify all the impacts on wetland ecosystems resulting from the proposed developments;

- Evaluate all identified impacts based on a significance rating scale embracing notions such as extent, magnitude, duration and significance of impacts;
- Recommend suitable mitigation and management measures, where applicable, to minimise any potential impacts; and
- Provide a comprehensive impact assessment report detailing all the information.

3. LIMITATIONS & ASSUMPTIONS

Field work for this current study was undertaken during May 2012 and July 2012. No additional biodiversity surveys of the wetland were undertaken as part of the current survey, which was undertaken during the dry season. Use was made of substantial existing information which was deemed more than adequate for the purpose of this report.

Due to the scale of the remote imagery used (1:10 000 orthophotos and Google Earth Imagery), as well as the accuracy of the handheld GPS unit used to delineate wetlands in the field, the delineated wetland boundaries cannot be guaranteed beyond an accuracy of about 20m on the ground. Should greater mapping accuracy be required, the wetlands would need to be pegged in the field and surveyed using conventional survey techniques.

The assessment of the proposed amendments is based on the description and locations of these amendments as provided in this report.

4. STUDY AREA

The Tweefontein MRA, the study area for this wetland assessment, is located immediately to the east of Ogies in the Mpumalanga Province. The N12 Johannesburg to eMalahleni Highway traverses the northern reaches of the study area.

The study area covers approximately 11 787 hectares.

The location and extent of the study area is illustrated in Figure 1 below.

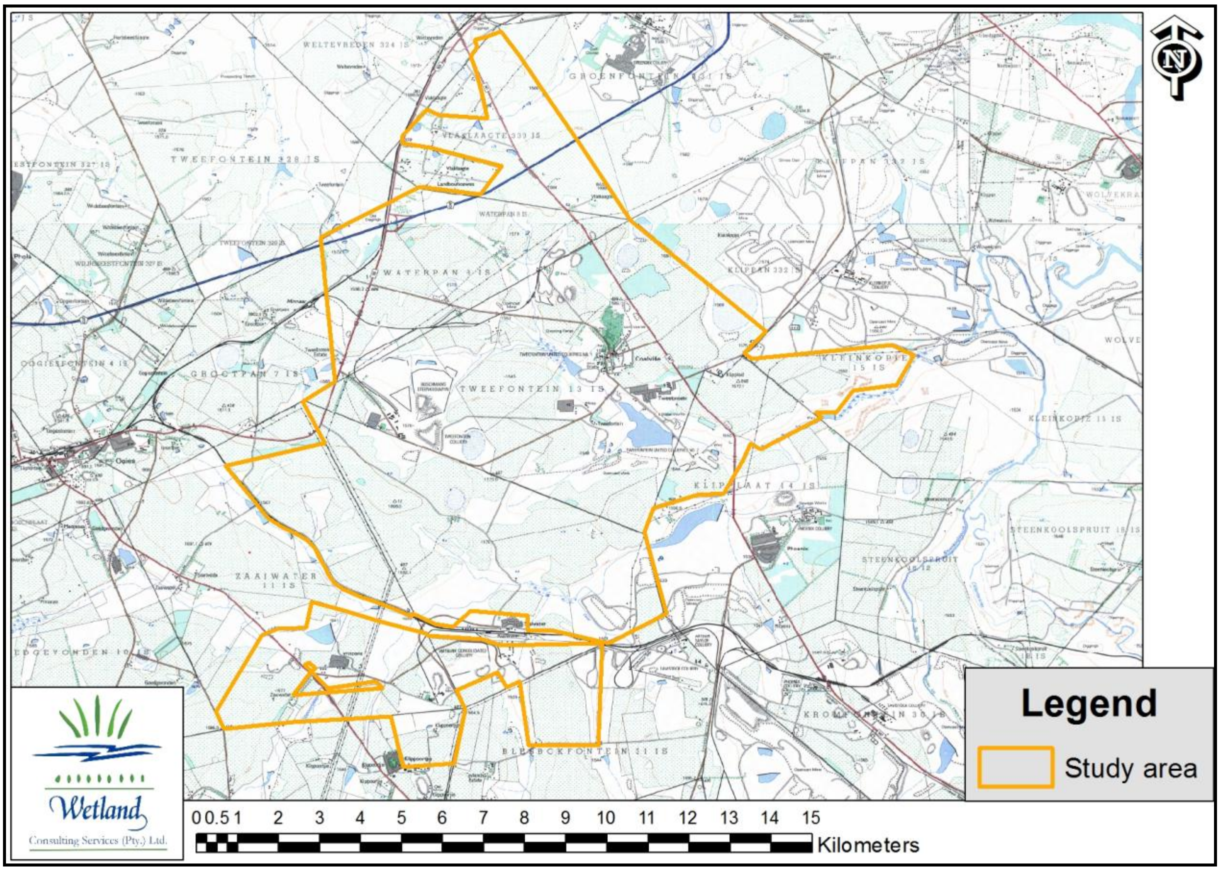


Figure 1. Map showing the location and extent of the TOPA study area.

4.1 Catchments

The study area is located within the Olifants River Catchment (Primary Catchment B), with three quarternary catchments affected, namely B11F, B11G and B20G. The majority of the study area is located within catchment B11F, which is drained by the Tweefonteinspruit and its tributaries, the Zaaiwaterspruit and Klippoortjiespruit.

Information on the catchment size, mean annual rainfall and runoff for the quaternary catchment is provided in the table below (Middleton, B.J., Midgley, D.C and Pitman, W.V., 1990). The low percentages of mean annual precipitation ending up as run-off out of the catchments (ranging from 4.96 % to 6.59 %) indicates that large volumes of water are retained within the catchments and are available to support wetland habitats.

Table 1. Table showing the mean annual precipitation, run-off and potential evaporation per quaternary catchment (Middleton, B.J., Midgley, D.C and Pitman, W.V., 1990).

Quaternary Catchment	Catchment Surface Area (ha)	Mean Annual Rainfall (MAP) in mm	Mean Annual Run-off (MAR) in mm	MAR as a % of MAP
B 11 F	38 643	691.6	34.3	4.96 %
B 11 G	33 155	692.5	35.8	5.17 %
B 20 G	47 059	669.3	44.1	6.59 %

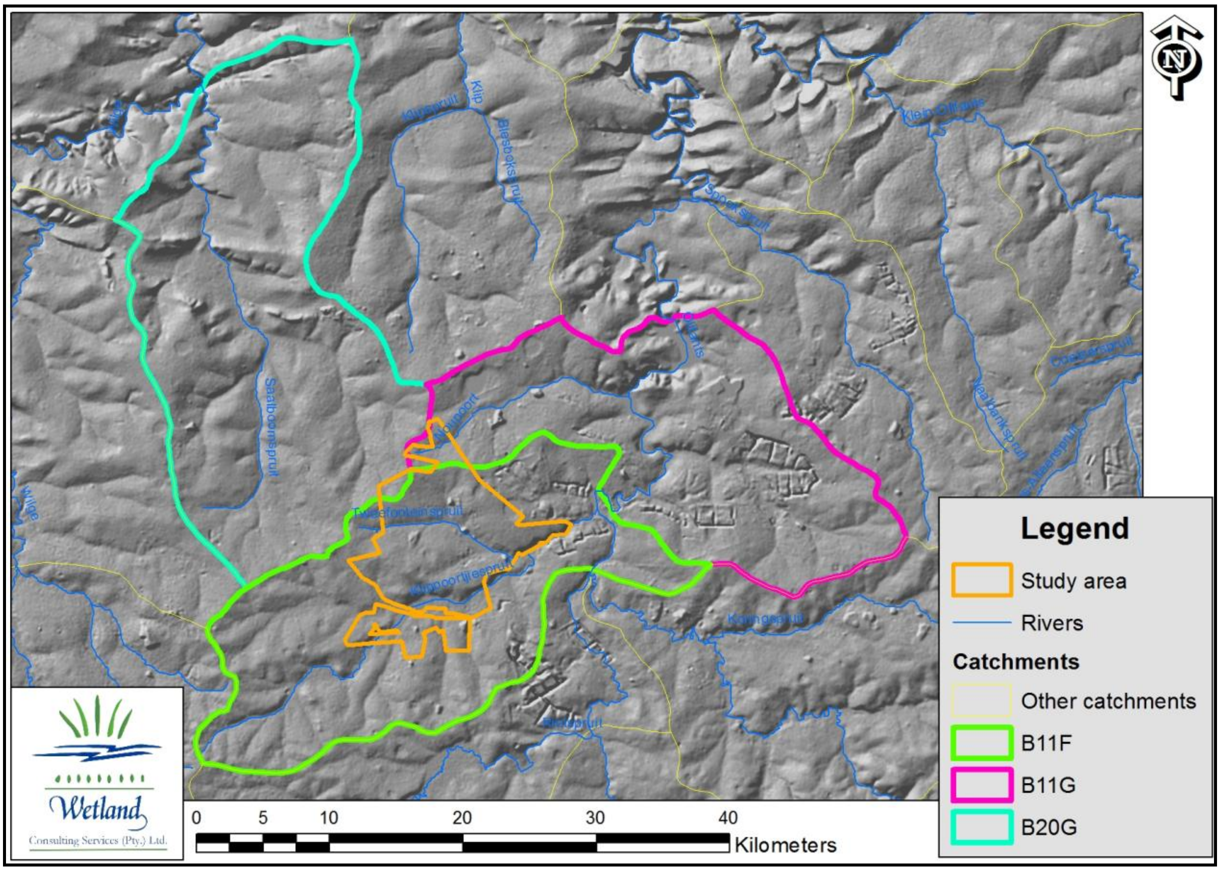


Figure 2. Map showing the study area in relation to the quaternary catchment.

4.2 National Freshwater Ecosystem Priority Areas

The recently published Atlas of Freshwater Ecosystem Priority Areas in South Africa (Nel *et al*, 2011) (The Atlas) which represents the culmination of the National Freshwater Ecosystem Priority Areas project (NFEPA), a partnership between the South African National Biodiversity Institute (SANBI), the Centre for Scientific and Industrial Research (CSIR), the Water Research Commission (WRC), Department of Environment (DEA), Department of Water (DWA), World Wide Fund For Nature (WWF), South African Institute for Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks), provides a series of maps detailing strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. Freshwater Ecosystem Priority Areas (FEPA's) were identified through a systematic biodiversity planning approach that incorporated a range of biodiversity aspects such as ecoregion, current condition of habitat, presence of threatened vegetation, fish, frogs and birds, and importance in terms of maintaining downstream habitat. The Atlas incorporates the National Wetland Inventory (SANBI, 2011) (NWI) to provide information on the distribution and extent of wetland areas. An extract of the NFEPA database is illustrated in Figure 3 below.

From Figure 3 it is clear that the Atlas indicates numerous wetlands falling within the study area, including FEPA wetlands associated with the Zaaiwaterspruit wetland system and its tributaries. The wetland data base included in the FEPA study is known to be incomplete and is based on currently available/published data. An example of such an inaccuracy is the classification of the upstream Zaaiwaterspruit wetlands (within the Goedgevonden Mineral Rights Area) as a FEPA even though the majority of these wetlands have already been lost to opencast mining and replaced by 2 large river diversions. A WRC funded project is currently underway to revise and update the NFEPA data for the Mpumalanga Highveld area, with targeted completion by the end of 2013.

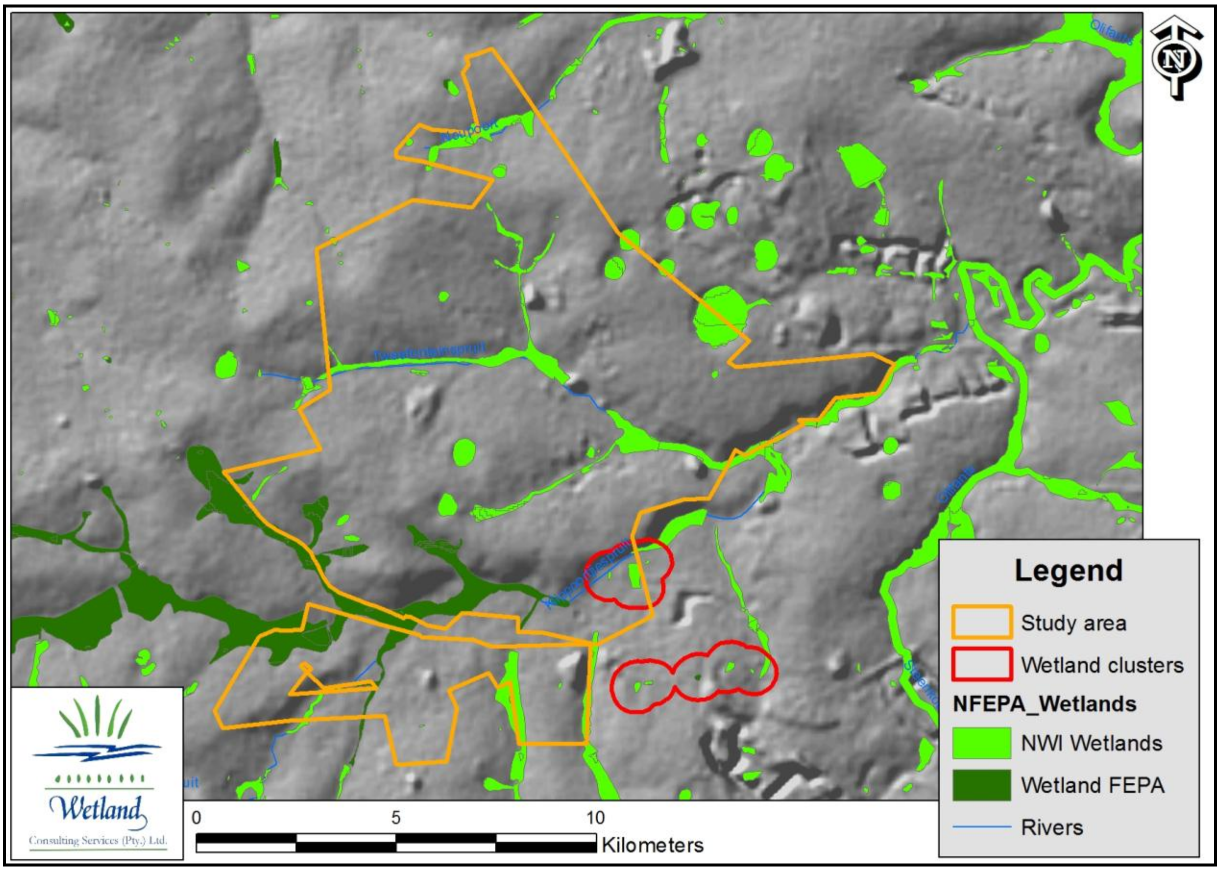


Figure 3. Extract of the Atlas of Freshwater Ecosystem Priority Areas in South Africa (Nel *et al*., 2011).

4.3 Vegetation

A number of vegetation classification systems have been compiled for South Africa. Initially Acocks (1953) classified the vegetation as being of the Bankenveld vegetation type. Low and Rebelo (1996) classified the vegetation of the area as Moist Sandy Highveld Grassland. According to the most recent vegetation classification of the country however, "*The Vegetation of South Africa, Lesotho and Swaziland*" (Mucina and Rutherford, 2006), the study area falls within the Grassland Biome, Mesic Highveld Grassland Bioregion Bioregion. At a finer level, the study area is classed as Eastern Highveld Grassland, though the larger pans of the area have been classified as Eastern Temperate Freshwater Wetlands vegetation type.

Eastern Highveld Grassland is mostly confined to Mpumalanga and western Swaziland, occurring marginally as well into Gauteng. The conservation status of this vegetation type is considered **Endangered** by Mucina & Rutherford (2006), and whilst the conservation target is 24%, only a small fraction (<1%) is currently protected and 44% is considered to be transformed, mostly by cultivation, forestry, mines, dams and urbanisation. According to the ***National List of Ecosystems***

that are Threatened and in Need of Protection (GN 1002 of 2011) the vegetation type is considered as <u>Vulnerable</u>. Typical species composition is as follows (Mucina & Rutherford 2006):

Graminoids: *Andropogon appendiculatus* (d), *Brachiaria serrata* (d), *Digitaria monodactyla* (d), *D. tricholaenoides* (d), *Elionurus muticus* (d), *Eragrostis capensis* (d), *E. chloromelas* (d), *E. plana* (d), *E. racemosa* (d), *Harpochloa falx* (d), *Heteropogon contortus* (d), *Microchloa caffra* (d), *Panicum natalense* (d), *Setaria nigrirostris* (d), *S. sphacelata* (d), *Themeda triandra* (d), *Trichoneura grandiglumis* (d), *Tristachya leucothrix* (d), *Abilgaardia ovata*, *Andropogon schirensis*, *Aristida bipartita*, *A. congesta*, *A. junciformis* subsp. *galpinii*, *A. stipittata* subsp. *graciliflora*, *Bulbostylis contexta*, *Chloris virgate, Cymbopogon caesius, C. pospischilii, Cynodon dactylon, Digitaria diagonalis, D. ternate, Diheteropogon amplectens, Eragrostis curvula, Koeleria capensis, Panicum coloratum*, and *Setaria incrassata*.

<u>Herbs</u>: *Berkheya setifera* (d), *Vernonia natalensis*, *V. oligocephala* (d), *Acalypha peduncularis, A. wilmsii, Berkheya insignis, B. pinnatifida, Crabbea acaulis, Cynoglossum hispidum, Dicoma anomala, Haplocarpha scaposa, Helichrysum caespititium, H. rugulosum, Hermannia coccocarpa, H. depressa, H. transvaalensis, Ipomoea crassipes, I. oblongata, Jamesbrittenia silenoides, Pelargonium luridum, Pentanisia prunelloides* subsp. *latifolia, Peucedanum magalismontanum, Pseudognaphalium luteo-album, Rhynchosia effusa, Salvia repens, Schistostephium crataegifolium, Sonchus nanus*, and *Wahlenbergia undulata*.

<u>Geophytic herbs</u>: *Gladiolus crassifolius, Haemanthus humilis* subsp. *hirsutus, Hypoxis rigidula* var. *pilosisima* and *Ledebouria ovatifolia*.

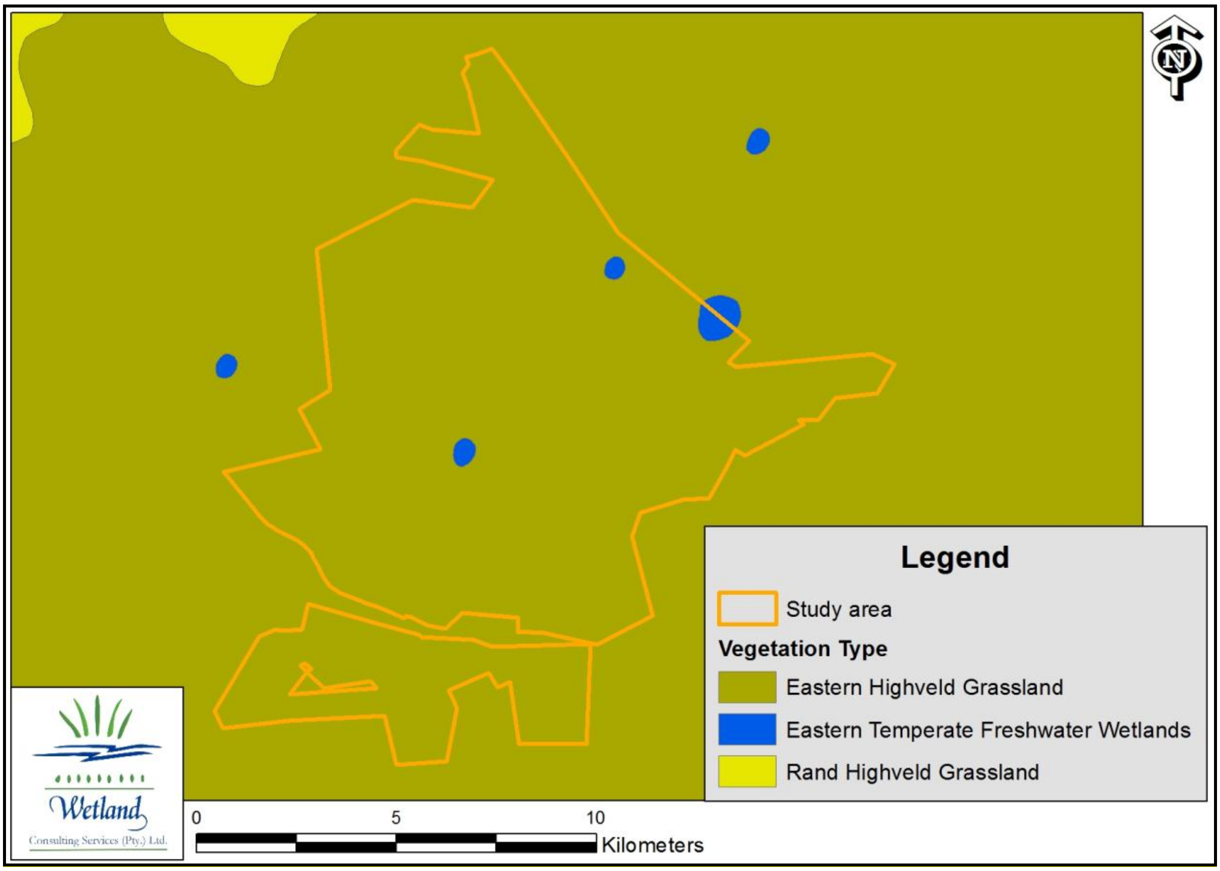


Figure 4. Map showing the vegetation of the area.

The Atlas of Freshwater Ecosystem Priority Areas in South Africa (Nel *et al*, 2011a) identified 791 wetland ecosystem types in South Africa based on classification of surrounding vegetation (taken from Mucina and Rutherford, 2006) and hydro-geomorphic (HGM) wetland type; seven HGM wetland types are recognised and 133 wetland vegetation groups. Based on this classification, the following wetland vegetation types are indicated as occurring on site:

- Mesic Highveld Grassland Group 4_Channelled valley bottom wetland
- Mesic Highveld Grassland Group 4_Depression
- Mesic Highveld Grassland Group 4_Flat
- Mesic Highveld Grassland Group 4_Floodplain wetland
- Mesic Highveld Grassland Group 4_Seep
- Mesic Highveld Grassland Group 4_Unchannelled valley bottom wetland
- Mesic Highveld Grassland Group 4_Valleyhead seep

The National Biodiversity Assessment 2011: Freshwater Component (Nel *et al*., 2011b) undertook an ecosystem threat status assessment for each of the 791 wetland ecosystem types where each wetland ecosystem type was assigned a threat status based on wetland type as well as on wetland vegetation group. A summary of the findings for the 3 wetland ecosystem types expected to occur on site is provided in Table 2 below.

Table 2. Summarised findings of the wetland ecosystem threat status assessment as undertaken by the National Biodiversity Assessment 2011: Freshwater Component (Nel *et al*., 2011b) for wetland ecosystems recorded on site.

Wetland Ecosystem Type	Wetland HGM Type (WT)	Threat Status of WT	Protection level of WT	Wetland Vegetation Group (WVG)	Threat Status of WVG
Mesic Highveld Grassland Group 4_Channelled valley bottom wetland	Channelled valley bottom	CR	Hardly protected	Mesic Highveld Grassland	CR
Mesic Highveld Grassland Group 4_Depression	Depression	CR	Hardly protected	Mesic Highveld Grassland	CR
Mesic Highveld Grassland Group 4_Flat	Flat	CR	Zero protection	Mesic Highveld Grassland	CR
Mesic Highveld Grassland Group 4_Floodplain wetland	Floodplain	CR	Zero protection	Mesic Highveld Grassland	CR
Mesic Highveld Grassland Group 4_Seep	Seep	EN	Zero protection	Mesic Highveld Grassland	CR
Mesic Highveld Grassland Group 4_Unchannelled valley bottom wetland	Unchannelled valley bottom	CR	Zero protection	Mesic Highveld Grassland	CR
Mesic Highveld Grassland Group 4_Valleyhead seep	Valleyhead seep	CR	Zero protection	Mesic Highveld Grassland	CR

CR = Critically Endangered, implying area of wetland ecosystem type in good (A or B) condition ≤ 20% of its original area
EN = indicates Endangered, area of wetland ecosystem type in good condition ≤ 35% of its original area

From the above table it is clear that the wetland ecosystem types represented within the TOPA study area are all considered Critically Endangered in terms of both the wetland vegetation group they fall into, and the wetland types (except for seeps, which are considered Endangered) that they represent.

5. APPROACH

5.1 Wetland Delineation and Classification

The National Water Act, Act 36 of 1998, defines wetlands as follows:

> *"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."*

The presence of wetlands in the landscape can be linked to the presence of both surface water and perched groundwater. Wetland types are differentiated based on their hydro-geomorphic (HGM) characteristics; i.e. on the position of the wetland in the landscape, as well as the way in which water moves into, through and out of the wetland systems. A schematic diagram of how these wetland systems are positioned in the landscape is given in the figure below.

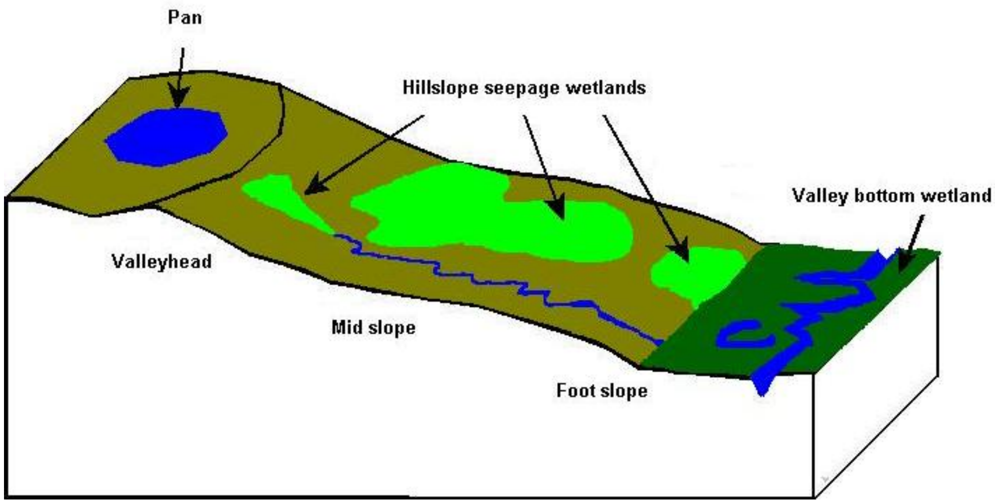


Figure 5. Diagram illustrating the position of the various wetland types within the landscape.

Use was made of 1:50 000 topographical maps, 1:10 000 orthophotos and Google Earth Imagery to create digital base maps of the study area onto which the wetland boundaries could be delineated using ArcMap 10. A desktop delineation of suspected wetland areas was undertaken by identifying rivers and wetness signatures on the digital base maps. All identified areas suspected to be wetlands were then further investigated in the field.

Wetlands were identified and delineated according to the delineation procedure as set out by the "*A Practical Field Procedure for the Identification and Delineation of Wetlands and Riparian Areas*" document, as described by DWAF (2005) and Kotze and Marneweck (1999). Using this procedure, wetlands were identified and delineated using the Terrain Unit Indicator, the Soil Form Indicator, the Soil Wetness Indicator and the Vegetation Indicator.

For the purposes of delineating the actual wetland boundaries use was made of indirect indicators of prolonged saturation, namely wetland plants (hydrophytes) and wetland soils (hydromorphic soils), with particular emphasis on hydromorphic soils. It is important to note that under normal conditions hydromorphic soils must display signs of wetness (mottling and gleying) within 50cm of the soil surface for an area to be classified as a wetland (*A practical field procedure for identification and delineation of wetlands and riparian areas*, DWAF).

The delineated wetlands were then classified using a hydro-geomorphic classification system based on the system proposed by Brinson (1993), and modified for use in South African conditions by Marneweck and Batchelor (2002).

5.2 Functional Assessment

A functional assessment of the wetlands on site was undertaken using the level 2 assessment as described in "Wet-EcoServices" (Kotze et al., 2007). This method provides a scoring system for establishing wetland ecosystem services. It enables one to make relative comparisons of systems based on a logical framework that measures the likelihood that a wetland is able to perform certain functions.

5.3 Present Ecological State and Ecological Importance & Sensitivity

A present ecological state (PES) and ecological importance and sensitivity (EIS) assessment was conducted for the entire Tweefonteinspruit valley bottom wetland using the methodology described by Macfarlane et al. (2009) in the WET-Health document.

6. FINDINGS

6.1 Wetland Delineation

Numerous wetlands, linked to the presence of both surface water and perched groundwater, were identified within the study area. Four types of natural wetlands systems, differentiated on the basis of their hydro-geomorphic (HGM) characteristics occur within the study area, namely:

- Channelled valley bottom wetlands;
- Unchannelled valley bottom wetlands;
- Hillslope seepage wetlands; and
- Pans/Depression wetlands.

Wetlands cover approximately 3 486.4 ha of the study area, equal to just over 29.5 % of the surface area of the site.

Table 3. Table indicating the extent of the various wetland types found within the study area.

Wetland Type	Area (ha)	% of wetland area	% of study area
Channelled valley bottom	106.62	3.06%	0.90%
Unchannelled valley bottom	480.28	13.78%	4.07%
Hillslope seepage	2634.35	75.56%	22.35%
Pan	139.67	4.01%	1.18%
Dam	125.47	3.60%	1.06%
TOTAL	**3486.39**	**100.00%**	**29.58%**

The wetland systems within the study area can be grouped into 4 main systems (Figure 7):

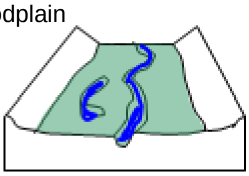
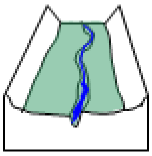
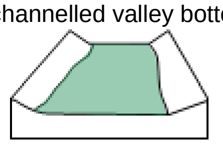
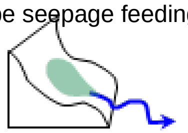
Noupoortspruit wetland system: Occurs in the far north of the study area north of the N12 and consists of the extreme upper reaches of the Noupoortspruit. On site the systems is characterised by a large hillslope seepage wetland draining towards the east.

Tweefonteinspruit wetland system: This forms the main wetland systems within the study area and occupies most of the central regions of the study area. The Tweefonteinspruit feeds into the Tweefontein Dam and then drains east off the study area and forms a tributary of the Olifants River. Characterised by a large unchannelled valley bottom wetland dominated by *Typha capensis* and *Phragmites australis* reed beds, as well as extensive hillslope seepage wetlands that feed into the valley bottom wetlands. This system has been significantly impacted by long-term mining activities within the catchment.

Zaaiwaterspruit wetland system: This wetland system enters the study area from the west, where the wetland originates in the Khutala and Goedgevonden mining areas. Large river diversions characterised these upper reaches. On site the drains from west to east within the southern portion of the site roughly parallel to the railway line. A broad mostly unchannelled wetland system with associated tributaries and hillslope seepage wetlands. Many of the southern tributaries are heavily impacted by mining and a number of further river diversions occur in this area, though outside the Tweefontein study area. This wetland system was classified as a FEPA.

Pan wetlands: 11 pan wetlands of varying sizes and hydroperiods fall within, or partially within, the Tweefontein study area.

Table 4. The definition of the different wetland units recorded during the study in relation to type, topographic setting and hydrological components (table and classification modified from Marneweck and Batchelor, 2002; Brinson, 1993).

Hydro-geomorphic types	**Description**	**Source of water maintaining the wetland**	
		Surface	**Sub-surface**
Floodplain 	Valley bottom areas with a well defined stream channel, gently sloped and characterized by the alluvial transport and deposition of material by water, and oxbow depressions and/or other characteristic floodplain features such as natural levees.	***	*
Channelled valley bottom 	Valley bottom areas with a well defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the alluvial transport and deposition of material by water or may have steeper slopes and characterized by the loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	***
Unchannelled valley bottom 	Valley bottom areas of low relief, alluvial sediment deposition and having no clearly defined stream channel. Water inputs mainly from channel entering the wetland and also from adjacent slopes.	***	*/ ***
Hillslope seepage feeding a stream 	Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs mainly from subsurface flow and outflow via a well defined channel.	*	***
Hillslope seepage not feeding a stream 	Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs mainly from subsurface flow and outflow either very limited or through diffuse subsurface and/or surface flow	*	***
Depression (includes Pans) 	A basin shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent.	*/ ***	***

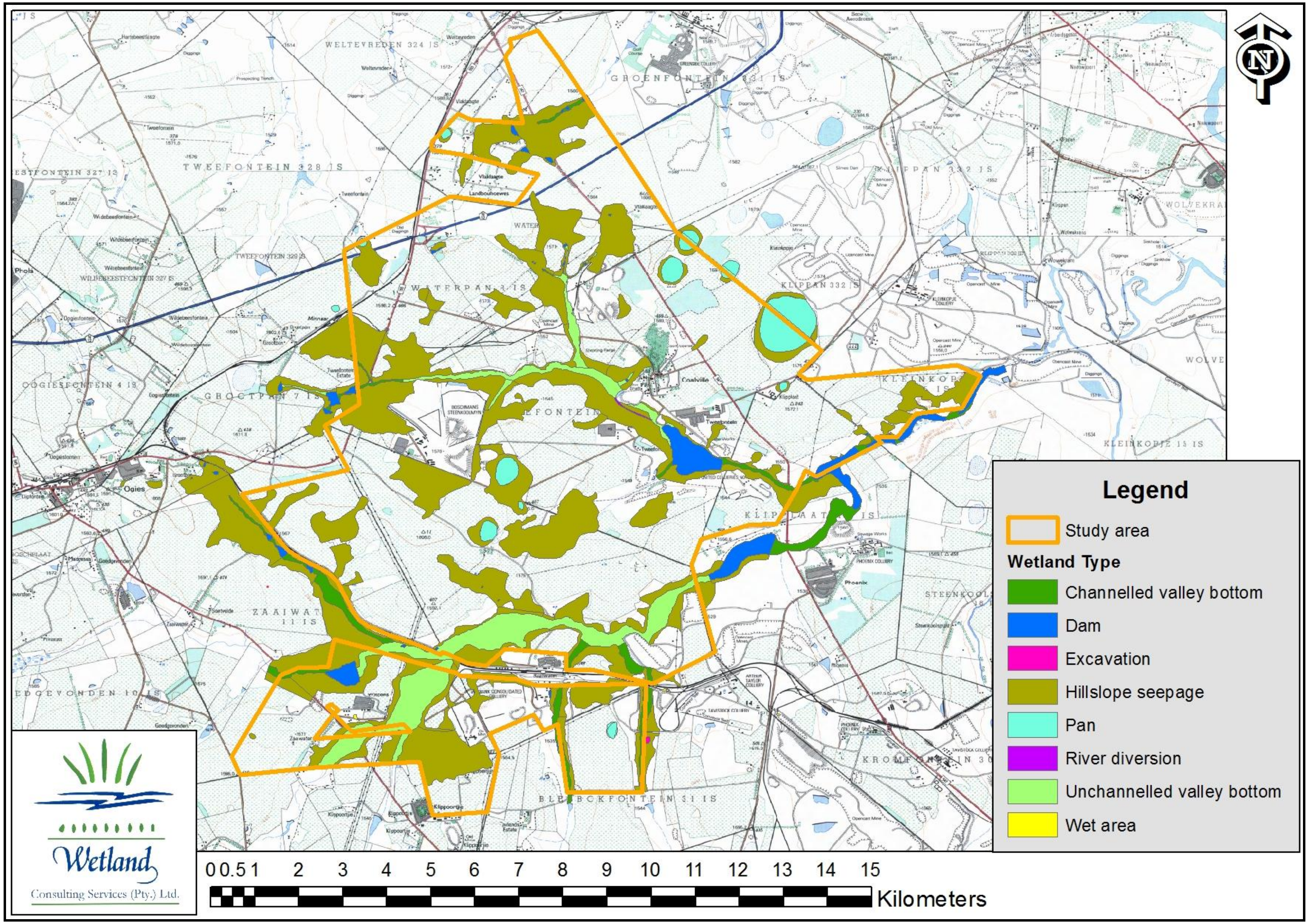


Figure 6. Map of the delineated wetlands within the TOPA study area.

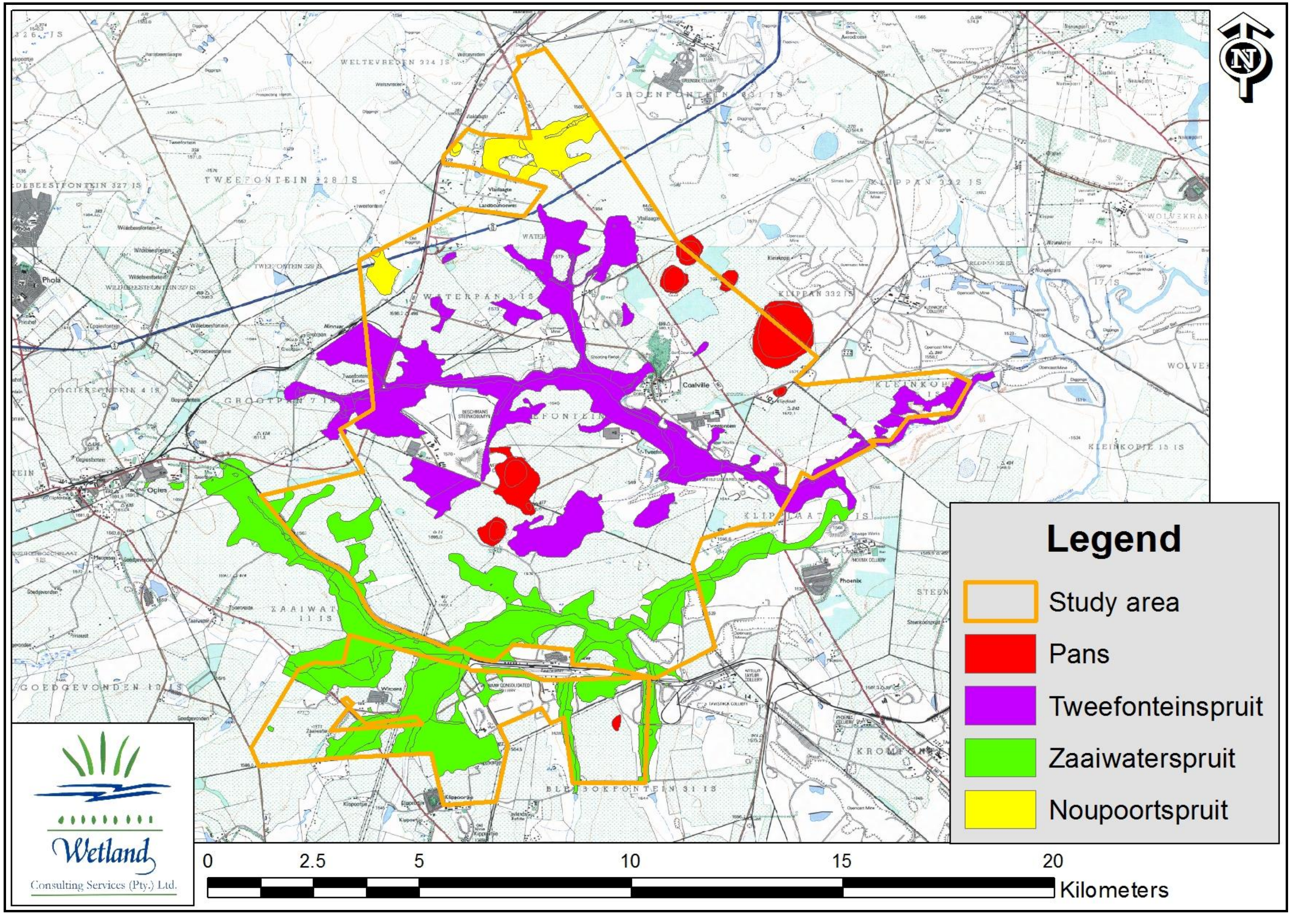


Figure 7. Map of the 4 wetland systems identified on site.

The wetland extent in the TOPA study area, as well as on the highveld in general, is dominated by extensive hillslope seepage wetlands which make up over 75 % of the wetland habitat within the study area. These seepage wetlands tend to be characteristically seasonal to temporary wetlands (i.e. implying temporary to seasonal saturation of the soil profile) that are maintained by shallow perched water within the soil profile. The perched water table is derived and maintained from rainfall that infiltrates the soil profile *within the wetland and its catchment* and is prevented from deeper infiltration by an aquitard within the soil profile, usually a hard or soft plinthic layer.

The hillslope seepage wetlands support a mixture of grass and sedge species and often represent the only remaining areas of natural grassland within a landscape largely altered by cultivation and are thus important for maintaining biodiversity. As these habitats represent an ecotone between the aquatic and terrestrial habitats they are, in an undisturbed state, typically the most species diverse wetland habitats on site. The seasonal saturation of the soil profile as well as the generally shallow nature of the soils within the seepage wetlands render them unsuitable for cultivation, though the more temporary edges are often cultivated. The dense grass cover of these wetlands, together with the shallow soils, suggests that these wetlands lose large volumes of water to evapotranspiration, though they are still expected to play an important role in contributing generally clean water to adjacent valley bottom and pan wetlands, though the flow contribution of individual wetlands is likely to vary greatly.

Valley bottom wetlands, both channelled and unchannelled, are the next most extensive wetland types recorded on site, together making up roughly 17 % of the wetland area. Two large valley bottom wetlands dominate on site, namely the Tweefonteinspruit and its tributary the Zaaiwaterspruit.

The Tweefonteinspruit valley bottom wetland originates in an agricultural landscape from the base of a number of hillslope seepage wetlands on the Farm Grootpan just to the west of the study area. Most of the Tweefonteinspruit and its Waterpan tributary have been classified as unchannelled, and are currently dominated by stands of *Typha capensis* and *Phragmites australis* reeds, though this is interpreted as a response to increased water inputs, increased sedimentation and nutrient enrichment within the wetland and is not expected to have been the case under natural conditions. Channelisation of the wetland has occurred in the vicinity of the R555 road crossing, most likely as a result of flow concentration through the road and railway crossing culverts, and again downstream of the Tweefontein Dam. After passing underneath the R555, and 350m further on the railway line, the wetland enters an area of active mining activity. Boschmans Plant and discard dump are located on the southern banks of the wetland, with the return water dams and pollution control dams located immediately adjacent the reed bed in the valley bottom wetland and with spillways discharging into the wetland. On the northern banks and extending right up to the confluence with the Waterpan tributary, active opencast mining is taking place and extends in places right into the valley bottom wetland and it appears as though seepage from the wetland into the opencast pits is taking place. Downstream of the confluence with the Waterpan tributary a discard dump, Dump 1A, is located virtually right across the valley bottom wetland with the water flow diverted via a narrow trench around the base of the dump. Dump 1B is a second small discard dump located slightly further downstream and immediately below a haul road crossing over the wetland. Below Dump 1B the Tweefonteinspruit wetland enters the Tweefontein Dam. At the time of the site visits (June and July 2012) water levels within the dam were low (+- 1m below full), though it is understood that the dam usually overflows (pers. com., mine personnel), though water levels are managed through the pumping of water from the Tweefontein Dam to Boschmans Pan for storage and evaporation. The Tweefontein Dam is roughly 70 ha in size and lined by dense *Phragmites australis* reed beds. Extensive salt crusts had formed on the exposed shoreline at the time of the site visit. Below Tweefontein Dam the valley bottom wetland is channelised up to the inflow to Faan's Dam. A second dam occurs immediately below Faan's Dam, shortly where after the confluence with the Olifants River is encountered.

The Zaaiwaterspruit valley bottom wetland originates upslope and to the west of the study area in the Khutala and Goedgevonden mining areas. The wetland enters the study area under the R545 road and immediately enters the Witcons Dam. This is the site of the proposed Tweefontein Water Treatment Plant (WTP) and, if the WTP is approved, treated water will in future be discharged into the wetland immediately below the Witcons Dam. The wetland in this area is predominantly unchannelled and is characterised by large stands of *Typha capensis*. A railway line and haul road cross the wetland before it enters Phoenix Dam. A number of tributaries enter the Zaaiwaterspruit from the south in this reach, with most of these southern tributaries currently having river diversions constructed to allow for opencast coal mining. Before entering Faan's Dam at the confluence with the Tweefonteinspruit, the wetland is crossed by the R547 road.

Eleven pans are located within, or partly within, the study area. One of these pans, Boschmans Pan, is currently being used as a storage and evaporation dam for water pumped from the Tweefontein Dam. The largest of these pans is Makoupan at 118 ha, with the smallest being less than 2 ha.

6.2 Water Quality

A total of 13 samples were collected in June and July 2013 and submitted to the Waterlab laboratory in Pretoria for analysis. As once off sampling is of limited use in assessing the overall water quality of the system, monitoring data was obtained from Tweefontein Colliery to provide an indication of trends in water quality.

The sampling locations are indicated in Figure 7, with the results reproduced in Table 5. Water samples were collected during the dry season in April (Zaaiwaterspruit) and June (Tweefonteinspruit) 2012. Very low flow conditions resulted in less than ideal sampling conditions, with most water samples collected from pools with no visible surface flow, with only samples TFN-5 and WTP-4 collected from obviously flowing water (though flow was minimal).

Samples TFN-US, WTP-US and KPS-1 were collected upstream of the perceived direct impact of mining activities within the Tweefonteinspruit, Waterpan tributary and Klippoortjiespruit respectively. These samples thus represent an estimation of the baseline water quality at the time of sampling as it enters the study area. Although low flow conditions likely resulted in concentration through evapotranspiration, the three upstream samples are the only samples were EC values of below 150 mS/m were recorded (average values for the remaining 10 samples were 385.5 mS/m). Sulphate values were elevated above natural levels at 294, 554 and 49 mg/l, but compared favourably to the average concentration of 2 395 mg/l across the remaining 10 samples. pH of the upstream samples was 7.6 (Tweefonteinspruit), 8.5 (Waterpan) and 7.2 (Klippoortjiespruit).

The results of the remaining samples clearly show the impacts of coal mining activities on water quality with significantly elevated EC, TDS and sulphate levels. This is supported by the long-term sulphate trends observed in monthly monitoring from January 2009 to September 2010 (see graph in Figure 8. Long term pH trends (see graph in Figure 9) from the same period indicate no difference between sampling points upstream and downstream of the mine on the Tweefonteinspruit, with pH values typically fluctuating within a range of around 7.5 to 8.

During the current sampling three samples (TFN-2, TFN-Seep, TFN-5 & ZWS-1) returned significantly acidic pH values, which is of concern. Associated with the low pH levels at sites TFN-2, TFN-5 and ZWS-1 were high Aluminium concentrations of 10, 28 and 12 mg/l respectively. ZWS-1 also had an exceptionally high Fe concentration of 54mg/l. Aluminium, as well as other metals, becomes mobile at low pH, with Aluminium being highly toxic to aquatic organisms. The target water quality range (TWQR) set for Aluminium in the water quality guidelines for aquatic ecosystems (DWAF, 1996) is 0.005 mg/l, with the acute effect value (AEV) set at 0.1 mg/l, for pH values below 6.5. These values are exceeded for samples TFN-2, TFN-Seep, TFN-5, ZWS-1, Bosch-1 and WTP-4). All other samples fall below the AEV with respect to Aluminium.

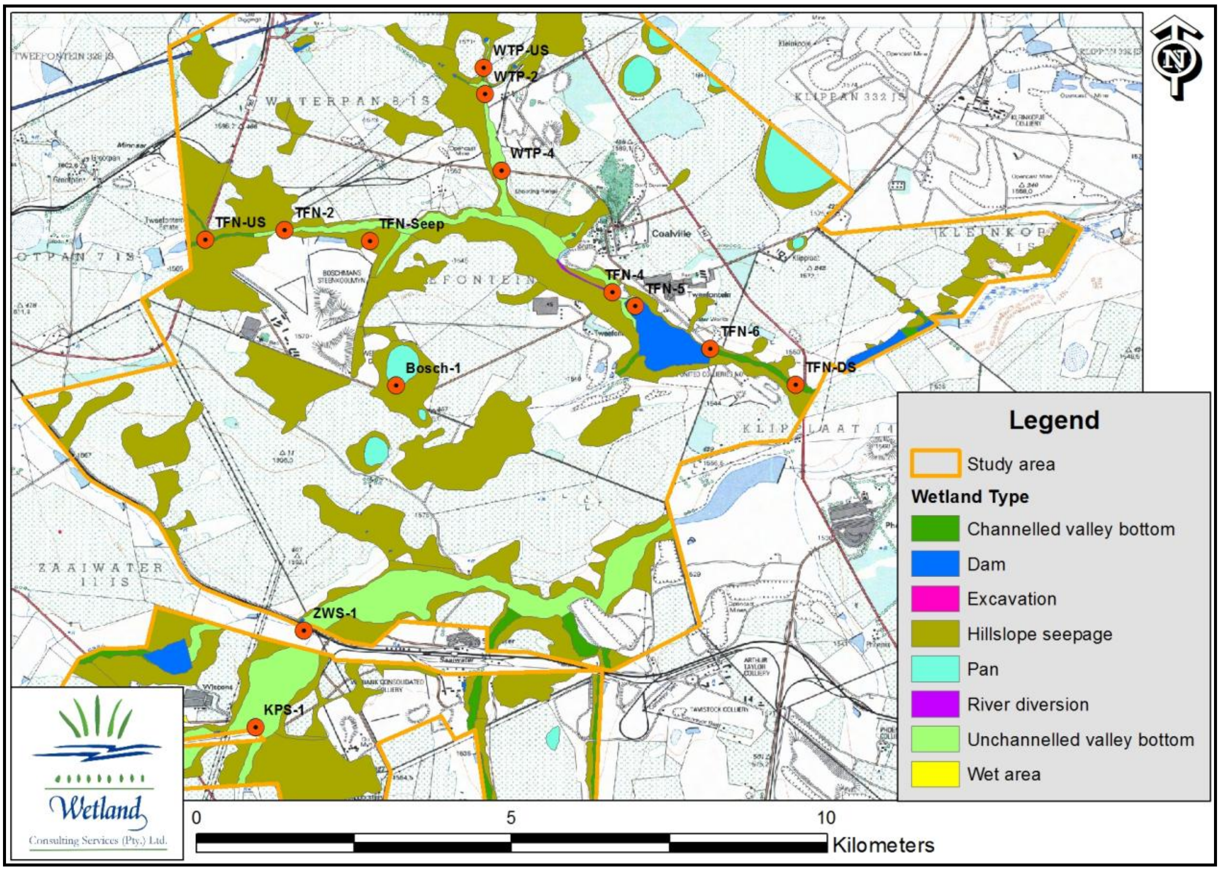


Figure 8. Map showing the location where water samples were collected.

Table 5. Results of the water quality analysis. Only elements where concentrations higher than the detection limits were recorded are shown.

Analyses in mg/ℓ (Unless specified otherwise)	Sample Number										Sample Number		
	TFN-US	**TFN-DS**	**TFN-2**	**TFN-4**	**TFN-5**	**TFN-6**	**TFN-Seep**	**WTP-US**	**WTP-2**	**WTP-4**	**Bosch-1**	**KPS-1**	**ZWS-1**
pH – Value at 25°C	7.6	7.6	4.8	7.5	3.5	8	4.5	8.5	7.2	6.4	8.5	7.2	3.1
Electrical Conductivity in mS/m at 25°C	112	337	619	411	421	315	496	141	220	474	296	41.6	266
Total Dissolved Solids at 180°C *	878	3 568	7 042	4 490	4 620	3 176	5 722	1 134	2038	5 492	2 656	270	2 362
Total Alkalinity as $CaCO_3$	264	160	<5	84	<5	100	<5	144	360	308	56	140	<5
Chloride as Cl *	14	41	236	61	97	95	53	52	28	<5	99	25	33
Sulphate as SO_4	294	1 875	3 838	2 795	2 960	1 657	3 417	554	860	3 353	1 609	49	1 585
Fluoride as F	0.3	0.8	0.2	1.0	<0.2	1.0	<0.2	0.7	0.6	0.9	1.5	0.9	<0.2
Nitrate as N *	0.3	0.3	0.3	0.4	0.4	0.3	0.2	0.3	0.3	0.2	0.2	0.2	0.2
Free & Saline Ammonia as N *	<0.2	0.4	3.1	0.4	1.3	0.2	1.8	<0.2	0.3	1.6	0.2	0.3	0.3
% Balancing	97.3	97.3	97.0	94.6	95.0	94.3	98.0	98.2	94.4	98.6	96.3	93	96.8
Element	**TFN-US**	**TFN-DS**	**TFN-2**	**TFN-4**	**TFN-5**	**TFN-6**	**TFN-Seep**	**WTP-US**	**WTP-2**	**WTP-4**	**Bosch-1**	**KPS-1**	**ZWS-1**
Al	0.133	0.147	10	0.142	28	0.142	0.290	0.137	0.137	0.433	1.72	0.144	12
B	0.027	0.122	0.045	1.530	0.526	0.212	<0.025	0.060	0.089	0.163	0.232	0.045	0.138
Ba	0.358	0.040	<0.025	0.049	0.027	0.045	<0.025	0.104	0.091	<0.025	0.073	0.05	0.151
Ca	168	409	507	595	409	357	438	129	342	488	259	41	291
Co	<0.025	<0.025	0.065	<0.025	0.221	<0.025	0.066	<0.025	<0.025	0.063	<0.025	<0.025	0.204
Fe	<0.025	<0.025	0.041	<0.025	2.85	<0.025	0.034	<0.025	<0.025	0.029	4.65	1.09	54
K	5.3	8.8	4.7	15.5	4.3	10.5	6.6	22.0	7.0	5.8	12.9	8.6	29
Li	<0.025	<0.025	<0.025	0.029	0.076	0.029	<0.025	<0.025	0.074	<0.025	0.534	<0.025	<0.025
Mg	36	268	649	425	368	273	617	94	125	571	148	21	132
Mn	0.848	2.47	5.56	0.287	6.56	1.21	31	0.374	2.22	21	1.65	1.24	16
Na	23	70	301	85	91	84	65	41	43	37	215	37	55
Ni	<0.025	<0.025	0.043	<0.025	0.256	<0.025	0.061	<0.025	<0.025	0.025	0.029	<0.025	0.132
P	0.076	0.034	0.203	0.125	0.263	0.063	0.227	0.065	<0.025	0.274	0.417	0.358	0.327
S	135	980	1298	1346	918	870	1189	254	441	1064			
Se	<0.020	<0.020	0.028	<0.020	<0.020	<0.020	0.037	<0.020	<0.020	0.035	<0.020	<0.020	<0.020
Si	4.1	1.86	4.4	<0.2	4.7	0.525	3.0	0.104	2.9	2.0	1.3	1.8	12.2
Sn	<0.025	<0.025	<0.025	0.039	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.084	0.088	<0.025
Sr	0.755	2.54	5.67	4.38	3.89	2.69	4.09	0.736	1.97	4.26	3.01	0.385	2.02
Zn	0.430	0.037	0.075	0.091	0.771	0.044	0.034	<0.025	0.094	0.067	0.365	0.028	1.4

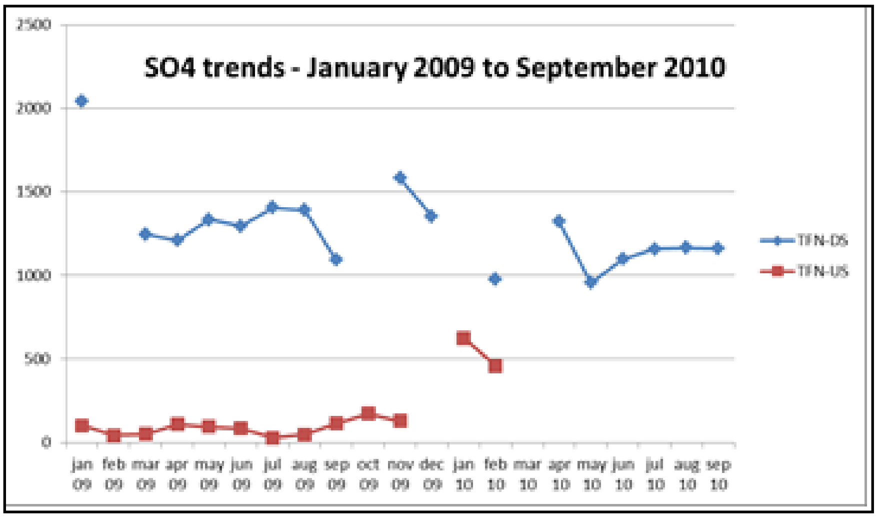


Figure 9. Long-term sulphate trends for TFN-US and TFN-DS.

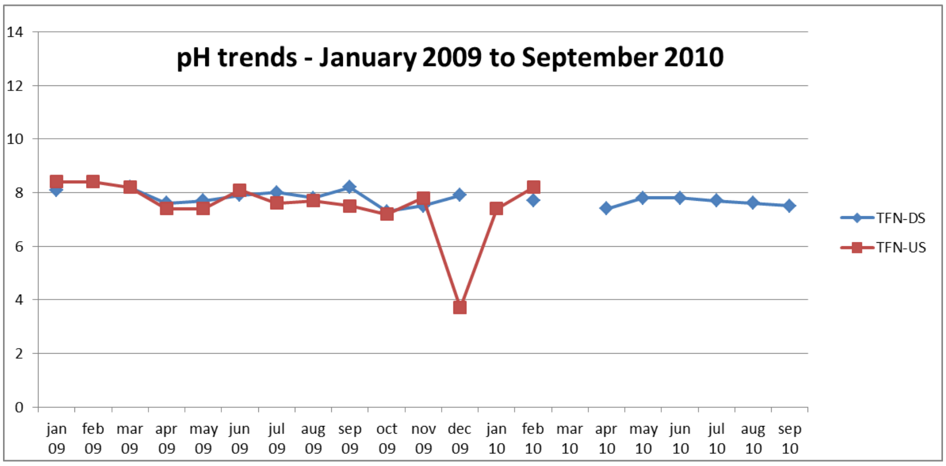


Figure 10. Long-term pH trends for TFN-US and TFN-DS.

6.2.1 Diatoms

Dams and valley bottom wetlands may have naturally elevated salinity and nutrient levels in comparison to some freshwater systems, and any attempt to use indices of biotic integrity suitable for freshwater ecosystems in South Africa (Specific Pollution Index IPS, Coste in CEMAGREF, 1982, Biological Index for Diatoms BDI, Lenoir and Coste, 1996, Prygiel and Coste, 2000) will likely result in misleading conclusions.

Analyses of diatoms were therefore based on measures of relative abundance and species composition (i.e. assemblage patterns) to infer baseline water quality conditions at these sites. Appendix A displays a list of species and abundances recorded for each site.

To further determine water quality based on diatom composition at the Tweefontein sites, diatoms assemblages collected from 228 sites throughout the Highveld were included in a cluster analysis to provide a more reliable inference of water quality.

Diatom assemblage patterns at the Tweefontein sites (Appendix A) suggest the following (remembering that 'pollution indicators' used to determine anthropogenic stress in freshwater systems may be equally tolerant to the natural stressors that accompany healthy, eutrophic wetland systems):

- The Tweefontein sites fall along a disturbance gradient, from significantly impaired sites TFN-4, TFN-6, WTP-2 to moderately disturbed sites WTP-US and TFN-US.
- Of concern are the high numbers of taxa *Nitzschia nana* at Site TFN-4, and *Fragilaria fasciculata* and *Stephanodiscus minutulus* at Site TFN-6, species often associated with industrial effluent and sulphate contaminated waters as a result of mining.
- At Site WTP-2 recorded is highly prevalent *Achnanthidium minutissimum*, a taxon often associated with clean, high oxygenated, freshwaters (Slàdecek, 1986; Leclercq and Maquet, 1987; Prygiel and Coste, 2000). Yet studies have also revealed this species to develop abundant populations at sites contaminated with acid mine drainage (AMD) precipitates (Deniseger *et al.*, 1986; Genter *et al.*, 1987; Medley and Clements, 1998; Ivorra *et al.,* 1999, Gold *et al.*, 2002, 2003, Cattaneo *et al.,* 2004, Ferreira da Silva *et al.*, 2009). Other dominant taxon recorded at this site is *Navicula cryptocephala* which has also been associated with AMD contaminated waters (DeNicola and Stapleton, 2002).
- At WTP-US prevalent taxon *Nitzschia archibaldii*, which is also dominant at Site TFN-6, is a species found in polluted waters with elevated electrolyte concentrations. The presence of dominant *Nitzschia paleacea*, a taxon which cannot tolerate high levels of pollution suggests that the level of disturbance at site WTP-US is moderate. The presence of *Nitzschia palea*, *Nitzschia amphibia* and *Mayamaea atomus var. permitis* indicates nutrient, organic and electrolyte enrichment most likely attributed to fertiliser run-off from surrounding agriculture and cattle utilising the site.
- Similar to Site WTP-2, Site TFN-US is dominated by *Achnanthidium minutissimum* (see discussion above regarding this taxon at Site TFN2). Other species recorded at this site such as *Navicula gregaria*, *Navicula cryptocephala*, *Nitzschia palea* and *Navicula veneta*, all extremely pollution tolerant species found in waters with elevated electrolyte and nutrient content, implies that the water quality is disturbed to some level from industrial and agricultural impacts.
- Cluster analysis of Tweefontein sites along with 228 wetland sites across the Highveld revealed the following:
    - Site TFN-US was closely grouped with a valley bottom site receiving contaminated water as a result of industrial activities.
    - Site WTP-2 was closely related to a relatively undisturbed valley bottom system also dominated by *Achnanthidium minutissimum* (see discussion above regarding this taxon at Site WTP-2). Yet again, we must be aware that *A. minutissimum*, the taxon grouping Site WTP-2 with this undisturbed valley bottom site, is a species whose ecology is still undergoing debate.
    - Site TFN-4 and TFN-6 were related to a pan with elevated salinity as a result of industrial wastewaters impacting the system.
    - Site WTP-US was very closely grouped with a nutrient, organic and electrolyte enriched valley bottom system as a result of agricultural activities and cattle farming in the area.

6.3 Wetland Biodiversity Assessment

No additional fauna, flora or aquatic ecology assessments were undertaken as part of the current wetland assessment study. Use was made of the extensive existing information that has been collected and compiled by a number of specialists during the last 5/6 years. Existing reports were reviewed and the main findings of these reports are briefly summarized in this document. The reader is referred to the full reports (see list of existing information above and list of references below) for additional detail.

6.3.1 Aquatic Ecology

Seven fish species are expected to have occurred within the study area under natural conditions given the habitat types available within the wetland. Species expected to occur are as follows:

- Chubbyhead Barb (*Barbus anoplus*)
- Sidespot Barb (*Barbus neefi*)
- Straightfin Barb (*Barbus paludinosus*)
- Threespot Barb (*Barbus trimaculatus*)
- Sharptoothed Catfish (*Clarias gariepinus*)
- Southern Mouthbrooder (*Pseudocrenilabrus philander*)
- Banded Tilapia (*Tilapia sparrmannii*)

All of the above species are common and generally occur within the slow flowing habitats provided by wetlands. With the exception of *Barbus neefi*, which is considered moderately intolerant to habitat degradation, all the species expected to occur are tolerant to moderately tolerant.

During the 2009 survey only 2 indigenous species were sampled, namely *P. philander* (TFN-US) and *T. sparrmannii* (TFN-US and TFN-DS). No indigenous fish species were sampled during the 2011 wet season Biomonitoring survey (November 2011, most recent Biomonitoring report made available). The alien fish *Gambusia affinis* (Mosquitofish) was recorded during the 2009 and 2011 surveys, while Cyprinus carpio, the common carp, is known to occur in Tweefontein Dam.

Clean Stream Biological Services (2011) found that the much lower than expected fish species diversity observed at the Tweefonteinspruit biomonitoring sites is a clear indication of poor biotic integrity, based on fish, prevailing currently in the system. This was reflected by a very low FRAI (Fish Response Assessment Index) score of 13.6%, falling into descriptive category F (Critically modified). It is further stated that the current poor condition of the fish assemblage cannot be attributed to a single impact, but is related to long-term exposure to various impacts, including flow modification, movement barriers, water quality deterioration and presence of alien fish.

Aquatic macro-invertebrate diversity as recorded during SASS5 (South African Scoring System 5) sampling on site largely mirrored the results of the fish sampling in that recorded diversity was generally low and taxa recorded were generally pollution tolerant. SASS scores and ASPT (Average Score Per Taxon) scores were largely similar for upstream and downstream sampling sites, though it must be noted that habitat availability at the downstream site is higher than for the upstream site and higher scores would thus have been expected from the downstream site. The observed composition of aquatic macroinvertebrate assemblages is a general reflection of the deteriorated biotic integrity currently prevailing in the Tweefonteinspruit.

6.3.2 Wetland Flora

Vegetation of the wetlands within the study area is dominated by a mosaic of hygrophilous grasses and sedges, with an average species richness of 16.1 species per $100m^2$. This is typical of wetlands within this region of the highveld. A list of the more common and most characteristic species is provided below.

In the case of the Tweefonteinspruit valley bottom wetland, the wetland vegetation has been substantially altered from the assumed natural condition. Under natural conditions the unchannelled valley bottom wetland is expected to have been dominated by hydrophytic and hygrophytic sedges and grasses, but currently large portions of the wetland are completely dominated by *Typha capensis* and *Phragmites australis* reed beds, typically with *Juncus effusus, Imperata cylindrica* and *Paspalum urvillei* along the margins. These species, especially *P. australis*, are most dominant in the direct vicinity of disturbances such as the various dumps and PCD's located in close proximity to the valley bottom wetland and the margins of Tweefontein Dam. The altered seasonality of water inputs to the wetland due to seepage of water from the dumps and PCD's and impounding by Tweefontein Dam, as well as increased sediment deposition within the wetland have created the opportunity for these species to dominate, often with the complete exclusion of other species within these reed beds.

In less impacted areas the wetland is still characterised by a mosaic of grasses and sedges, typically including the following species: *Agrostis eriantha, A. lachnantha, A. continuata, Andropogon appendiculatus, Andropogn eucomis, Aristida junciformis, Arundinella nepalensis, Cynodon dactylon, Cyperus congestus, C. denudatus, C. longus, C. sphaerospermus, Eleocharis dregeana, Eragrostis curvula, E. inamoena, E. plana, E. planiculmis, Fuirena pubescens, Hemarthria altissima, Juncus effusus, J. lomatophyllus, J. punctorius, Kyllinga allata, K. melanosperma, Leersia hexandra, Panicum repens, Paspalum dilatatum, Paspalum distichum, Paspalum urvillei, Pennisetum clandestinum, Pycreus macranthus, Setaria sphacelata, Themeda triandra* and *Typha capensis*.

Below Witcons Dam the wetland vegetation of the Zaaiwaterspruit is dominated by a number of grass and sedge species, but this changes to a largely *Typha capensis* dominated system further downstream. It is assumed that the extent of *Typha capensis* within the wetland system has increased in response to increased sediment inputs to the wetland from both agricultural and mining activities, as well as increased nutrient inputs associated mostly with past agricultural activities.

According to the specialist flora report prepared by De Castro and Brits (2010), two Red Data species could occur within the Tweefonteinspruit wetlands:

- *Crinum bulbispermum*
- *Gunnera perpensa*

In addition, a further 9 species protected in terms of the Mpumalanga Nature Conservation Act could occur within the wetlands:

- *Crinum bulbispermum*
- *Cyrtanthus breviflorus* var. *breviflorus*
- *Cyrtanthus contractus*
- *Disa woodii*
- *Eucomis autumnalis*
- *Gladiolus elliotii*
- *Gladiolus papilio*
- *Habeneria filicornis*
- *Habenaria nyikana*

Under Schedule 11 of the Mpumalanga Nature Conservation Act (Act no. 10 of 1998), a permit has to be obtained prior to the removal of any of these protected species. In this regard the presence of large numbers of *Disa woodii* seen flowering along the Waterpan tributary during the 2009 wetland survey is pointed out. These flowers were observed along the western bank of the valley bottom wetland upstream of the tar road crossing. If the proposed clean-up activities impact on this area, a permit will need to be applied for.

Figure 11. Photograph of flowering *Disa woodii* along the western edge of the Waterpan tributary as observed in 2009.

6.3.3 Wetland Fauna

According to the 2013 update of the Tweefontein Biodiversity Management Plan, the following number of species per faunal group is expected to utilise the habitat provided by the Tweefonteinspruit wetland:

- 79 Mammal species
- 194 Bird species
- 37 Reptile species
- 13 Frog species

Complete lists of the expected species are not reproduced in this report, and the reader is referred to the 2013 Biodiversity Management Plan for Tweefontein Colliery.

A total of 12 species of high conservation value are confirmed to occur within the TOPA study area:

- *Pyxicephalus adspersus* (Giant Bullfrog) – confirmed on site
- *Geronticus calvus* (Southern Bald Ibis) – confirmed on site
- *Circus ranivorus* (African Marsh Harrier) – observed 2009
- *Tito capensis* (African Grass Owl) – confirmed on site
- *Phoenicopterus ruber* (Greater Flamingo) – confirmed on site
- *Oxyura maccoa* (Maccoa Duck) – confirmed on site
- *Falco biarmicus* (Lanner Falcon) – confirmed on site
- *Felis serval* (Serval) – confirmed on site
- *Aonyx capensis* (Cape Clawless Otter) – confirmed on site, tracks observed 2012
- *Lutra maculicolis* (Spttednecked Otter) – confirmed on site
- *Dasymys incomtus* (Water Rat) – confirmed on site

Figure 12. Photograph of cape clawless otter tracks observed on the shores of Tweefontein Dam during the current survey.

In addition, the threatened butterfly the marsh sylph (*Metisella meninx*) was confirmed from one of the pans within the area and it is possible that where extensive patches of *Leersia hexandra* occur within the Tweefonteinspruit wetland, these could also be utilised by this species.

6.4 Functional Assessment

The functional importance of the wetlands in the study area was assessed using the WET-EcoServices methodology (Kotze *et al*., 2009). WET-EcoServices is a tool developed to assess the goods and services that individual wetlands provide so as to aid informed planning and decision making (Kotze *et al*., 2009). In interpreting the results of the WET-EcoServices assessment, the following must be borne in mind:

- *The level of services delivered is based on current as well as future potential benefits* (i.e. a wetland might have high ability to perform a service such as trapping pollutants but is currently afforded little opportunity to perform the service due to a lack of pollutants within the wetland catchment, resulting in an intermediate score);
- *WET-EcoServices scores make no reference to the size of the wetland* (i.e. a 3ha wetland and a 300ha wetland might both score 3 for flood attenuation. Given the size of the wetlands in question, the overall importance of flood attenuation performed by the 300ha wetland is obviously greater than for the 3ha wetland);
- *Scores between different hydro-geomorphic wetland units (i.e. different wetland types) should not be compared directly*

<u>Valley bottom wetlands</u>

The results of the WET-EcoServices assessment for both the Tweefonteinspruit and the Zaaiwaterspruit are reproduced on radial plots in Figure 18 below. From the plots it is immediately clear that the water quality maintenance functions of sediment trapping, phosphate trapping, nitrate removal and toxicant removal provided the highest scores and thus represent the functions the wetlands re most likely to play an important role in performing. The extensive sources of sediments and pollutants within the catchments however also provide the wetland with great opportunity to perform these functions, elevating the scores somewhat.

The low slope, robust and dense vegetation cover and generally unchannelled nature of the valley bottom wetlands ensures slow, diffuse flow of water through the wetland. The extended retention time and contact with the wetland vegetation and sediments provides the opportunity for water quality enhancement. Sediments are deposited as flows slow down (and associated with this is the trapping of phosphates bound to iron as a component of the sediment), with deposited sediments quickly held by the dense wetland vegetation roots, limiting further sediment movement and erosion. Nitrate and sulphate reduction are facilitated by the organic carbon rich sediments and anaerobic conditions that predominate in saturated reaches of the wetland. In a coal mining environment where acidification of water due to acid mine drainage is a threat, the reduction of sulphate has the added benefit of producing alkalinity (Vile and Wieder, 1992; Abd-el-Malek and Rizk, 1963) that aids to buffer against a drop in pH.

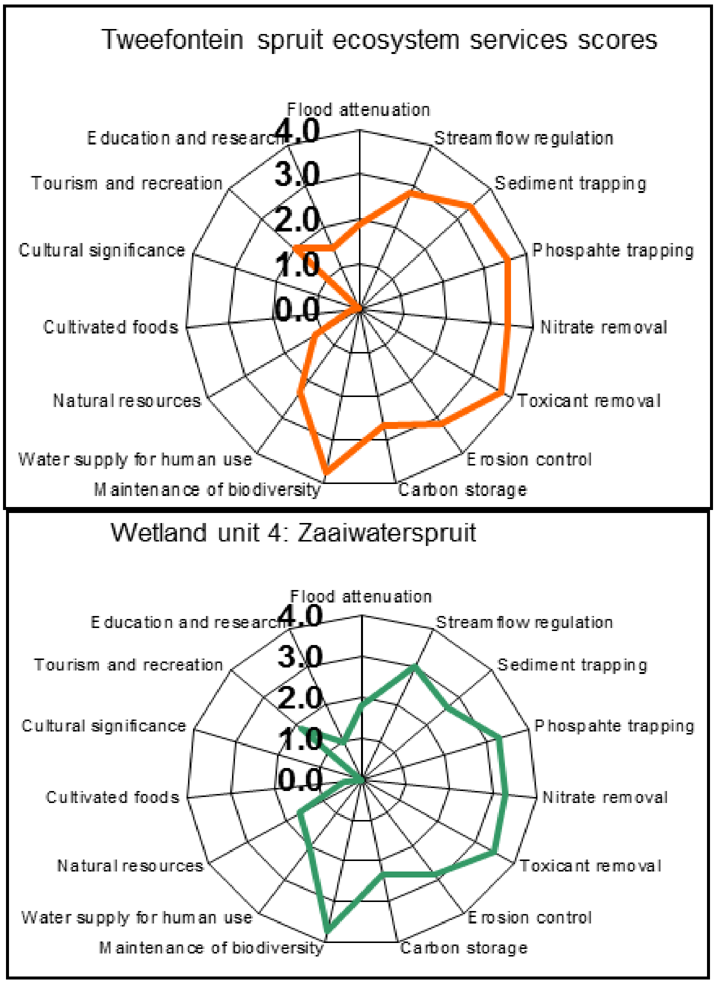


Figure 13. Results of the WET-EcoServices assessment.

The wetlands are further considered to be important from a biodiversity maintenance perspective, despite the degradation they have undergone. A number of Red Data species are known to utilise the wetland habitat along the Tweefonteinspruit and at a local scale, the fact that the wetland habitats represents the major extent of natural vegetation on site elevates their importance in terms of biodiversity support and in providing ecological corridors through an otherwise altered landscape.

Hillslope seepage wetlands

As alluded to earlier, hillslope seepage wetlands are maintained by shallow sub-surface interflow, derived from rainwater. Rainfall infiltrates the soil profile, percolates through the soil until it reaches an impermeable layer (e.g. a plinthic horizon or the underlying sandstone), and then percolates laterally through the soil profile along the aquitard (resulting in the formation of a perched water table). Such a perched water table occurs across large areas of the Mpumalanga Highveld, not only within hillslope seepage wetlands, but also within terrestrial areas, only at greater depth. The hillslope seepage wetlands are merely the surface expression of this perched water table in those areas where a shallow soil profile results in the perched water table leading to saturation of the profile within 50cm of the soil surface. The importance of individual seepage wetlands in temporarily storing and then discharging flows to downslope wetlands (flow regulation) varies and depends on a number of factors. Generally, seepage wetlands associated with springs and located adjacent to terrestrial areas characterised by deep, well-drained soils are more likely to play an important role in flow regulation than seepage wetlands where the wetland and catchment are characterised by shallower soils. Such seepage wetlands are thought to be mostly maintained by direct rainfall and lose most of their water to evapotranspiration, and surface run-off during large storm events.

Hillslope seeps can support conditions that facilitate both sulphate and nitrate reduction as interflow emerges through the organically rich wetland soil profile, and are thus thought to contribute to water quality improvement and/or the provision of high quality water. The greatest importance of the hillslope seepage wetlands on site is thus taken to be the movement of clean water through the hillslope seepage wetlands and into the adjacent valley bottom wetlands, though the flow contribution from hillslope seepage wetlands to downslope wetlands was not quantified.

As hillslope seepage wetlands, for the most part, are dependent on the presence of an aquiclude, either a hard or soft plinthic horizon, they are not generally regarded as significant sites for groundwater recharge (Parsons, 2004). However, by retaining water in the landscape and then slowly releasing this water into adjacent valley bottom or floodplain wetlands, some hillslope seepage wetlands can contribute to stream flow augmentation, especially during the rainy season and early dry season. From an overall water yield perspective there is evidence that seepage wetlands contribute to water loss. The longer the water is retained on or near the surface the more likely it is to be lost through evapo-transpiration (McCartney, 2000). Hillslope seepage wetlands are not generally considered to play an important role in flood attenuation, though early in the season, when still dry, the seeps have some capacity to retain water and thus reduce surface run-off. Later in the rainy season when the wetland soils are typically saturated, infiltration will decrease and surface run-off increase. Further flood attenuation can be provided by the surface roughness of the wetland vegetation; the greater the surface roughness of a wetland, the greater is the frictional resistance offered to the flow of water and the more effective the wetland will be in attenuating floods (Reppert et al., 1979). In terms of the hillslope seepage wetlands on site, the surface roughness is taken to be moderately low, given that most of the seepage wetlands are either cultivated of characterised by typical grassland vegetation, thus offering only slight resistance to flow.

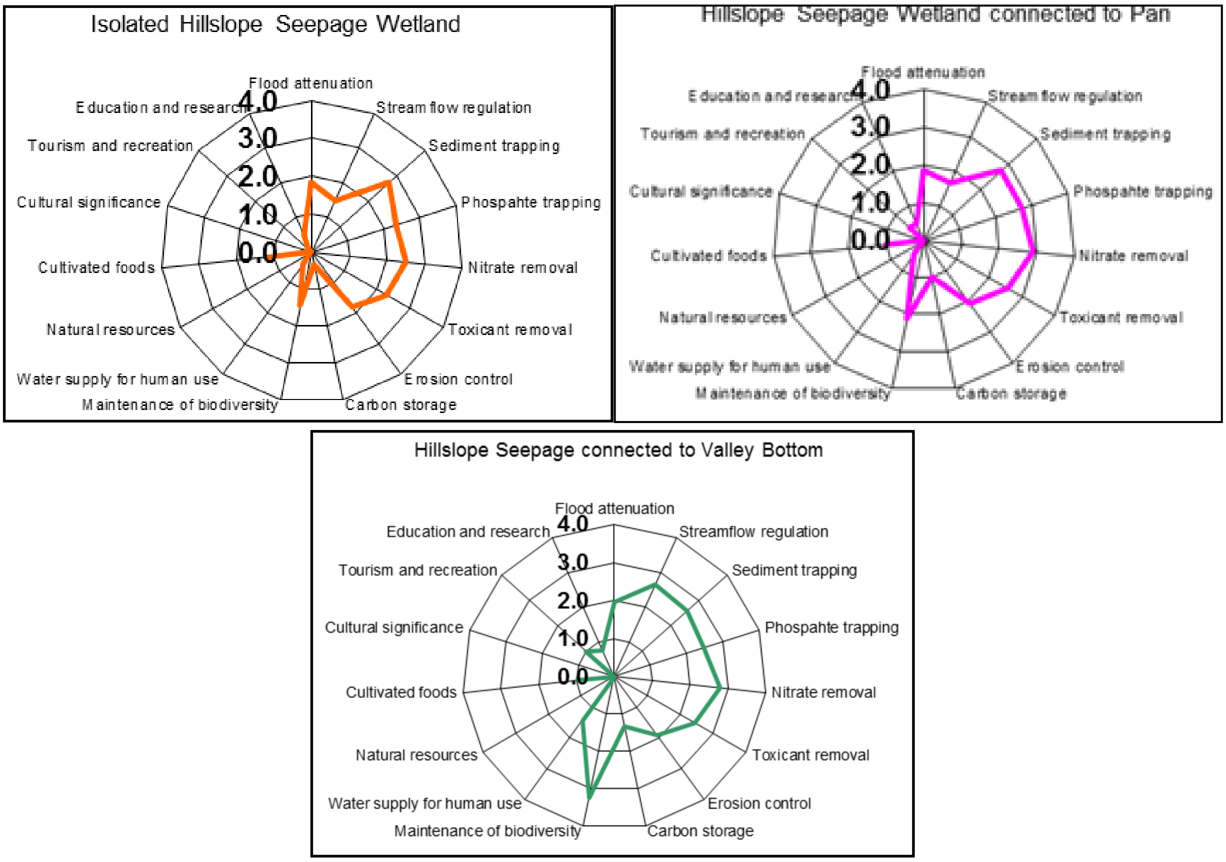


Figure 14. Radial plots showing the results of the WET-EcoServices assessments.

Pans

Given the position of most pans within the landscape, which is usually isolated from any stream channels, the opportunity for pans to attenuate floods is fairly limited, though some run-off is stored in pans. Pans are also not considered important for sediment trapping, as many pans are formed through the removal of sediment by wind when the pan basins are dry. Some precipitation of minerals and de-nitrification is expected to take place within pans, which contributes to improving water quality, though accumulated salts and nutrients can be transported out of the system and deposited on the surrounding slopes by wind during dry periods. An important function performed by pans is the support of faunal and floral biodiversity, which is enhanced by the diversity in habitat types offered by different pans, and the differences in hydroperiod between the pans, ensuring that a range of habitats are available at any one time across the various pans and depressions.

A rapid desktop assessment of pans within the affected quarternary catchment, catchment B11F, indicates 34 pans within the catchment. This number was based on a rapid assessment of 1:50 000 topographical maps, 1:50 000 vector data, and NFEPA. Although an underestimate of the pans actually occurring within the catchment, the general tendencies observed are expected to be applicable to all of the pan wetlands within the catchment. The following observations were made:

- 26.5 % of the pans (9 pans) have been mined and no longer exist
- A further 7 pans (20.6 %) appear significantly impacted by mining activities in close proximity to the pan as well as storage of mine water
- At least 3 pans (8.8 %) have been completely cultivated in the past

- 15 pans (44.1 %) are considered to still be in a moderately modified condition and are located within a mostly agricultural landscape

The extensive transformation that has occurred within the pan habitats of the area considerably raises the importance of the remaining pans in terms of biodiversity support. Within the study area, both Boschmans Pan and Makou Pan have been significantly impacted by mining activities.

6.5 Present Ecological Status (PES) Assessment

The results depicted below show that overall, the majority of wetlands (67.65 %) are considered moderately modified (PES category C). In terms of the various wetland types:

- More than 45 % of wetlands are considered moderately modified with a PES (C), though a significant number are also considered largely modified (PES D);
- Hillslope seepage wetlands are generally moderately to largely modified with a PES (C) or (D);
- Most of the valley bottom wetlands are considered largely modified with a PES (D);
- Only 170ha of hillslope seepage wetlands, roughly 5 % of the total wetland habitat on site, are still considered largely natural with a PES (B); and
- More than 50 % of the pan habitat within the study area is considered seriously modified with a PES (E).

Various impacts have contributed to the altered state of the wetlands, most as a result of a change in land use brought about by the onset of mining activities, as well as agricultural activities. Impacts observed on site include:

- Historic and current mining activity within the study area;
- Water quality deterioration due to mining activities;
- Historic and recent cultivation across wetlands and within and along the wetland edges;
- Impoundments constructed within the wetlands and river systems;
- Grazing and cattle tracks which create preferential flow paths leading to erosion; and
- Construction of roads, bridges and culverts across wetlands also leading to erosion.

Table 6. Results of the PES assessment for the Tweefontein study area.

Wetland Type	B - Largely Natural	C - Moderately Modified	D - Largely Modified	E - Seriously Modified	TOTAL
Channelled valley bottom	---	10.52	60.80	35.30	**106.62**
Unchannelled valley bottom	---	152.01	220.34	107.92	**480.28**
Hillslope seepage	169.31	1356.78	876.87	231.39	**2634.35**
Pan	---	54.66	5.06	83.12	**142.84**
TOTAL	**169.31**	**1573.98**	**1163.07**	**457.73**	**3364.09**
% of wetland area	**5.03%**	**46.79%**	**34.57%**	**13.61%**	**100.00%**

Table 7. Table showing the rating scale used for the PES assessment.

Description	Combined impact score	PES Category
Unmodified, natural.	0-0.9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place.	1-1.9	B
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
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
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
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

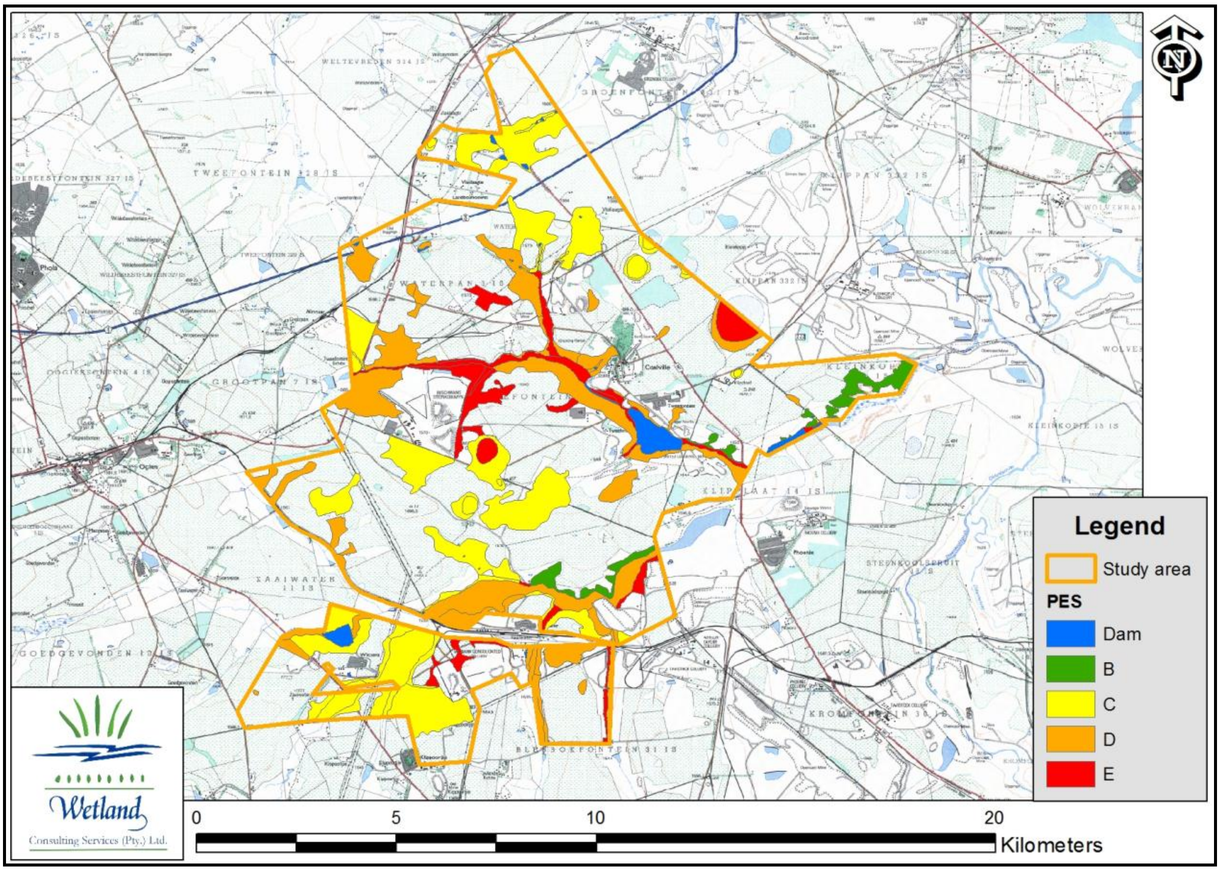


Figure 15. Map showing the PES categories for all the wetlands within the study area.

6.6 Ecological Importance and Sensitivity (EIS)

Ecological Importance and Sensitivity is a concept introduced in the reserve methodology to evaluate a wetland in terms of:

- Ecological Importance;
- Hydrological Functions; and

- Direct Human Benefits

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 (the WET-EcoServices tool). Based on this methodology, an EIS assessment was undertaken for all the delineated wetlands on site, with the result discussed and illustrated below.

The wetlands within the study area all form part of the Olifants River Primary catchment which is a heavily utilised and economically important catchment. Wetlands and rivers within the Olifants River Catchment upstream of Loskop Dam have been greatly impacted upon by various activities, which include mining, power stations, water abstraction, urbanization, agriculture etc. As a result of these impacts serious water quality concerns and also water quantity concerns have been raised within the sub-catchment. Given this situation, and the fact that wetlands can support functions such as water purification and stream flow regulation, a high importance and conservation value is placed on all wetlands and rivers within the catchment that have as yet not been seriously modified. Within this context an EIS assessment was conducted for every hydro-geomorphic wetland unit identified within the study area. Further considerations that informed the EIS assessment include:

- The location of the study area within a vegetation type considered to be extensively transformed and threatened, and classed as ***Vulnerable***
- The wetland ecosystem type of the area, Mesic Highveld Grassland Group 4 wetlands, are considered to be ***Critically Endangered***
- The location of the study area within an area and quarternary catchment heavily impacted by mining activities and which is experiencing a number of further mining applications

It is these considerations that have informed the scoring of the systems in terms of their ecological importance and sensitivity. The results of the assessment and rankings based on our current understanding of the wetlands is illustrated in Figure 20 and summarised in Table 8, while an explanation of the scoring system is presented in Table 9.

Table 8. Summarised results of the EIS assessment.

Wetland Type	High	Moderate	Low/Marginal	TOTAL
Channelled valley bottom		38.56	68.07	**106.62**
Unchannelled valley bottom	141.20	112.94	226.14	**480.28**
Hillslope seepage	326.81	1405.43	902.10	**2634.35**
Pan	48.10	5.06	84.62	**137.78**
TOTAL	**516.11**	**1561.98**	**1280.94**	**3359.04**
% of wetland area	**15.36%**	**46.50%**	**38.13%**	**100.00%**

The ***ecological importance*** and functioning of the wetlands on site has been significantly impaired by the degradation that the wetland systems have undergone, specifically the deterioration in water quality that has resulted in an impoverished aquatic biodiversity, but also the changes in vegetation structure and composition towards *T. capensis* (and *P. australis)* dominated systems in the case of the Tweefonteinspruit and the Zaaiwaterspruit. Nonetheless, some of the wetlands still support some Red Data species and provide important movement corridors through a landscape altered by mining and agricultural activities. Specifically the hillslope seepage wetlands associated with rocky outcrops along the northern banks of the Tweefonteinspruit are considered to be of High ecological importance, as well as the cluster of 3 pans to the north of Makou Pan and the Klippoortjiespruit valley bottom wetland.

The ***hydrological functions*** of water quality maintenance were highlighted in the WET-EcoServices assessment as likely being the most important functions performed by especially the Tweefonteinspruit and Zaaiwaterspruit wetlands. The elevated scores are partly due to the opportunity afforded the wetlands to play a role in this regard due to the extensive pollution sources within their catchments, though the characteristics of the wetland (i.e. a large unchannelled valley bottom wetland with extensive reed beds) suggest that the wetlands provide an ideal environment for the trapping and removal of pollutants.

The ***direct human use benefits*** derived from the wetlands on site is currently limited as the wetlands re mostly located on private mine land and thus inaccessible to the general public. No livestock grazing or harvesting of any natural resources is thought to take place (with the exception of the Noupoortspruit wetland system), and no cultural significance is attached to the wetlands to our knowledge. However, in an agricultural setting, the wetlands would undoubtedly be an important source of livestock grazing.

Table 9. Scoring system used for the EIS assessment.

Ecological Importance and Sensitivity categories	Range of Median	Ecological Management Class
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands 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.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands 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.	>1 and <=2	C
Low/marginal Wetlands that is not ecologically important and sensitive at any scale. The biodiversity of these wetlands 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.	>0 and <=1	D

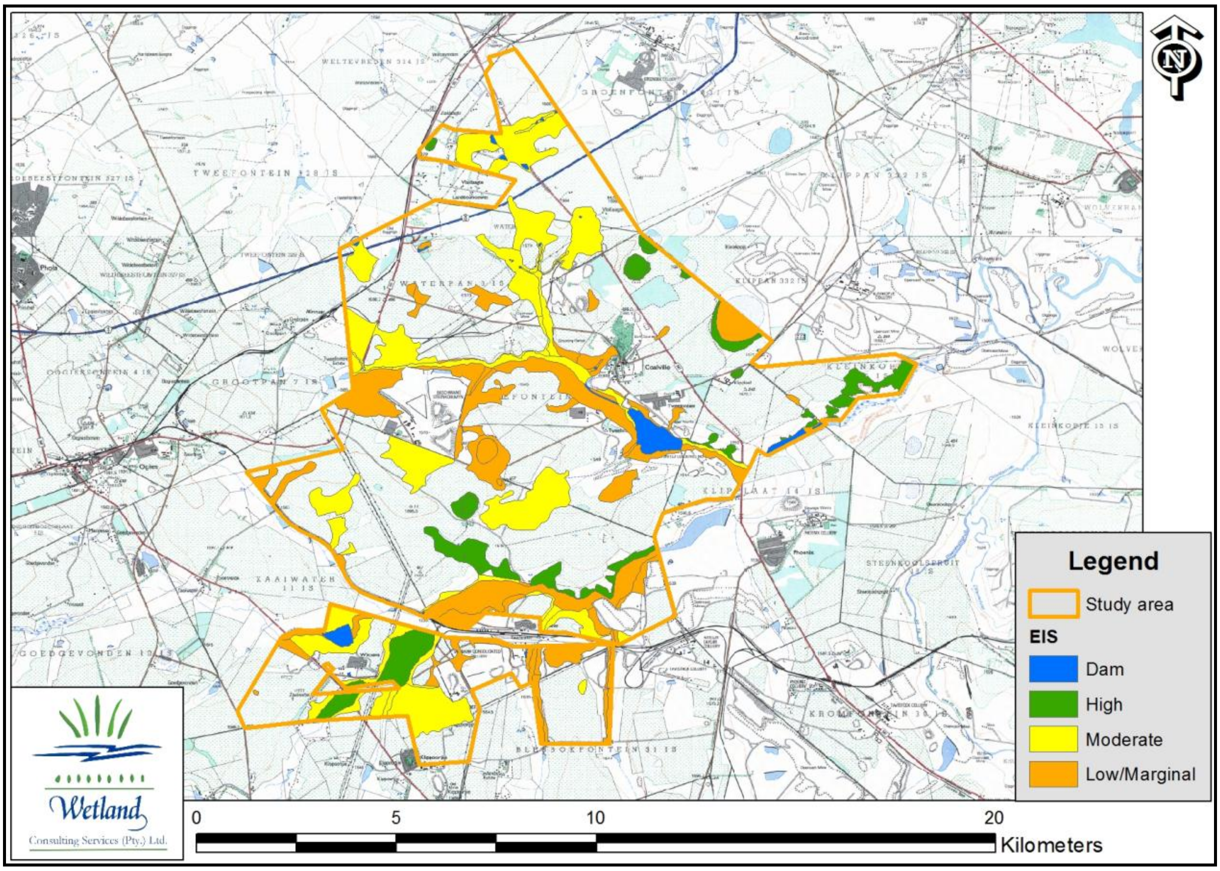


Figure 16. Map showing the EIS categories for all the wetlands within the study area.

7. IMPACT ASSESSMENT

A detailed project description is provided in the full EIA report as compiled by Clean Stream Environmental Consultants (CSEC). A summary of proposed activities, as provided by CSEC, that have been included in the wetland impact assessment is provided below:

Construction Phase:

A. Mining Activities
   1. Opening of initial boxcuts for opencast coal mining.
   2. Preparation for the underground mining of coal. All new underground mining will be accessed from existing shafts and will make us of existing infrastructure. ***No construction activities applicable***.
   3. Opening of initial boxcuts for sand and gravel mining (borrow pits) for construction purposes.

B. Mining-related Activities
   4. Construction of water management infrastructure.
   5. Construction of diesel storage tanks.
   6. Construction of waste management infrastructure.
   7. Construction of temporary coal stockpile.
   8. Construction of explosives magazine.
   9. Construction of general fencing on site.
   10. Construction of roads.
   11. Construction of ROM tip.
   12. Construction of raw coal stockpile.

Operational Phase

C. Mining Activities
   13. Opencast mining of coal.
   14. Concurrent rehabilitation of opencast voids.
   15. Underground mining of coal.
   16. Opencast mining of sand and gravel (borrow pits).

D. Mining-related Activities
   17. Use and maintenance of water and waste management infrastructure.
   18. Use and maintenance of linear infrastructure.
   19. Use and maintenance of other infrastructure.

Decommissioning Phase

E. Decommissioning & closure activities
   20. Use and maintenance of water and waste management infrastructure.
   21. Use and maintenance of linear infrastructure.
   22. Use and maintenance of other infrastructure.

For each of the above activities an impact assessment was undertaken as per the template (EIAMAP) and methodology supplied by CSEC. Refer to the full EIA report as compiled by CSEC for more details on the templates and methodology.

7.1 Construction Phase

7.1.1 Mining Activities

7.1.1.1 Opening of initial boxcuts for opencast coal mining

The proposed opencast mining activities will result in the further loss of approximately 137.54 hectares of wetland, as detailed below. More than 135 ha of the affected wetlands are hillslope seepage wetlands. Opening of the initial boxcuts, were this takes place in wetland areas, will contribute to the overall wetlands loss.

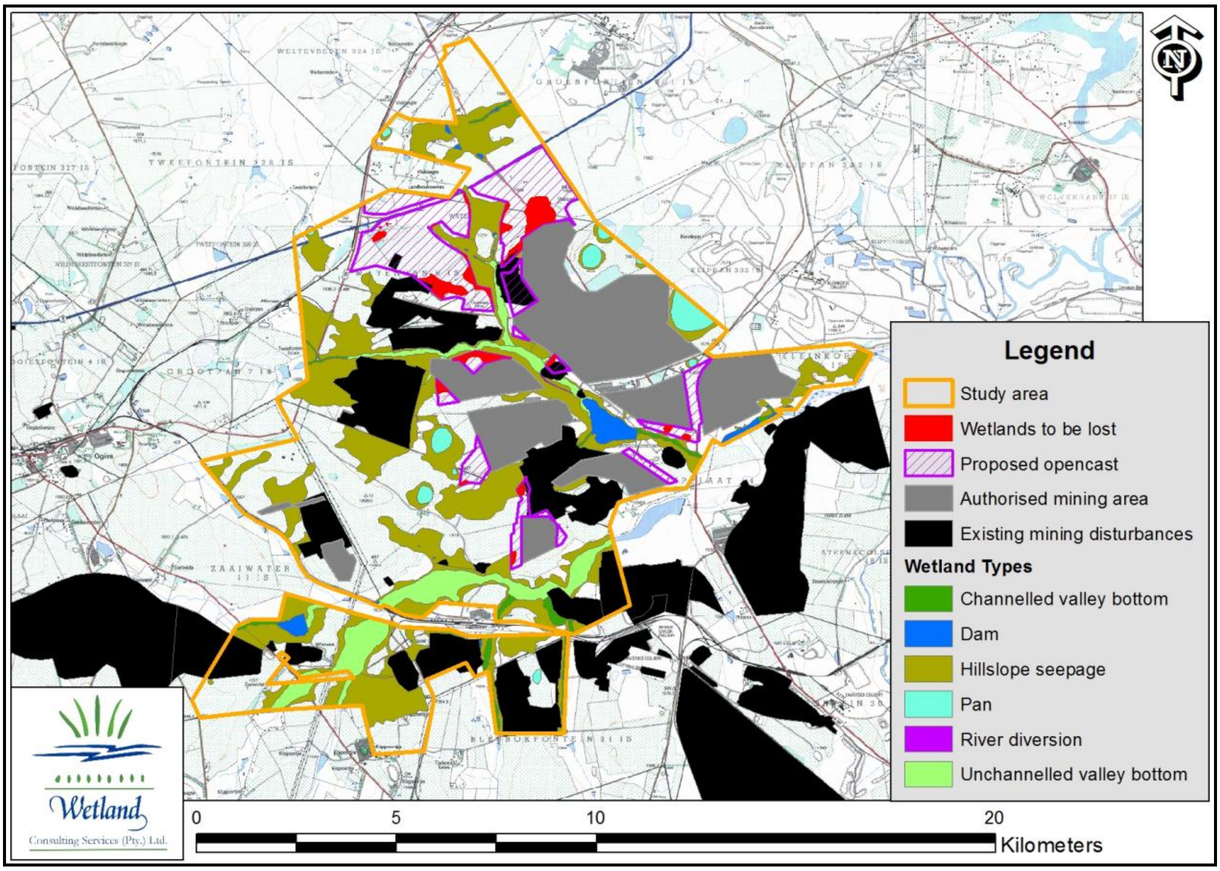


Figure 17. Map showing the proposed mining activities and the wetland habitat likely to be lost as a result.

Figure 16 above shows the proposed opencast pits in relation to existing mining disturbances and already authorized opencast mining areas where mining has not yet commenced. In most cases the proposed new opencast areas represent expansions of the already authorized opencast pits and the wetlands affected by the proposed expansions will already be significantly impacted by already authorized but not yet commenced opencast pits.

The most significant new opencast pits are located just to the south of the N12 highway in the catchment of the Waterpan tributary to the Tweefonteinspruit. The valley bottom wetlands have been excluded from the proposed opencast footprint, but hillslope seepage wetlands will be impacted.

The initial mine plan was amended to exclude the high sensitivity hillslope seepage wetlands in the extreme east of the study area, and also to ensure that the cluster of three pans to the north west of Makoupan, as well as their catchments, was excluded from the opencast footprint.

Opening of the initial boxcuts will result in the following impacts to wetlands:

- **Loss and disturbance to wetland habitat –** all wetlands falling within the direct footprint of the boxcuts will be permanently destroyed. Construction activities are likely to also cause disturbances to adjacent wetland habitat and displace the species supported by this habitat.
- **Increased sediment transport into wetlands** - Bare soil areas resulting from vegetation clearing and soil stripping will provide extensive sediment sources delivering increased sediment loads to downslope wetlands. Transported sediments are likely to deposit in the receiving wetlands, leading to changes in vegetation and habitat.
- **Water quality deterioration** – During the construction phase, water quality deterioration is likely to mostly take the form of increased turbidity, though spills of hazardous materials used on site during construction could also enter wetland areas via surface runoff.
- **Decreased water make to adjacent wetlands** – Where the boxcut is located upslope of wetland areas, the boxcut is likely to intercept subsurface seepage, as well as direct rainfall. Water make to downslope wetlands is thus likely to decrease.

Table 10. Table showing the type and extent of wetlands likely to be directly impacted by opencast mining.

Tweefontein			
Wetland Type	Wetland Extent (Current)	Wetlands to be lost	Percentage of wetlands lost
Channelled valley bottom	106.62	0.98	0.92%
Unchannelled valley bottom	480.28	0.71	0.15%
River diversion	2.83	---	---
Pan	139.67	---	---
Hillslope seepage	2634.35	135.85	5.16%
Dams	125.47	n/a	n/a
TOTAL	**3489.22**	**137.54**	**3.94%**

7.1.1.2 Preparation for the underground mining of coal

Only existing shafts and infrastructure will be utilised to access the proposed new underground mining areas. As such no construction phase activities will take place. ***No impacts to wetlands are expected as a result***.

7.1.1.3 Opening of initial boxcuts for sand and gravel mining

7 borrow pits are proposed as a source of sand and gravel for construction purposes. The location and extent of the borrow pits is illustrated below.

5 of the borrow pits fall within an area earmarked (and already authorized) for opencast mining. Although these borrow pits will impact directly on an isolated hillslope seepage wetland, this wetland will be destroyed by opencast mining at a later stage in any event. A further borrow pit is located immediately adjacent to the Waterpan tributary valley bottom area within an existing mining disturbed area (old Waterpan Plant area). The south eastern Klienkopje borrow pit is located in previously cultivated land outside delineated wetland habitat.

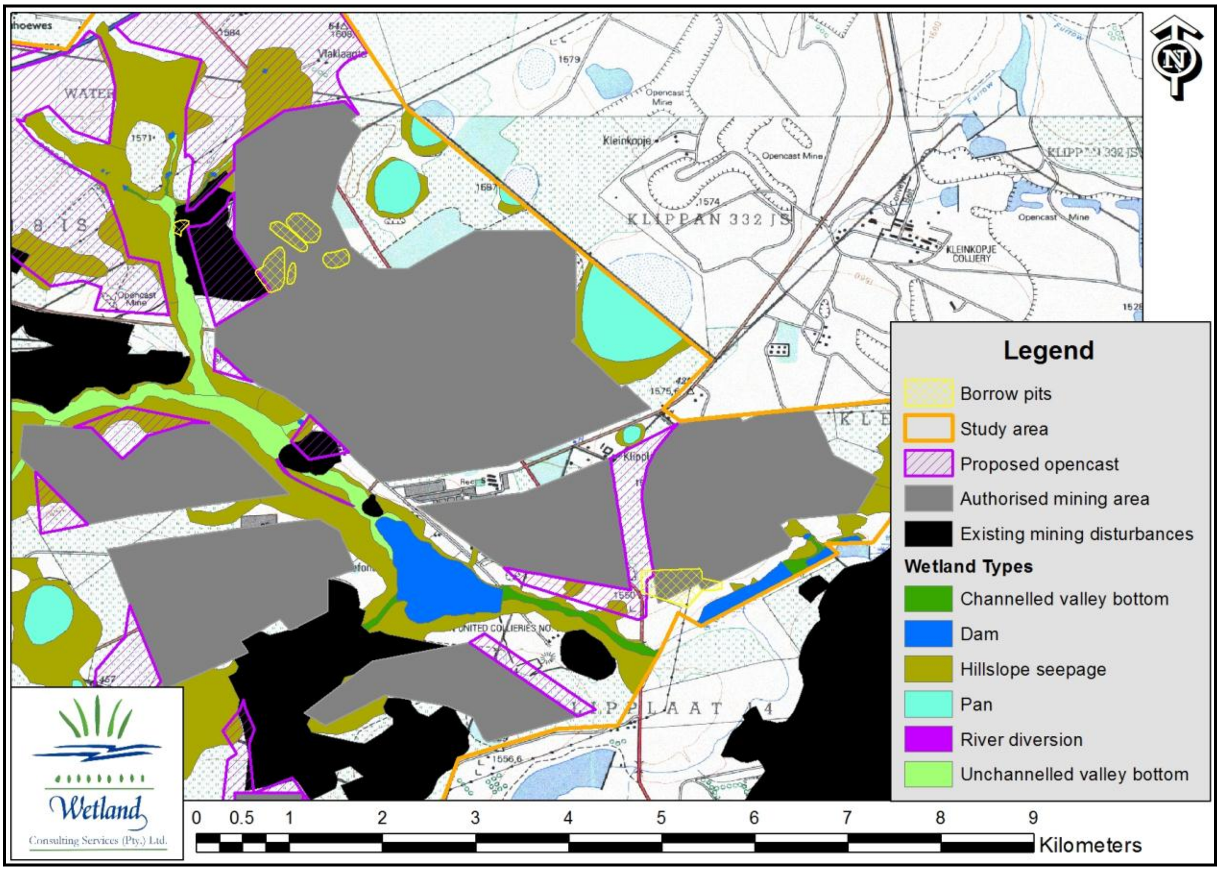


Figure 18. Map showing the location of the proposed borrow pits.

Development of the borrow pits is however still likely to impact on wetlands:

- **Disturbance to wetland habitat** –Construction activities are likely to cause disturbances to adjacent wetland habitat and displace the species supported by this habitat.

- **Increased sediment transport into wetlands** - Bare soil areas resulting from vegetation clearing and soil stripping will provide extensive sediment sources delivering increased sediment loads to downslope wetlands. Transported sediments are likely to deposit in the receiving wetlands, leading to changes in vegetation and habitat.
- **Water quality deterioration** – During the construction phase, water quality deterioration is likely to mostly take the form of increased turbidity, though spills of hazardous materials used on site during construction could also enter wetland areas via surface runoff.
- **Decreased water make to adjacent wetlands** – Where the boxcut is located upslope of wetland areas, the boxcut is likely to intercept subsurface seepage, as well as direct rainfall. Water make to downslope wetlands is thus likely to decrease.

7.1.2 Mining-related Activities

7.1.2.1 Construction of water management infrastructure

The following water management infrastructure is required as part of the proposed project (locations illustrated below):

- Pollution Control Dam (PCD) at the railway loop (RLO)
- PCD and pump station at the proposed Zaaiwater Tailings Storage Facility
- Silt traps associated with the Coal Handling and Preparation Plant (CHPP) and the conveyor route to the Rail Load-Out (RLO)
- Drainage canal north of the CHPP
- Conveyor PCD
- Various pipelines for slurry and water
- Borehole at the RLO

From Figure 18 it is clear that a number of these activities will take place within wetland areas; mostly hillslope seepage wetlands, though specifically the Klipplaat dewatering pipeline will cross numerous valley bottom wetlands, though all along existing crossings.

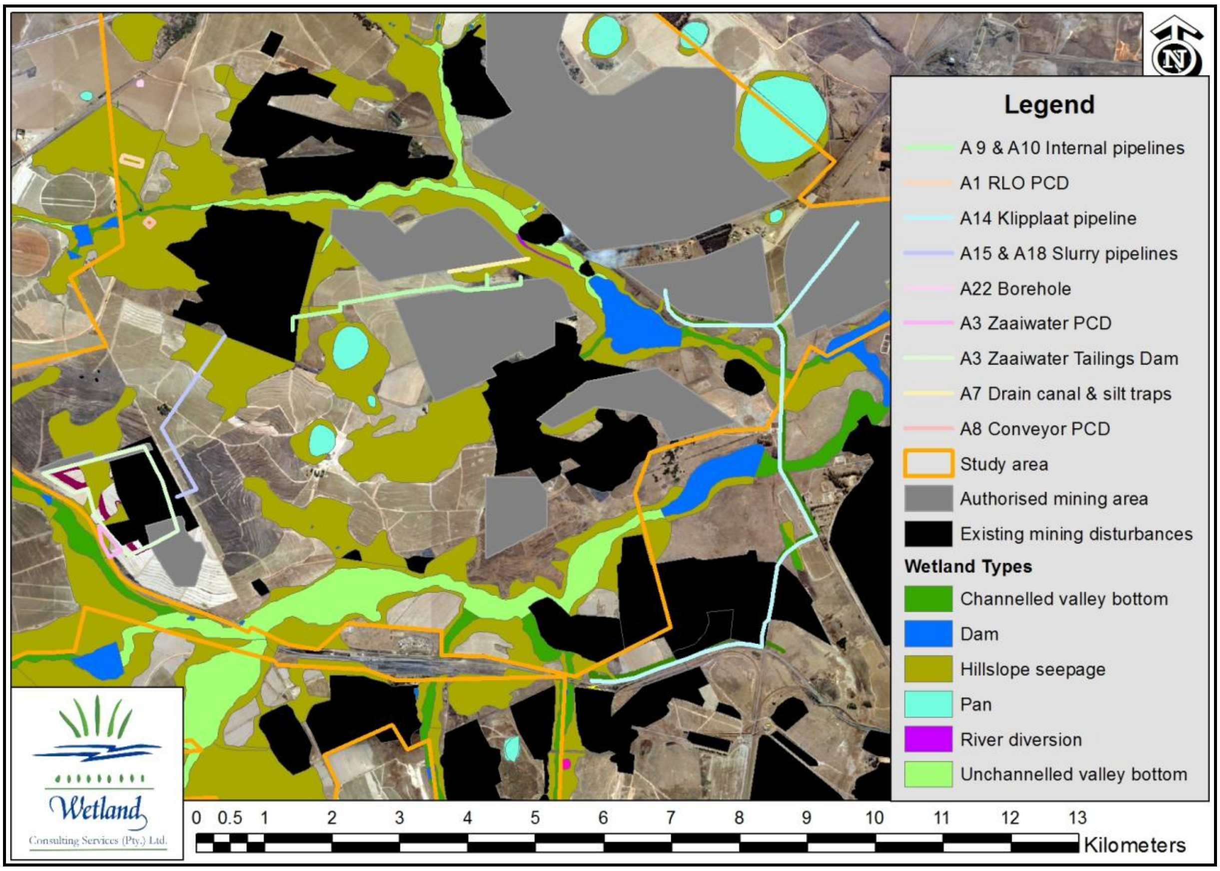


Figure 19. Map showing the proposed water management infrastructure in relation to wetlands.

It is assumed that all pipeline will be above ground and that no trenching will be required as part of the pipelines.

Construction of this infrastructure will result in the following impacts:

- Disturbance of wetland habitat
- **Increased sediment transport into wetlands** - Bare soil areas resulting from vegetation clearing and soil stripping will provide extensive sediment sources delivering increased sediment loads to downslope wetlands. Transported sediments are likely to deposit in the receiving wetlands, leading to changes in vegetation and habitat.
- **Increased risk of erosion within wetlands** – disturbances to wetland vegetation and sediments, as well as the potential concentration of flows and creation of preferential flow paths will increase the risk of erosion.
- **Invasion of alien vegetation into wetlands** – disturbance to wetland habitat will create conditions suitable for alien invasive vegetation to become established.
- **Compaction of soils** – movement of heavy machinery and vehicles through the wetlands will lead to compaction of soils.

7.1.2.2 Construction of diesel storage tanks

The required diesel storage facility will be constructed within the mine infrastructure area approved as part of the 2010 EIA/EMP application and does not fall within a delineated wetland area. Construction of the facility might however still impact on wetlands:

- **Increased sediment transport into wetlands** - Bare soil areas resulting from vegetation clearing and soil stripping will provide extensive sediment sources delivering increased sediment loads to downslope wetlands. Transported sediments are likely to deposit in the receiving wetlands, leading to changes in vegetation and habitat.
- **Water quality deterioration** – During the construction phase, water quality deterioration is likely to mostly take the form of increased turbidity, though spills of hazardous materials used on site during construction could also enter wetland areas via surface runoff.

7.1.2.3 Construction of waste management infrastructure

Waste management infrastructure includes the construction of the Zaaiwater Tailings Storage Facility (TSF) over the currently being mined Zaaiwater opencast pit. Once the current opencast mining has been completed, no wetlands will remain within the footprint.

Slurry pipelines will also be required as part of the proposed Zaaiwater TSF. These pipelines will be required to cross a large hillslope seepage to the south of Boschmans Plant and Dump area. The following impacts are expected:

- Disturbance of wetland habitat
- **Increased sediment transport into wetlands** - Bare soil areas resulting from vegetation clearing and soil stripping will provide extensive sediment sources delivering increased sediment loads to downslope wetlands. Transported sediments are likely to deposit in the receiving wetlands, leading to changes in vegetation and habitat.
- **Increased risk of erosion within wetlands** – disturbances to wetland vegetation and sediments, as well as the potential concentration of flows and creation of preferential flow paths will increase the risk of erosion.
- **Invasion of alien vegetation into wetlands** – disturbance to wetland habitat will create conditions suitable for alien invasive vegetation to become established.
- **Compaction of soils** – movement of heavy machinery and vehicles through the wetlands will lead to compaction of soils.

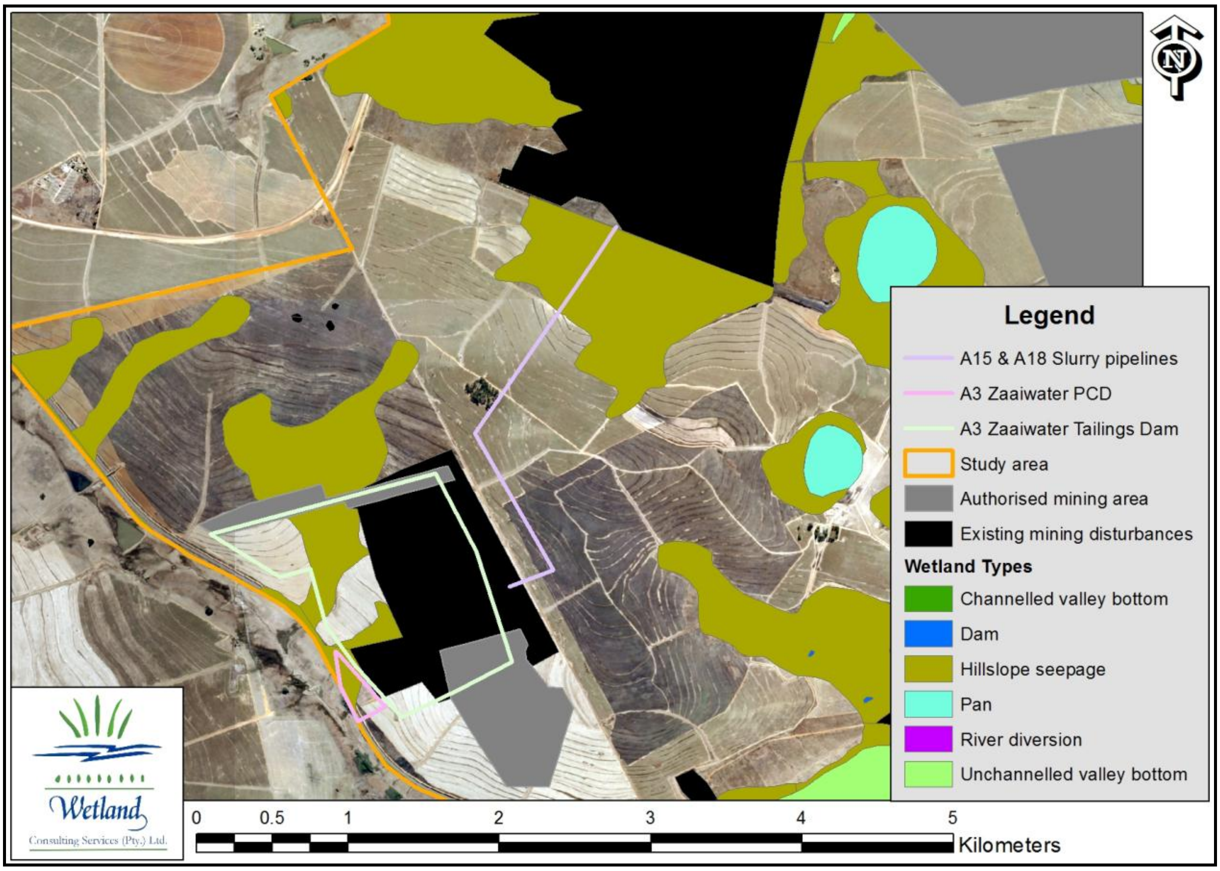


Figure 20. Waste infrastructure.

7.1.2.4 Construction of temporary coal stockpiles

Two temporary coal stockpiles are required, one at the Boschmans central pit area and one at the Boschmans north pit area. Both stockpiles will be located within areas approved for opencast coal mining, though mining has not yet commenced. Both sites are also located well away from wetland areas. Impacts to wetlands are thus expected to be minimal, but the following impacts could result:

- **Increased sediment transport into wetlands** - Bare soil areas resulting from vegetation clearing and soil stripping will provide extensive sediment sources delivering increased sediment loads to downslope wetlands. Transported sediments are likely to deposit in the receiving wetlands, leading to changes in vegetation and habitat.
- **Water quality deterioration –** During the construction phase, water quality deterioration is likely to mostly take the form of increased turbidity, though spills of hazardous materials used on site during construction could also enter wetland areas via surface runoff.

7.1.2.5 Construction of explosives magazine

An explosives magazine was approved as part of the 2010 EIA/EMP application. However, the site needs to be moved. The new proposed site is located between Tweefontein Dam and Phoenix Dam and does not fall within a wetland area. The nearest delineated wetland is around 500m away. Impacts to wetlands are thus expected to be minimal, but the following impacts could result:

- **Increased sediment transport into wetlands** - Bare soil areas resulting from vegetation clearing and soil stripping will provide extensive sediment sources delivering increased sediment loads to downslope wetlands. Transported sediments are likely to deposit in the receiving wetlands, leading to changes in vegetation and habitat.
- **Water quality deterioration –** During the construction phase, water quality deterioration is likely to mostly take the form of increased turbidity, though spills of hazardous materials used on site during construction could also enter wetland areas via surface runoff.

7.1.2.6 Construction of general fencing on site

Extensive fencing will be required on site, specifically also around all proposed opencast pits. The exact nature of the fence or the method statements for wetland crossings was not yet available. These fences will be required to cross a large number of wetland areas, mostly hillslope seepage wetlands. Construction of the fences across wetland areas will result in a number of impacts:

- Disturbance of wetland habitat
- **Increased sediment transport into wetlands** - Bare soil areas resulting from vegetation clearing and soil stripping will provide extensive sediment sources delivering increased sediment loads to downslope wetlands. Transported sediments are likely to deposit in the receiving wetlands, leading to changes in vegetation and habitat.
- **Increased risk of erosion within wetlands –** disturbances to wetland vegetation and sediments, as well as the potential concentration of flows and creation of preferential flow paths will increase the risk of erosion.
- **Invasion of alien vegetation into wetlands –** disturbance to wetland habitat will create conditions suitable for alien invasive vegetation to become established.
- **Compaction of soils –** movement of heavy machinery and vehicles through the wetlands will lead to compaction of soils.

7.1.2.7 Construction of roads

The new roads required as part of the proposed TOPA project include:

- A maintenance road to the RLO
- Haul road from Boschmans south east to ROM stockpile
- Haul road bridge over eastern proposed provincial road
- Haul road bridge crossing provincial road along Ogies Dyke

The two haul road bridges over the provincial roads are not expected to directly impact on wetlands, though the maintenance road to the RLO, which will follow the conveyor route, as well as the haul road to the ROM stockpile will require a number of wetland crossings.

The following impacts are expected:

- Disturbance of wetland habitat
- **Increased sediment transport into wetlands** - Bare soil areas resulting from vegetation clearing and soil stripping will provide extensive sediment sources delivering increased

sediment loads to downslope wetlands. Transported sediments are likely to deposit in the receiving wetlands, leading to changes in vegetation and habitat.

- **Increased risk of erosion within wetlands** – disturbances to wetland vegetation and sediments, as well as the potential concentration of flows and creation of preferential flow paths will increase the risk of erosion.
- **Invasion of alien vegetation into wetlands** – disturbance to wetland habitat will create conditions suitable for alien invasive vegetation to become established.
- **Compaction of soils** – movement of heavy machinery and vehicles through the wetlands will lead to compaction of soils.

7.1.2.8 Construction of ROM tip

A ROM tip was approved as part of the 2010 EIA/EMP application. However, the site needs to be moved. The new proposed site will fall within the approved mine infrastructure area which is currently under construction and does not fall within a wetland area. Impacts to wetlands are thus expected to be minimal, but the following impacts could result:

- **Increased sediment transport into wetlands** - Bare soil areas resulting from vegetation clearing and soil stripping will provide extensive sediment sources delivering increased sediment loads to downslope wetlands. Transported sediments are likely to deposit in the receiving wetlands, leading to changes in vegetation and habitat.
- **Water quality deterioration** – During the construction phase, water quality deterioration is likely to mostly take the form of increased turbidity, though spills of hazardous materials used on site during construction could also enter wetland areas via surface runoff.

7.1.2.9 Construction of raw coal stockpile

A raw coal stockpile tip was approved as part of the 2010 EIA/EMP application. However, the site needs to be moved. The new proposed site will fall within the approved mine infrastructure area which is currently under construction and lies just to the south of the Boschmans Pan in close proximity to hillslope seepage wetlands. Impacts to wetlands are expected:

- **Disturbance of wetland habitat** – Wetland habitat immediately adjacent to the construction footprint could be disturbed by careless placement of temporary construction infrastructure and laydown areas, as well as careless and poorly controlled vehicle and machinery movements.
- **Increased sediment transport into wetlands** - Bare soil areas resulting from vegetation clearing and soil stripping will provide extensive sediment sources delivering increased sediment loads to downslope wetlands. Transported sediments are likely to deposit in the receiving wetlands, leading to changes in vegetation and habitat.
- **Water quality deterioration** – During the construction phase, water quality deterioration is likely to mostly take the form of increased turbidity, though spills of hazardous materials used on site during construction could also enter wetland areas via surface runoff.

7.1.3 Construction Phase EIAMAPs

TABLE 7.3.1: ACTIVITY / GROUP OF ACTIVITIES																							
				Rating														Financial Plan		Residual Impacts after mitigation – Rating			
No.	Environmental Component	Potential Impact	Issue of Concern with I&APs (Yes / No)	Status	Magnitude	Extent	Duration	Probability	Significance	Reversibility	Irreplaceable loss of resources	Potential of impacts to be mitigated	Mitigation management objectives and principles	Mitigation by design	Proposed Mitigation measures	Responsible person	Timeframe of mitigation	Concurrent (Annual Cost)	Final (Rehabilitation)	Magnitude	Extent	Duration	Probability
1. CONSTRUCTION PHASE																							
1.1 Opening of initial boxcuts for coal mining																							
	Wetlands	Loss and disturbance of wetland habitat and species		**-**	**8**	**1**	**5**	**5**	**70**	**3**	**3**	**2**	Minimise disturbances to wetland habitat.	Opencast pits were adjusted to exclude the high sensitivity hillslope seepage wetlands in the extreme east of the study area, and to exclude the pan cluster and its catchment to the north of Makoupan.	Limit soil stripping activities to the footprint of the proposed opencast pits only. Fence off either the development footprint or the adjacent wetlands to prevent access to the wetland areas. All wetland areas adjacent to the mining areas should be clearly demarcated as such and all staff educated as to the sensitivity of the wetland areas. Locate all soil and overburden stockpiles outside wetland areas. Sediment barriers (refer to Appendix 2 in wetland report) to be installed between stripped areas and downslope wetlands. Investigate wetland offsets as a means to mitigate against the loss of wetland habitat. Develop and implement a wtland offset strategy using the SANBI offset guideline methodology					**6**	**1**	**5**	**4**
	Wetlands	Increased sediment transport into wetlands		**-**	**6**	**2**	**2**	**5**	**50**	**2**	**2**	**2**	Minimise sediment transport into adjacent wetlands		Vegetation clearing and earthworks should be limited to as small an area as possible, preferably no larger than the direct footprint of the proposed development. Bare soil areas falling outside the direct footprint should be landscaped to the original landscape profile and re-vegetated as soon as possible. Hydroseeding with a mix of indigenous species should be done. Where practically possible, the major earthworks should be undertaken during the dry season (roughly from June to September) to limit erosion due to rainfall runoff. A low berm should be constructed between the proposed opencast footprint and the downslope wetlands to prevent sediment rich runoff from the construction site entering the wetlands. These berms should thus be constructed prior to the commencement of construction on the opencast pits.					**4**	**1**	**2**	**3**

	Wetlands	Water quality deterioration		**-**	**8**	**3**	**2**	**5**	**65**	**2**	**2**	**2**	Minimise water quality deterioration, specific focus on turbidity		Implement a construction stormwater management plan that aims to limit sediment movement of site and prevents the concentrated discharge of flows and high velocity discharges off site. All clean water from upslope should be diverted around the opencast area. Surface run-off from the opencast area should also be discharged into the downstream environment in a controlled manner. Discharge points should incorporate sediment traps and should encourage low velocity, diffuse flows through the receiving wetland. Sediment barriers or low berms should be installed along the downslope edge of the opencast areas to trap sediments.					**4**	**1**	**2**	**3**
	Wetlands	Decreased watermake to downslope wetlands		**-**	**6**	**2**	**5**	**5**	**65**	**2**	**2**	**2**	Minimise decrease in watermake		Limited opportunity to mitigate. All clean water from upslope must be diverted around the opencast areas and discharged back into downslope wetland. Discharge points should incorporate sediment traps and should encourage low velocity, diffuse flows through the receiving wetland.					**6**	**2**	**5**	**5**
1.2 Preparation for the underground mining of coal																							
	Wetlands	No construction phase impact			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	N/a	Use is made of existing shafts and infrastructure. No new infrastructure or shafts will be constructed.	None required					**0**	**0**	**0**	**0**
1.3 Opening of initial boxcuts for sand and gravel mining (borrow pits) for construction purposes																							
	Wetlands	Disturbance to wetland habitat		**-**	**8**	**1**	**2**	**4**	**44**	**2**	**2**	**2**	Prevent disturbance of wetland habitat outside the borrow pit footprint	All borrow pits are located within proposed and in many cases already authorised opencast mining areas.	Clearly demarcate the full extent of the proposed borrow pit. Maintain all construction activities to the demarcated area. Use existing access roads or provide a single, clearly marked access road for all machinery and staff movements. All wetland areas adjacent to the mining areas should be clearly demarcated as such and all staff educated as to the sensitivity of the wetland areas. Locate all soil and overburden stockpiles outside wetland areas. Sediment barriers to be installed between stripped areas and downslope wetlands.					**4**	**1**	**2**	**3**
	Wetlands	Increased sediment transport into wetlands		**-**	**6**	**2**	**2**	**5**	**50**	**2**	**2**	**2**	Minimise sediment transport into adjacent wetlands		Vegetation clearing and earthworks should be limited to as small an area as possible, preferably no larger than the direct footprint of the proposed borrow pit, and sho0uld be phased to ensure the area of exposed soils is as small as possible at any one time. Bare soil areas falling outside the direct footprint should be landscaped to the original landscape profile and re-vegetated as soon as possible. Hydroseeding with a mix of indigenous species should be done. Where practically possible, the major earthworks should be undertaken during the dry season (roughly from June to September) to limit erosion due to rainfall runoff. A low berm should be constructed between the proposed borrow pit and the downslope wetlands to prevent sediment rich runoff from the construction site entering the wetlands. These berms should thus be constructed prior to the commencement of construction on the opencast pits. Implement a construction stormwater management plan.					**4**	**1**	**1**	**3**

	Wetlands	Water quality deterioration		**-**	**6**	**2**	**2**	**3**	**30**	**2**	**2**	**2**	Prevent contamination of surface runoff leaving the construction site		All hazardous substances used during the construction phase should be stored on impervious surfaces that allow for the containment of spills and leakages (e.g. bunded areas). Should spills occur, these should be reported to the environmental officer. Larger spills will require the appointment of specialist clean-up teams to rehabilitate the affected area. No hazardous materials may be stockpiled in any wetland area on site. Sufficient spill clean-up materials should be kept on site at all times					**4**	**1**	**1**	**3**
	Wetlands	Decreased watermake to adjacent wetlands		**-**	**6**	**2**	**4**	**4**	**48**	**2**	**2**	**2**	Direct all clean water back into natural wetland areas and discharge in an environmentally friendly manner.		Limited opportunity to mitigate. All clean water from upslope must be diverted around the borrow pit areas and discharged back into downslope wetland. Clean runoff generated within the borrow pit should also be discharged to downslope areas. Discharge points should incorporate sediment traps and should encourage low velocity, diffuse flows through the receiving wetland. Clean surface runoff from within the borrow pit should also be discharged via a sediment trap.					**4**	**2**	**4**	**3**
1.4 Construction of water management infrastructure																							
	Wetlands	Disturbance to wetland habitat		**-**	**8**	**1**	**2**	**4**	**44**	**2**	**2**	**2**	Minimise disturbance of wetland habitat outside the direct development footprint		Undertake construction during the dry season as far as possible. Use existing tracks and roads to access the required pipeline routes. Lay pipes along existing disturbances such as roads. Locate all laydown areas and temporary construction infrastructure at least 100m from delineated wetland habitat, preferably on already disturbed land. Clearly demarcate identified laydown areas. Rehabilitate disturbed areas immediately following completion of construction activities.					**4**	**1**	**2**	**3**
	Wetlands	Increased sediment transport into wetlands		**-**	**6**	**2**	**2**	**5**	**50**	**2**	**2**	**2**	Minimise sediment transport into adjacent wetlands		Limit earthmoving activities to the dry season. Limit the extent of exposed bare soils surfaces at anyone time by phasing clearing activities. Clear areas only in the week prior to commencement of construction activities. Implement a construction stormwater management plan that aims to limit sediment movement of site and prevents the concentrated discharge of flows and high velocity discharges off site.					**4**	**1**	**2**	**4**
	Wetlands	Increased risk of erosion within wetlands		**-**	**6**	**2**	**4**	**3**	**36**	**2**	**2**	**2**	Prevent gully erosion		Undertake construction during the dry season as far as possible. Use existing tracks and roads to access the required pipeline routes. Lay pipes along existing disturbances such as roads. Rehabilitate disturbed areas immediately following completion of construction activities. Rehabilitation activities should focus on landscaping the disturbed area back to the natural landscape profile to prevent flow concentration, and to re-vegetated disturbed areas. Implement a monitoring plan to ensure success of rehabilitation activities.					**4**	**1**	**2**	**3**
	Wetlands	Invasion of alien vegetation into wetlands		**-**	**6**	**2**	**5**	**3**	**39**	**2**	**2**	**2**	Prevent establishment of alien invasive vegetation within the wetlands		Compile and implement an alien vegetation removal and management plan to deal with all invasive alien species on site. Monitor areas disturbed during construction activities for signs of alien invasive species and clear immediately					**4**	**1**	**2**	**2**

	Wetlands	Compaction of soils		**-**	**6**	**1**	**3**	**4**	**40**	**2**	**2**	**2**	Prevent compacted soils remaining on site at the end of the construction phase.		Undertake construction during the dry season as far as possible. Use existing tracks and roads to access the required pipeline routes and construction sites. Lay pipes along existing disturbances such as roads if possible. Locate all laydown areas and temporary construction infrastructure at least 100m from delineated wetland habitat, preferably on already disturbed land. Clearly demarcate identified laydown areas. Rehabilitate disturbed areas immediately following completion of construction activities.					**4**	**1**	**1**	**3**
1.5 Construction of diesel storage tanks																							
	Wetlands	Increased sediment transport into wetlands		**-**	**4**	**2**	**2**	**4**	**32**	**2**	**1**	**2**	Minimise sediment transport off the construction site.		Limit earthmoving activities to the dry season. Limit the extent of exposed bare soils surfaces at anyone time by phasing clearing activities. Clear areas only in the week prior to commencement of construction activities. Implement a construction stormwater management plan that aims to limit sediment movement of site and prevents the concentrated discharge of flows and high velocity discharges off site.					**2**	**1**	**2**	**2**
	Wetlands	Water quality deterioration		**-**	**6**	**2**	**2**	**3**	**30**	**2**	**1**	**2**	Prevent contamination of surface runoff leaving the construction site		All hazardous substances used during the construction phase should be stored on impervious surfaces that allow for the containment of spills and leakages (e.g. bunded areas). Should spills occur, these should be reported to the environmental officer. Larger spills will require the appointment of specialist clean-up teams to rehabilitate the affected area. No hazardous materials may be stockpiled in any wetland area on site. Sufficient spill clean-up materials should be kept on site at all times					**2**	**1**	**2**	**2**
1.6 Construction of waste management infrastructure																							
	Wetlands	Disturbance to wetland habitat		**-**	**8**	**1**	**2**	**4**	**44**	**2**	**2**	**2**	Minimise disturbance of wetland habitat outside the direct development footprint		Undertake construction during the dry season as far as possible. Use existing tracks and roads to access the required construction sites. Locate all laydown areas and temporary construction infrastructure at least 100m from delineated wetland habitat, preferably on already disturbed land. Clearly demarcate identified laydown areas. Rehabilitate disturbed areas immediately following completion of construction activities.					**4**	**1**	**2**	**3**
	Wetlands	Increased sediment transport into wetlands		**-**	**6**	**2**	**2**	**5**	**50**	**2**	**2**	**2**	Minimise sediment transport into adjacent wetlands		Limit earthmoving activities to the dry season. Limit the extent of exposed bare soils surfaces at anyone time by phasing clearing activities. Clear areas only in the week prior to commencement of construction activities. Implement a construction stormwater management plan that aims to limit sediment movement of site and prevents the concentrated discharge of flows and high velocity discharges off site.					**4**	**1**	**2**	**4**
	Wetlands	Increased risk of erosion within wetlands		**-**	**6**	**2**	**4**	**3**	**36**	**2**	**2**	**2**	Prevent gully erosion		Undertake construction during the dry season as far as possible. Use existing tracks and roads to access the required construction sites. Rehabilitate disturbed areas immediately following completion of construction activities. Rehabilitation activities should focus on landscaping the disturbed area back to the natural landscape profile to prevent flow concentration, and to re-vegetated disturbed areas. Implement a monitoring plan to ensure success of rehabilitation activities.					**4**	**1**	**2**	**3**
	Wetlands	Invasion of alien vegetation into wetlands		**-**	**6**	**2**	**5**	**3**	**39**	**2**	**2**	**2**	Prevent establishment of alien invasive vegetation within the wetlands		Compile and implement an alien vegetation removal and management plan to deal with all invasive alien species on site. Monitor areas disturbed during construction activities for signs of alien invasive species and clear immediately					**4**	**1**	**2**	**2**

	Wetlands	Compaction of soils		**-**	**6**	**1**	**3**	**4**	**40**	**2**	**2**	**2**	Prevent compacted soils remaining on site at the end of the construction phase.		Undertake construction during the dry season as far as possible. Use existing tracks and roads to access the required pipeline routes and construction sites. Lay pipes along existing disturbances such as roads if possible. Locate all laydown areas and temporary construction infrastructure at least 100m from delineated wetland habitat, preferably on already disturbed land. Clearly demarcate identified laydown areas. Rehabilitate disturbed areas immediately following completion of construction activities.					**4**	**1**	**1**	**3**
1.7 Construction of temporary coal stockpile																							
	Wetlands	Increased sediment transport into wetlands		**-**	**4**	**2**	**2**	**4**	**32**	**2**	**1**	**2**	Minimise sediment transport off the construction site.		Limit earthmoving activities to the dry season. Limit the extent of exposed bare soils surfaces at anyone time by phasing clearing activities. Clear areas only in the week prior to commencement of construction activities. Implement a construction stormwater management plan that aims to limit sediment movement of site and prevents the concentrated discharge of flows and high velocity discharges off site.					**2**	**1**	**2**	**2**
	Wetlands	Water quality deterioration		**-**	**6**	**2**	**2**	**3**	**30**	**2**	**1**	**2**	Prevent contamination of surface runoff leaving the construction site		All hazardous substances used during the construction phase should be stored on impervious surfaces that allow for the containment of spills and leakages (e.g. bunded areas). Should spills occur, these should be reported to the environmental officer. Larger spills will require the appointment of specialist clean-up teams to rehabilitate the affected area. No hazardous materials may be stockpiled in any wetland area on site. Sufficient spill clean-up materials should be kept on site at all times					**2**	**1**	**2**	**2**
1.8 Construction of explosives magazine																							
	Wetlands	Increased sediment transport into wetlands		**-**	**4**	**2**	**2**	**4**	**32**	**2**	**1**	**2**	Minimise sediment transport off the construction site.		Limit earthmoving activities to the dry season. Limit the extent of exposed bare soils surfaces at anyone time by phasing clearing activities. Clear areas only in the week prior to commencement of construction activities. Implement a construction stormwater management plan that aims to limit sediment movement of site and prevents the concentrated discharge of flows and high velocity discharges off site.					**2**	**1**	**2**	**2**
	Wetlands	Water quality deterioration		**-**	**6**	**2**	**2**	**3**	**30**	**2**	**1**	**2**	Prevent contamination of surface runoff leaving the construction site		All hazardous substances used during the construction phase should be stored on impervious surfaces that allow for the containment of spills and leakages (e.g. bunded areas). Should spills occur, these should be reported to the environmental officer. Larger spills will require the appointment of specialist clean-up teams to rehabilitate the affected area. No hazardous materials may be stockpiled in any wetland area on site. Sufficient spill clean-up materials should be kept on site at all times					**2**	**1**	**2**	**2**
1.9 Construction of general fencing on site																							
	Wetlands	Disturbance to wetland habitat		**-**	**8**	**1**	**2**	**4**	**44**	**2**	**2**	**2**	Minimise disturbance of wetland habitat outside the direct development footprint		Undertake construction during the dry season as far as possible. Use existing tracks and roads to access the required fence line. Make use of simple cattle fences wherever possible. Construct such fences across wetland areas on foot if possible. Locate all laydown areas and temporary construction infrastructure at least 100m from delineated wetland habitat, preferably on already disturbed land. Clearly demarcate identified laydown areas. Rehabilitate disturbed areas immediately following completion of construction activities.					**4**	**1**	**2**	**3**

	Wetlands	Increased sediment transport into wetlands		**-**	**6**	**2**	**2**	**5**	**50**	**2**	**2**	**2**	Minimise sediment transport into adjacent wetlands		As far as possible, no vegetation clearing should accompany fence construction. If required, mowing of the grass with a tractor mower could be considered to open up the route for construction activities. If required, clear areas only in the week prior to commencement of construction activities. Implement a construction stormwater management plan that aims to limit sediment movement of site and prevents the concentrated discharge of flows and high velocity discharges off site.					**4**	**1**	**2**	**4**
	Wetlands	Increased risk of erosion within wetlands		**-**	**6**	**2**	**4**	**3**	**36**	**2**	**2**	**2**	Prevent gully erosion		Undertake construction during the dry season as far as possible. Use existing tracks and roads to access the required construction sites. Rehabilitate disturbed areas immediately following completion of construction activities. Rehabilitation activities should focus on landscaping the disturbed area back to the natural landscape profile to prevent flow concentration, and to re-vegetated disturbed areas. Implement a monitoring plan to ensure success of rehabilitation activities.					**4**	**1**	**2**	**3**
	Wetlands	Invasion of alien vegetation into wetlands		**-**	**6**	**2**	**5**	**3**	**39**	**2**	**2**	**2**	Prevent establishment of alien invasive vegetation within the wetlands		Compile and implement an alien vegetation removal and management plan to deal with all invasive alien species on site. Monitor areas disturbed during construction activities for signs of alien invasive species and clear immediately					**4**	**1**	**2**	**2**
	Wetlands	Compaction of soils		**-**	**6**	**1**	**3**	**4**	**40**	**2**	**2**	**2**	Prevent compacted soils remaining on site at the end of the construction phase.		Undertake construction during the dry season as far as possible. Use existing tracks and roads to access the required fence routes and construction sites. Install fences along existing disturbances such as roads if possible. Locate all laydown areas and temporary construction infrastructure at least 100m from delineated wetland habitat, preferably on already disturbed land. Clearly demarcate identified laydown areas. Rehabilitate disturbed areas immediately following completion of construction activities.					**4**	**1**	**1**	**3**
1.10 Construction of roads																							
	Wetlands	Disturbance to wetland habitat		**-**	**6**	**2**	**4**	**4**	**48**	**2**	**2**	**2**	Minimise disturbance of wetland habitat outside the direct development footprint		Undertake construction during the dry season as far as possible. Use existing tracks and roads to access the required construction sites. Locate all laydown areas and temporary construction infrastructure at least 100m from delineated wetland habitat, preferably on already disturbed land. Clearly demarcate identified laydown areas. Rehabilitate disturbed areas immediately following completion of construction activities. Develop and submit detailed method statements of all required wetland crossings to the DWA for approval .					**4**	**1**	**2**	**3**
	Wetlands	Increased sediment transport into wetlands		**-**	**6**	**2**	**2**	**5**	**50**	**2**	**2**	**2**	Minimise sediment transport into adjacent wetlands		Limit earthmoving activities to the dry season. Limit the extent of exposed bare soils surfaces at anyone time by phasing clearing activities. Clear areas only in the week prior to commencement of construction activities. Implement a construction stormwater management plan that aims to limit sediment movement of site and prevents the concentrated discharge of flows and high velocity discharges off site. Develop and submit detailed method statements of all required wetland crossings to the DWA for approval .					**4**	**1**	**2**	**4**

	Wetlands	Increased risk of erosion within wetlands		-	6	2	4	3	36	2	2	2	Prevent gully erosion		Undertake construction during the dry season as far as possible. Use existing tracks and roads to access the required construction sites. Rehabilitate disturbed areas immediately following completion of construction activities. Rehabilitation activities should focus on landscaping the disturbed area back to the natural landscape profile to prevent flow concentration, and to re-vegetated disturbed areas. Implement a monitoring plan to ensure success of rehabilitation activities. Develop and submit detailed method statements of all required wetland crossings to the DWA for approval .					4	1	2	3
	Wetlands	Invasion of alien vegetation into wetlands		-	6	2	5	3	39	2	2	2	Prevent establishment of alien invasive vegetation within the wetlands		Compile and implement an alien vegetation removal and management plan to deal with all invasive alien species on site. Monitor areas disturbed during construction activities for signs of alien invasive species and clear immediately					4	1	2	2
	Wetlands	Compaction of soils		-	6	1	3	4	40	2	2	2	Prevent compacted soils remaining on site at the end of the construction phase.		Undertake construction during the dry season as far as possible. Use existing tracks and roads to access the required pipeline routes and construction sites. Lay pipes along existing disturbances such as roads if possible. Locate all laydown areas and temporary construction infrastructure at least 100m from delineated wetland habitat, preferably on already disturbed land. Clearly demarcate identified laydown areas. Rehabilitate disturbed areas immediately following completion of construction activities. Develop and submit detailed method statements of all required wetland crossings to the DWA for approval .					4	1	1	3
1.11 Construction of ROM tip																							
	Wetlands	Increased sediment transport into wetlands		-	4	2	2	4	32	2	1	2	Minimise sediment transport off the construction site.		Limit earthmoving activities to the dry season. Limit the extent of exposed bare soils surfaces at anyone time by phasing clearing activities. Clear areas only in the week prior to commencement of construction activities. Implement a construction stormwater management plan that aims to limit sediment movement of site and prevents the concentrated discharge of flows and high velocity discharges off site.					2	1	2	2
	Wetlands	Water quality deterioration		-	6	2	2	3	30	2	1	2	Prevent contamination of surface runoff leaving the construction site		All hazardous substances used during the construction phase should be stored on impervious surfaces that allow for the containment of spills and leakages (e.g. bunded areas). Should spills occur, these should be reported to the environmental officer. Larger spills will require the appointment of specialist clean-up teams to rehabilitate the affected area. No hazardous materials may be stockpiled in any wetland area on site. Sufficient spill clean-up materials should be kept on site at all times					2	1	2	2
1.12 Construction of raw coal stockpile																							
	Wetlands	Disturbance to wetland habitat		-	8	1	2	4	44	2	2	2	Minimise disturbance of wetland habitat outside the direct development footprint		Undertake construction during the dry season as far as possible. Use existing tracks and roads to access the required construction sites. Locate all laydown areas and temporary construction infrastructure at least 100m from delineated wetland habitat, preferably on already disturbed land. Clearly demarcate identified laydown areas. Rehabilitate disturbed areas immediately following completion of construction activities.					4	1	2	3

	Wetlands	Increased sediment transport into wetlands		**-**	**6**	**2**	**2**	**4**	**40**	**2**	**1**	**2**	Minimise sediment transport off the construction site.		Limit earthmoving activities to the dry season. Limit the extent of exposed bare soils surfaces at anyone time by phasing clearing activities. Clear areas only in the week prior to commencement of construction activities. Implement a construction stormwater management plan that aims to limit sediment movement of site and prevents the concentrated discharge of flows and high velocity discharges off site.					**4**	**1**	**1**	**4**
	Wetlands	Water quality deterioration		**-**	**6**	**2**	**2**	**4**	**40**	**2**	**1**	**2**	Prevent contamination of surface runoff leaving the construction site		All hazardous substances used during the construction phase should be stored on impervious surfaces that allow for the containment of spills and leakages (e.g. bunded areas). Should spills occur, these should be reported to the environmental officer. Larger spills will require the appointment of specialist clean-up teams to rehabilitate the affected area. No hazardous materials may be stockpiled in any wetland area on site. Sufficient spill clean-up materials should be kept on site at all times					**4**	**1**	**1**	**4**

7.2 Operational Phase

7.2.1 Mining Activities

7.2.1.1 Opencast mining of coal

The opencast mining activities proposed as part of TOPA will result in the further loss of approximately 137.54 hectares of wetland, as detailed below. Wetlands that will be affected by the already authorized but not yet commenced mining activities are not included in this figure. More than 135 ha of the affected wetlands are hillslope seepage wetlands. As opencast pits progress, all wetlands within their footprint will be permanently destroyed.

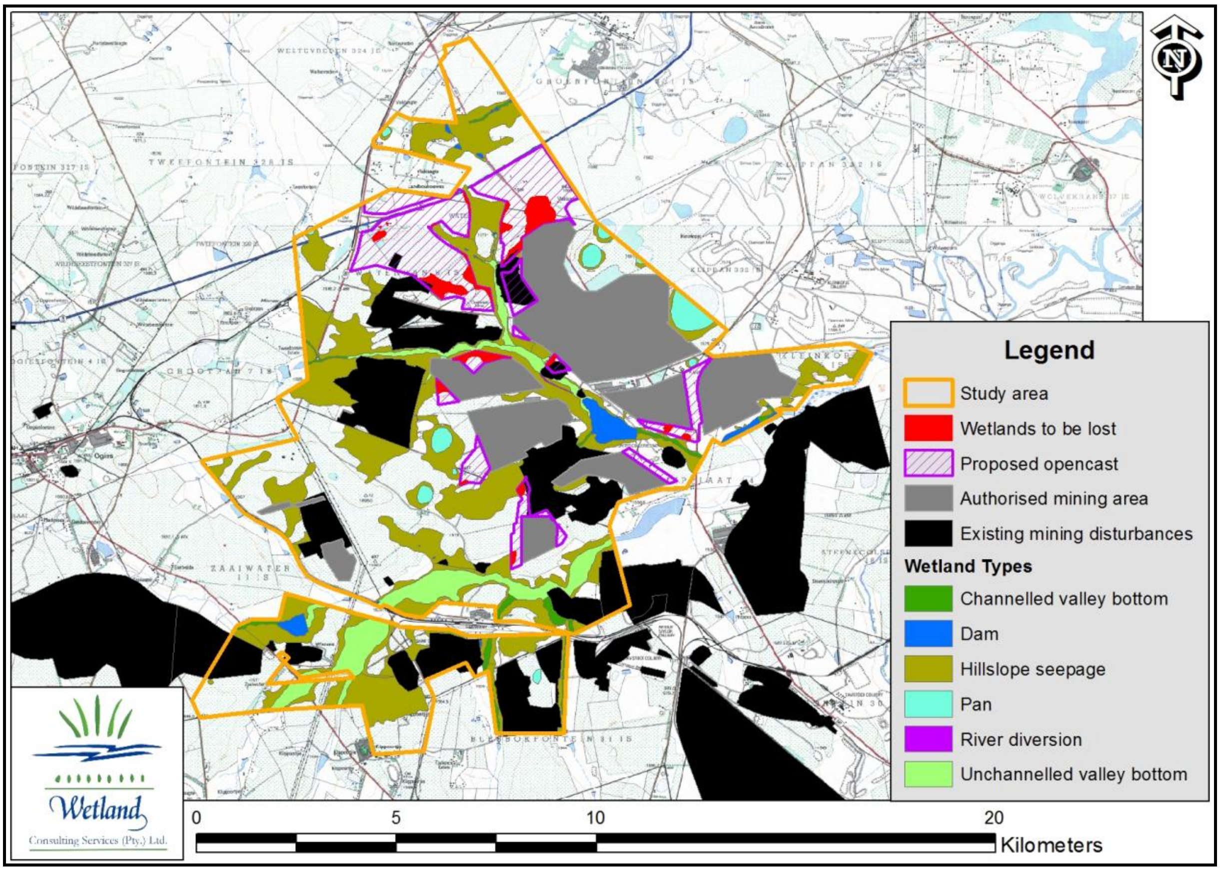


Figure 21. Map showing the proposed mining activities and the wetland habitat likely to be lost as a result.

Figure 21 above shows the proposed opencast pits in relation to existing mining disturbances and already authorized opencast mining areas where mining has not yet commenced. In most cases the proposed new opencast areas represent expansions of the already authorized opencast pits and the wetlands affected by the proposed expansions will already be significantly impacted by already authorized but not yet commenced opencast pits.

The most significant new opencast pits are located just to the south of the N12 highway in the catchment of the Waterpan tributary to the Tweefonteinspruit. The valley bottom wetlands have been excluded from the proposed opencast footprint, but hillslope seepage wetlands will be impacted.

The initial mine plan was amended to exclude the high sensitivity hillslope seepage wetlands in the extreme east of the study area, and also to ensure that the cluster of three pans to the north west of Makoupan, as well as their catchments, was excluded from the opencast footprint.

Opencast mining will result in the following impacts to wetlands:

- **Loss and disturbance to wetland habitat** – all wetlands falling within the direct footprint of the opencast pits will be permanently destroyed. Construction activities are likely to also cause disturbances to adjacent wetland habitat and displace the species supported by this habitat.
- **Increased sediment transport into wetlands** - Bare soil areas resulting from vegetation clearing and soil stripping will provide extensive sediment sources delivering increased sediment loads to downslope wetlands. Transported sediments are likely to deposit in the receiving wetlands, leading to changes in vegetation and habitat.
- **Water quality deterioration** – During the construction phase, water quality deterioration is likely to mostly take the form of increased turbidity, though spills of hazardous materials used on site during construction could also enter wetland areas via surface runoff.
- **Decreased water make to adjacent wetlands** – Where the opencast pits are located upslope of wetland areas, the opencast pits are likely to intercept subsurface seepage, as well as direct rainfall. Water make to downslope wetlands is thus likely to decrease.

Table 11. Table showing the type and extent of wetlands likely to be directly impacted by opencast mining.

Tweefontein			
Wetland Type	**Wetland Extent (Current)**	**Wetlands to be lost**	**Percentage of wetlands lost**
Channelled valley bottom	106.62	0.98	0.92%
Unchannelled valley bottom	480.28	0.71	0.15%
River diversion	2.83	---	---
Pan	139.67	---	---
Hillslope seepage	2634.35	135.85	5.16%
Dams	125.47	n/a	n/a
TOTAL	**3489.22**	**137.54**	**3.94%**

7.2.1.2 Concurrent rehabilitation of opencast voids

Rehabilitation of opencast pits will involve the backfilling of the pits, the shaping of the landform, placement of topsoil and revegetation of the rehabilitated areas. No wetlands are likely to reform on the rehabilitated areas due to the lack of an aquitard in the replaced soil profile.

Increased sediment inputs to wetlands - The extensive bare soil areas exposed during the rehabilitation process prior to revegetation will provide a large sediment source, with sediments likely to be washed into adjacent wetlands via surface runoff.

Changes in wetland hydrology - Bare soil areas are likely to increase the volumes and velocities of surface runoff compared to pre-mining conditions. This will increase flow velocities in receiving wetlands and decrease time to concentration and increase flood peaks, increasing the risk of erosion.

7.2.1.3 Underground mining of coal

All additional underground mining areas will be accessed via existing infrastructure. No new infrastructure will be required. All underground mining will take place via bord-and-pillar mining. Existing underground mining on site is also done via bord-and-pillar mining – however, some surface subsidence has occurred on site.

Undermining of wetland areas could result in the following impacts:

- Surface subsidence leading to increased water ingress to the underground workings and decreased flows within affected wetlands
- Increased risk of erosion in wetlands due to changes in flow characteristics brought about by changes in the wetland topography

7.2.1.4 Opencast mining of borrow pits

7 borrow pits are proposed as a source of sand and gravel for construction purposes. The location and extent of the borrow pits is illustrated below.

5 of the borrow pits fall within an area earmarked (and already authorized) for opencast mining. Although these borrow pits will impact directly on an isolated hillslope seepage wetland, this wetland will be destroyed by opencast mining at a later stage in any event. A further borrow pit is located immediately adjacent to the Waterpan tributary valley bottom area within an existing mining disturbed area (old Waterpan Plant area). The south eastern Klienkopje borrow pit is located in previously cultivated land outside delineated wetland habitat.

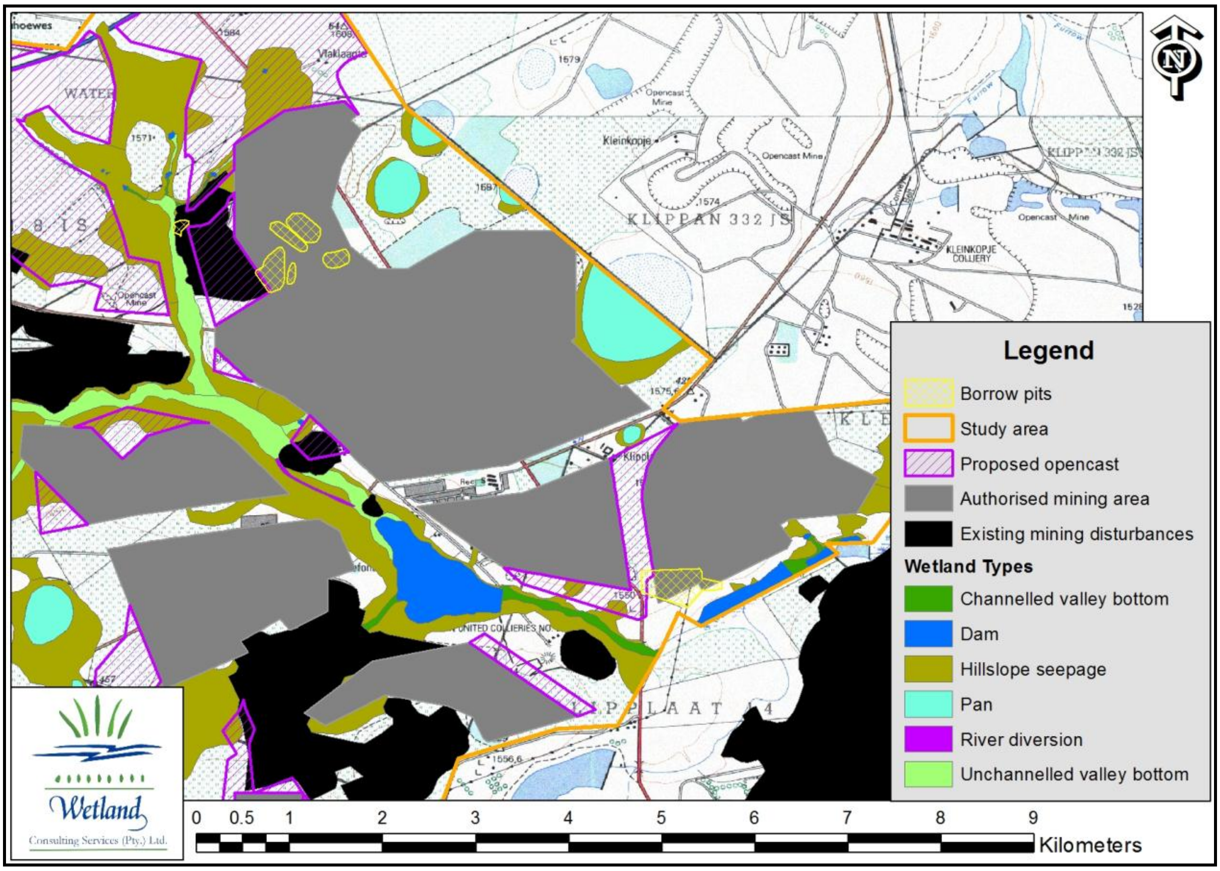


Figure 22. Map showing the location of the proposed borrow pits.

Development of the borrow pits is however still likely to impact on wetlands:

- **Disturbance to wetland habitat** –Construction activities are likely to cause disturbances to adjacent wetland habitat and displace the species supported by this habitat.
- **Increased sediment transport into wetlands** - Bare soil areas resulting from vegetation clearing and soil stripping will provide extensive sediment sources delivering increased sediment loads to downslope wetlands. Transported sediments are likely to deposit in the receiving wetlands, leading to changes in vegetation and habitat.
- **Water quality deterioration** – During the construction phase, water quality deterioration is likely to mostly take the form of increased turbidity, though spills of hazardous materials used on site during construction could also enter wetland areas via surface runoff.
- **Decreased water make to adjacent wetlands –** Where the boxcut is located upslope of wetland areas, the boxcut is likely to intercept subsurface seepage, as well as direct rainfall. Water make to downslope wetlands is thus likely to decrease.

7.2.2 Mining-related Activities

7.2.2.1 Use and maintenance of water and waste management infrastructure

The following impacts are expected:

- **Disturbance to wetland habitat** - Maintenance activities along the pipeline route could lead to disturbance to wetland habitat through vehicle and human traffic through wetlands.

- **Water quality deterioration due to leaks along pipelines** - Pipe failure or leakage of the dirty water pipeline could result in untreated mine water entering the wetlands, leading to a significant deterioration in water quality within the affected wetlands.
- **Erosion within wetlands crossed by pipelines due to pipeline leaks and failure** - Pipe failure could result in significant increases in flow within wetlands, especially hillslope seepage wetlands. Such increase in flows will likely lead to erosion. Pipe leaks will have a more subtle impact, depending on the severity of the leak. Small leaks will result in increased soil wetness in temporary to seasonally saturated areas, leading to changes in vegetation structure and composition. Where leaks occur outside wetland areas, extended leaks could result in formation of artificial wetland habitat.
- Water quality deterioration due to seepage or leakage out of dirty water storage areas such as PCD's
- **Erosion due to discharge of clean stormwater** - Hardened surfaces associated with infrastructure will increase surface runoff volumes and velocities. Clean stormwater will be collected in the stormwater management system and likely discharged as a point source into the landscape. Increased volumes and velocities of water inputs will increase the risk of erosion within the wetlands.

7.2.2.2 Use and maintenance of linear infrastructure

Use and maintenance of pipeline infrastructure was dealt with in the previous section. This section deals with the assessment of impacts due to use of linear infrastructure other than pipelines, e.g. the roads.

- **Disturbance to wetland habitat** - Maintenance activities along the pipeline route could lead to disturbance to wetland habitat through vehicle and human traffic through wetlands.
- **Erosion due to discharge of clean stormwater** – Concentrated high velocity discharge from road surfaces could lead to erosion in receiving wetlands..

7.2.2.3 Use and maintenance of other infrastructure

The following impacts are expected to wetlands:

Water quality deterioration – Failure to successfully separate clean and dirty water areas and isolate dirty water areas could lead to water quality deterioration in adjacent water resources. Leakage, seepage or overflow from dirty water storage areas could also lead to water quality deterioration.

Erosion due to discharge of clean stormwater - Hardened surfaces associated with infrastructure will increase surface runoff volumes and velocities. Clean stormwater will be collected in the stormwater management system and likely discharged as a point source into the landscape. Increased volumes and velocities of water inputs will increase the risk of erosion within the wetlands.

7.2.3 Operational Phase EIAMAPs

TABLE 7.3.1: ACTIVITY / GROUP OF ACTIVITIES

No.	Environmental Component	Potential Impact	Issue of Concern with I&APs (Yes / No)	Rating: Status	Rating: Magnitude	Rating: Extent	Rating: Duration	Rating: Probability	Rating: Significance	Rating: Reversibility	Rating: Irreplaceable loss of resources	Rating: Potential of impacts to be mitigated	Mitigation management objectives and principles	Mitigation by design	Proposed Mitigation measures	Responsible person	Timeframe of mitigation	Financial Plan: Concurrent (Annual Cost)	Financial Plan: Final (Rehabilitation)	Residual Impacts after mitigation Rating: Magnitude	Residual Impacts after mitigation Rating: Extent	Residual Impacts after mitigation Rating: Duration	Residual Impacts after mitigation Rating: Probability
2. Operational Phase																							
2.13 Opencast mining of coal																							
	Wetlands	Loss and disturbance of wetland habitat and species		**-**	**8**	**3**	**5**	**5**	**80**	**3**	**3**	**2**	Minimise disturbances to wetland habitat.	Opencast pits were adjusted to exclude the high sensitivity hillslope seepage wetlands in the extreme east of the study area, and to exclude the pan cluster and its catchment to the north of Makoupan.	Limit soil stripping activities to the footprint of the proposed opencast pits only. Fence off either the development footprint or the adjacent wetlands to prevent access to the wetland areas. All wetland areas adjacent to the mining areas should be clearly demarcated as such and all staff educated as to the sensitivity of the wetland areas. Locate all soil and overburden stockpiles outside wetland areas. Sediment barriers (refer to Appendix 2 of wetland report for examples) to be installed between stripped areas and downslope wetlands. Investigate wetland offsets as a means to mitigate against the loss of wetland habitat. Apply SANBI offset guideline methodology for any offsets					**6**	**1**	**5**	**5**
	Wetlands	Increased sediment transport into wetlands		**-**	**6**	**2**	**2**	**5**	**50**	**2**	**2**	**2**	Minimise sediment transport into adjacent wetlands		Vegetation clearing and earthworks should be limited to as small an area as possible, preferably no larger than the direct footprint of the proposed development. Bare soil areas falling outside the direct footprint should be landscaped to the original landscape profile and re-vegetated as soon as possible. Hydroseeding where necessary with a mix of indigenous species should be done. Where practically possible, the major earthworks should be undertaken during the dry season (roughly from June to September) to limit erosion due to rainfall runoff. A low berm should be constructed between the proposed opencast footprint and the downslope wetlands to prevent sediment rich runoff from the construction site entering the wetlands. These berms should thus be constructed prior to the commencement of construction on the opencast pits.					**4**	**1**	**2**	**3**

	Wetlands	Water quality deterioration		**-**	**8**	**3**	**2**	**5**	**65**	**2**	**2**	**2**	Minimise water quality deterioration, specific focus on turbidity		Implement a construction stormwater management plan that aims to limit sediment movement of site and prevents the concentrated discharge of flows and high velocity discharges off site. All clean water from upslope should be diverted around the opencast area. Surface run-off from the opencast area should also be discharged into the downstream environment in a controlled manner. Discharge points should incorporate sediment traps and should encourage low velocity, diffuse flows through the receiving wetland. Sediment barriers or low berms should be installed along the downslope edge of the opencast areas to trap sediments.					**6**	**1**	**2**	**3**
	Wetlands	Decreased watermake to downslope wetlands		**-**	**6**	**2**	**5**	**5**	**65**	**2**	**2**	**2**	Minimise decrease in watermake		Limited opportunity to mitigate. All clean water from upslope must be diverted around the opencast areas and discharged back into downslope wetland. Discharge points should incorporate sediment traps and should encourage low velocity, diffuse flows through the receiving wetland.					**6**	**2**	**5**	**5**
2.14 Concurrent rehabilitation of opencast voids																							
	Wetlands	Increased sediment inputs into wetlands		-	8	2	3	5	**65**	**2**	**2**	**2**	Limit sediment transport off the rehabilitated areas		Replaced spoils should be landscaped to be free draining, but should avoid steep slopes and concentrated run-off. The rehabilitated areas should be re-vegetated as soon as possible following completion of the earthworks to minimise erosion. Regular long-term follow up of rehabilitated areas will be required to ensure the successful establishment of vegetation and to survey for any erosion damage on site. Erosion damage should be repaired immediately. The recommendations contained within the specialist vegetation and soils reports should be fully implemented to ensure successful rehabilitation					**6**	**2**	**2**	**4**
	Wetlands	Altered hydrology		**-**	**6**	**2**	**5**	**5**	**65**	**2**	**2**	**2**			Limited opportunity to mitigate. Opencast coal mining permanently alters the movement of water through the landscape. Replaced spoils should be landscaped to be free draining, but should avoid steep slopes and concentrated run-off. The rehabilitated areas should be re-vegetated as soon as possible following completion of the earthworks to minimise erosion. Regular long-term follow up of rehabilitated areas will be required to ensure the successful establishment of vegetation and to survey for any erosion damage on site. Erosion damage should be repaired immediately. The recommendations contained within the specialist vegetation and soils reports should be fully implemented to ensure successful rehabilitation					**6**	**2**	**3**	**5**
2.15 Underground mining of coal																							
	Wetlands	Increased ingress to underground mines		**-**	**6**	**3**	**5**	**3**	**42**	**2**	**2**	**2**	Prevent surface subsidence		Prevent surface subsidence by making use of a sufficient pillar safety factor during bord-and-pillar mining					**4**	**1**	**4**	**1**
	Wetlands	Increased risk of erosion within wetlands		**-**	**4**	**1**	**4**	**2**	**18**	**2**	**1**	**2**	Prevent surface subsidence		Prevent surface subsidence by making use of a sufficient pillar safety factor during bord-and-pillar mining					**2**	**1**	**2**	**1**
2.16 Opencast mining of sand and gravel (borrow pits) for construction																							

	Wetlands	Loss and disturbance of wetland habitat and species		**-**	**8**	**1**	**2**	**4**	**44**	**2**	**2**	**2**	Prevent disturbance of wetland habitat outside the borrow pit footprint		Clearly demarcate the full extent of the proposed borrow pit. Maintain all construction activities to the demarcated area. Use existing access roads or provide a single, clearly marked access road for all machinery and staff movements. All wetland areas adjacent to the mining areas should be clearly demarcated as such and all staff educated as to the sensitivity of the wetland areas. Locate all soil and overburden stockpiles outside wetland areas. Sediment barriers to be installed between stripped areas and downslope wetlands.					**4**	**1**	**1**	**2**
	Wetlands	Increased sediment transport into wetlands		**-**	**6**	**2**	**2**	**5**	**50**	**2**	**2**	**2**	Minimise sediment transport into adjacent wetlands		Vegetation clearing and earthworks should be limited to as small an area as possible, preferably no larger than the direct footprint of the proposed borrow pit, and sho0uld be phased to ensure the area of exposed soils is as small as possible at any one time. Bare soil areas falling outside the direct footprint should be landscaped to the original landscape profile and re-vegetated as soon as possible. Hydroseeding with a mix of indigenous species should be done. Where practically possible, the major earthworks should be undertaken during the dry season (roughly from June to September) to limit erosion due to rainfall runoff. A low berm should be constructed between the proposed borrow pit and the downslope wetlands to prevent sediment rich runoff from the construction site entering the wetlands. These berms should thus be constructed prior to the commencement of construction on the opencast pits. Implement a construction stormwater management plan.					**4**	**1**	**1**	**4**
	Wetlands	Water quality deterioration		**-**	**6**	**2**	**2**	**3**	**30**	**2**	**2**	**2**	Prevent contamination of surface runoff leaving the construction site		All hazardous substances used during the construction phase should be stored on impervious surfaces that allow for the containment of spills and leakages (e.g. bunded areas). Should spills occur, these should be reported to the environmental officer. Larger spills will require the appointment of specialist clean-up teams to rehabilitate the affected area. No hazardous materials may be stockpiled in any wetland area on site. Sufficient spill clean-up materials should be kept on site at all times					**4**	**1**	**1**	**4**
	Wetlands	Decreased watermake to downslope wetlands		**-**	**6**	**2**	**4**	**4**	**48**	**2**	**2**	**2**			Limited opportunity to mitigate. All clean water from upslope must be diverted around the opencast areas and discharged back into downslope wetland. Discharge points should incorporate sediment traps and should encourage low velocity, diffuse flows through the receiving wetland. Clean surface runoff from within the borrow pit should also be discharged via a sediment trap.					**6**	**2**	**4**	**4**
2.17 Use and maintenance of water and waste management infrastructure																							
	Wetlands	Disturbance to wetland habitat		**-**	**6**	**1**	**4**	**3**	**33**	**2**	**1**	**2**	Prevent disturbance of wetland habitat outside the direct activity footprint		Maintenance activities should make use of existing roads and tracks and all vehicles should stick to roads and tracks. No off-road driving should be allowed unless absolutely unavoidable. No temporary stockpiling of material in wetland habitat.					**4**	**1**	**1**	**3**

	Wetlands	Water quality deterioration due to leaks along pipelines		-	8	3	4	4	60	2	2	2	Limit deterioration of water quality in wetlands		Leak detection systems will need to be put in place that will allow for rapid detection of leaks. Rapid shutdown mechanisms need to be in place to allow for immediate shutdown should pipe failure occur. Emergency response procedures must be clearly defined and all staff must be fully aware of the procedures. All leaks and pipe failures must be reported to the DWA in compliance with XSA procedure. Include dirty pipeline crossings over wetlands in water quality monitoring and biomonitoring plans					6	1	4	4
	Wetlands	Erosion within wetlands crossed by pipelines due to leaks and pipeline failure		-	6	2	4	4	48	2	2	2	Prevent erosion in wetlands crossed by pipelines		Leak detection systems will need to be put in place that will allow for rapid detection of leaks. Rapid shutdown mechanisms need to be in place to allow for immediate shutdown should pipe failure occur. Emergency response procedures must be clearly defined and all staff must be fully aware of the procedures. All leaks and pipe failures must be reported to the DWA in compliance with XSA procedure.					4	1	4	4
	Wetlands	Water quality deterioration due to leakage and seepage out of PCD's		-	8	2	4	3	42	2	2	2	Limit deterioration of water quality in wetlands		All potentially contaminating activities and infrastructures should be located within the dirty water area. The dirty water area should be isolated from the surrounding catchments. The dirty water management system should be designed as per the minimum requirements as a minimum. All dirty water storage facilities should be lined. No dirty water may be discharged untreated. All clean water to be diverted around the site and discharged into the surrounding environment.					4	1	4	2
	Wetlands	Erosion due to discharge of stormwater		-	6	2	4	4	48	2	2	2	Prevent erosion damage at stormwater discharge points		Clean water system should be constructed as grassed swales (shallow sloped vegetated channels) rather than just dug trenches to limit sediment transport. Discharge points should be located within terrestrial grassland and not in wetland areas. Discharge points should be protected against erosion.					4	1	1	3
2.18 Use and maintenance of linear infrastructure																							
	Wetlands	Disturbance to wetland habitat		-	6	1	4	3	33	2	1	2	Prevent disturbance of wetland habitat outside the direct activity footprint		Maintenance activities should make use of existing roads and tracks and all vehicles should stick to roads and tracks. No off-road driving should be allowed unless absolutely unavoidable. No temporary stockpiling of material in wetland habitat.					4	1	1	3
	Wetlands	Erosion due to discharge of stormwater		-	6	2	4	4	48	2	2	2	Prevent erosion damage at stormwater discharge points		Prevent discharge of concentrated high velocity stormwater flows. Locate discharge points outside wetland areas. Protect discharge points against erosion. Regular maintenance and inspections of all discharge points should be undertaken.					4	1	1	3
2.19 Use and maintenance of other infrastructure																							
	Wetlands	Disturbance to wetland habitat		-	6	1	4	3	33	2	1	2	Prevent disturbance of wetland habitat outside the direct activity footprint		Maintenance activities should make use of existing roads and tracks and all vehicles should stick to roads and tracks. No off-road driving should be allowed unless absolutely unavoidable. No temporary stockpiling of material in wetland habitat.					4	1	1	3
	Wetlands	Erosion due to discharge of stormwater		-	6	2	4	4	48	2	2	2	Prevent erosion damage at stormwater discharge points		Clean water system should be constructed as grassed swales (shallow sloped vegetated channels) rather than just dug trenches to limit sediment transport. Discharge points should be located within terrestrial grassland and not in wetland areas. Discharge points should be protected against erosion.					4	1	1	3

7.3 Decommissioning Phase

7.3.1.1 Rehabilitation of areas impacted by mining

Impacts expected due to the decommissioning and closure phase of the project:

Altered hydrology - Opencast mining permanently alters the movement of water through the landscape through its impacts on geological strata and soils. Compared to the pre-mining landscape, the rehabilitated opencast pit will have significantly increased infiltration to groundwater and increased surface runoff. Typically the rehabilitated opencast areas lack the shallow perched water table that characterised the pre-mining landscape. The implications of these changes are that no wetlands are likely to reform on the rehabilitated opencast areas, and that the remaining wetlands downslope of these areas will be faced with altered runoff characteristics from their catchment. Typically, surface runoff volumes and velocities are expected to increase, leading to increases in flood peaks and erosive energy, while subsurface inputs are expected to decrease, reducing low flows and increasing seasonality.

Water quality deterioration - Post-mining, the backfilled opencast pits are likely to fill with water as groundwater levels rebound. Eventually the pits are likely to start decanting. Decanting water is likely to be acidic as well as metal and sulphate rich. Decant is likely to enter the Zaaiwaterspruit and Tweefonteinspruit, and eventually the Olifants River and Witbank Dam

Increased sediment transport into wetlands - The rehabilitated mine impacted areas will be susceptible to erosion following rehabilitation, especially in areas that are sparsely vegetated or not vegetated at all. This will result in increased sediment loads in the downslope wetlands, leading to deteriorating water quality (increased turbidity and TSS) and changes in the aquatic fauna. Changes in wetland vegetation can also occur as sediment loving plants (e.g. *Phragmites australis*) become dominant.

Increase in alien vegetation - Following the completion of decommissioning activities, the recently placed and disturbed soils will be susceptible to invasion by alien vegetation, e.g. *Acacia mearnsii* (black wattle). These alien species could spread to the adjacent wetland areas and result in decreased flows, increased erosion and decreased biodiversity in these systems.

7.3.1.2 Legacy rehabilitation project

The aim of the proposed Tweefonteinspruit legacy project is understood to be the improvement of water quality, with the goal being to improve water quality downstream of the Tweefontein Dam; water which eventually enters the Olifants River and then the Witbank Dam.

Currently the water quality within the Tweefonteinspruit is significantly deteriorated, with water downstream of Tweefontein Dam consistently measured with sulphate concentrations above 1 200mg/l. Given these water quality concerns, the Tweefontein Dam is currently partly managed as a dirty water dam in that water is pumped from the dam into Boschmans Pan to minimise overflow from the dam. Nonetheless overflow regularly occurs and supposedly clean water flows from upstream also continue to feed into the dam.

To address the water quality concerns the Tweefonteinspruit Clean-up Project has been proposed. This project proposes to tackle the water quality issue by addressing a number of pollution sources within the Tweefonteinspruit catchment, specifically the old discard dumps and plant areas associated with Waterpan, and removing contaminated sediments from the Tweefonteinspruit wetland. The proposed interventions have been grouped into 7 phases (Figure 22).

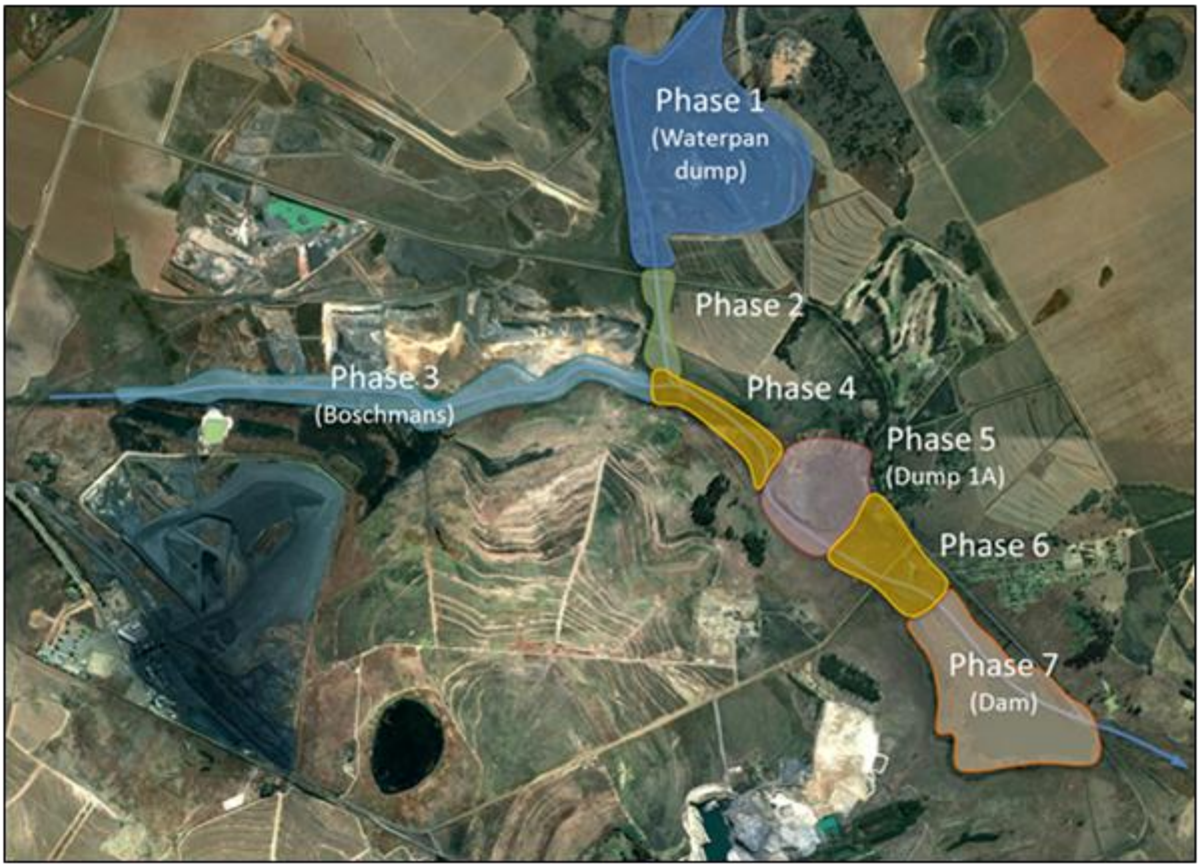


Figure 23. Map of the Tweefonteinspruit showing the location of the various phases of the clean-up project.

The exact details of the proposed legacy project are not yet available, but are understood to include:

- Rehabilitation of the Waterpan Dump in situ, with diversion of the valley bottom wetland around the dump
- Removal of coal fines from the valley bottom wetland adjacent to Waterpan Dump
- Rehabilitation of Dump 1A in situ, with diversion of the valley bottom wetland around the dump
- Removal of Dump 1B
- Exclusion of the Tweefontein Dam from the Tweefonteinspruit through the construction of river diversions. The Tweefontein Dam would then be treated as a dirty water facility

The following impacts are expected during the construction phase of the legacy project:

- Loss of wetland habitat & associated biodiversity -

- Mobilisation of sediments & water quality deterioration
- Erosion within the wetland

The following impacts are expected in the operational phase:

- Erosion within the stream diversion
- Sedimentation due to erosion of side slopes of rehabilitated dump and stream diversion
- Increase in alien vegetation
- Increased water loss along the stream diversion
- Improvement in water quality
- Improvement in wetland habitat integrity

As the proposed legacy project measures are permanent, no decommissioning phase is applicable.

7.3.1.3 Golf Course

Figure 22 shows the location of the proposed golf course. No wetlands fall within the direct footprint of the proposed site. In fact, most of the site falls across already mine impacted land.

No direct impacts to wetlands are thus expected. However, because of the size of the golf course and its proximity to wetland areas, impacts to wetlands are nonetheless expected:

Construction Phase:

- **Increased sediment transport into wetlands** - Bare soil areas resulting from vegetation clearing and soil stripping will provide extensive sediment sources delivering increased sediment loads to downslope wetlands. Transported sediments are likely to deposit in the receiving wetlands, leading to changes in vegetation and habitat.
- **Water quality deterioration** – During the construction phase, water quality deterioration is likely to mostly take the form of increased turbidity, though spills of hazardous materials used on site during construction could also enter wetland areas via surface runoff.

Operational Phase:

- **Increased flows within seepage wetlands** – Irrigation of the golf course could result in increased flows and saturation of adjacent wetland areas, leading to changes in vegetation composition and structure
- **Water quality deterioration** – Use of fertilizers and pesticides on site could lead to water quality deterioration where these enter adjacent wetlands via surface runoff or sub-surface seepage.

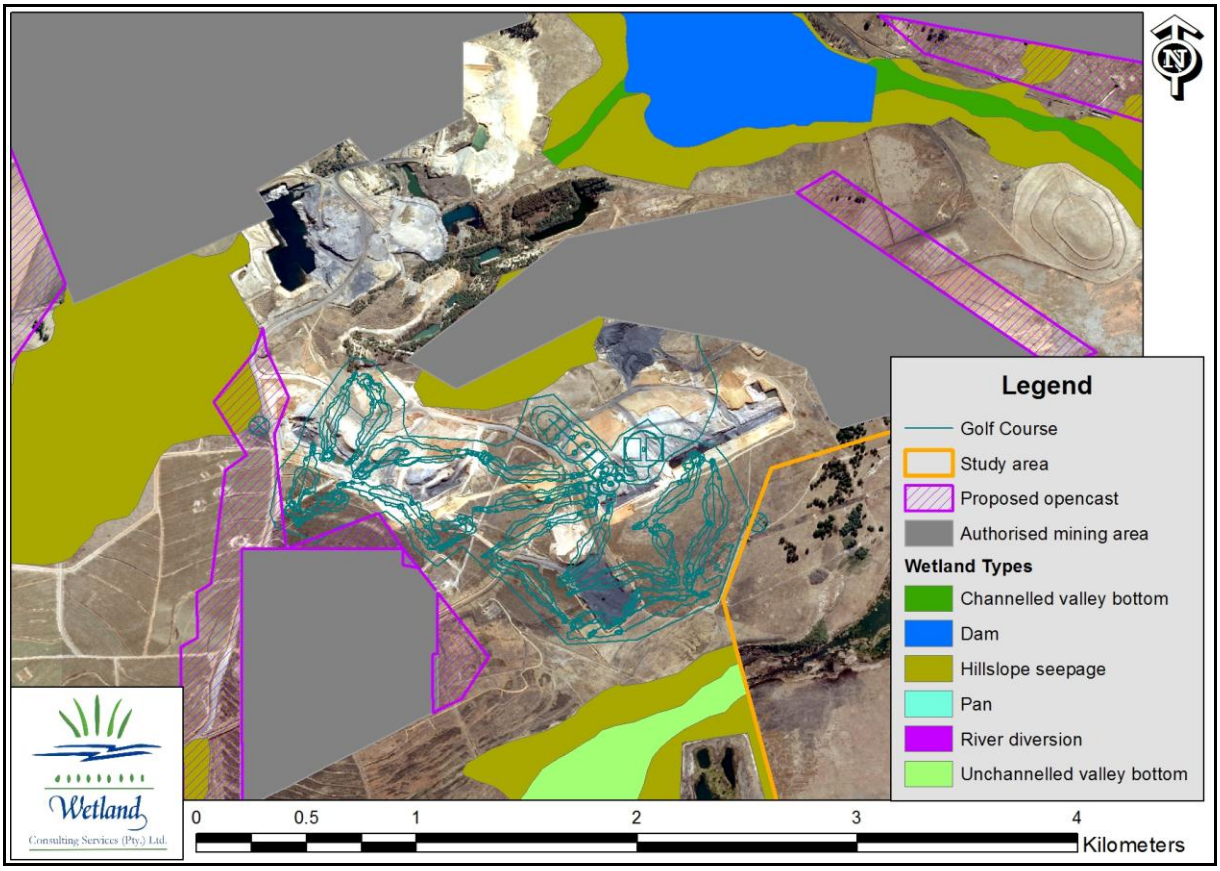


Figure 24. Proposed golf course in relation to delineated wetlands and mining areas.

7.3.2 Decommissioning Phase EIAMAPs

TABLE 7.3.1: ACTIVITY / GROUP OF ACTIVITIES

No.	Environmental Component	Potential Impact	Issue of Concern with I&APs (Yes / No)	Rating: Status	Rating: Magnitude	Rating: Extent	Rating: Duration	Rating: Probability	Rating: Significance	Rating: Reversibility	Rating: Irreplaceable loss of resources	Rating: Potential of impacts to be mitigated	Mitigation management objectives and principles	Mitigation by design	Proposed Mitigation measures	Responsible person	Timeframe of mitigation	Financial Plan: Concurrent (Annual Cost)	Financial Plan: Final (Rehabilitation)	Residual Impacts after mitigation Rating: Magnitude	Residual Impacts after mitigation Rating: Extent	Residual Impacts after mitigation Rating: Duration	Residual Impacts after mitigation Rating: Probability
3. Decommissioning Phase (after operational phase until closure goals are reached)																							
3.20 Rehabilitation of areas impacted by the mining and related activities within the Tweefontein Complex																							
	Wetlands	Altered hydrology		**-**	**6**	**2**	**5**	**5**	**65**	**2**	**2**	**2**			Limited opportunity to mitigate. Opencast coal mining permanently alters the movement of water through the landscape. Replaced spoils should be landscaped to be free draining, but should avoid steep slopes and concentrated run-off. The rehabilitated areas should be re-vegetated as soon as possible following completion of the earthworks to minimise erosion. Regular long-term follow up of rehabilitated areas will be required to ensure the successful establishment of vegetation and to survey for any erosion damage on site. Erosion damage should be repaired immediately. The recommendations contained within the specialist vegetation and soils reports should be fully implemented to ensure successful rehabilitation					**6**	**1**	**5**	**5**
	Wetlands	Water quality deterioration		**-**	**8**	**4**	**5**	**5**	**85**	**2**	**3**	**2**	Prevent decant of contaminated water from backfilled opencast pits	Water treatment plant near Witcons Dam has already been made allowance for.	Actively manage water levels within the backfilled opencast areas to prevent decant. All water abstracted from the backfilled pits should be treated prior to discharge. Discharge should ideally take place into the catchment where water was abstracted.					**4**	**2**	**5**	**3**

	Wetlands	Increased sediment transport into wetlands		-	8	2	3	5	65	2	2	2	Limit sediment transport off the rehabilitated areas		Replaced spoils should be landscaped to be free draining, but should avoid steep slopes and concentrated run-off. The rehabilitated areas should be re-vegetated as soon as possible following completion of the earthworks to minimise erosion. Regular long-term follow up of rehabilitated areas will be required to ensure the successful establishment of vegetation and to survey for any erosion damage on site. Erosion damage should be repaired immediately. The recommendations contained within the specialist vegetation and soils reports should be fully implemented to ensure successful rehabilitation					**6**	**2**	**2**	**4**
	Wetlands	Increase in alien vegetation		**-**	**6**	**2**	**5**	**3**	**39**	**2**	**2**	**2**	Prevent establishment of alien invasive vegetation within the wetlands		Compile and implement an alien vegetation removal and management plan to deal with all invasive alien species on site. Monitor areas disturbed during mining and related activities for signs of alien invasive species and clear immediately					**4**	**1**	**3**	**3**
3.21 Legacy rehabilitation project																							
	Wetlands	Loss of wetland habitat		**-**	**6**	**1**	**5**	**5**	**60**	**3**	**2**	**2**	Minimise loss of wetland habitat and disturbance outside direct development footprint		The required construction servitude within the wetlands should be clearly demarcated and all activities limited to the demarcated area to minimise the disturbance footprint. Laydown areas, temporary stockpiles and all construction related infrastructure should be located at least 50m from the edge of delineated wetland habitat. All within wetland construction activity should take place during the dry season. It is recommended that the isolation of the Tweefontein Dam from the wetland system be reconsidered and only undertaken if the risk of water quality deterioration posed by the sediments within the dams warrants such action. The dam should be managed as a clean water system. The proposed stream diversion should be designed and constructed in an environmentally friendly manner, i.e. they should be broad, shallow sloped, vegetated systems that incorporate features to enhance biodiversity support.					**4**	**1**	**5**	**5**

	Wetlands	Mobilisation of sediments and water quality deterioration		**-**	**8**	**2**	**2**	**5**	**60**	**2**	**2**	**1**	Prevent water quality deterioration		Undertake all within wetland activities only during the dry season. Temporarily divert flows around the construction area. Should construction activities within the wetland extend over an extended period (more than a month), the activities should be phased and rehabilitation commence as soon as construction activity within an area has been completed. Rehabilitation should include the landscaping of soils to prevent any preferential flow paths through the wetland that could result in channel incision. Should revegetation not commence on its own, selective harvesting of Typha capensis and Phragmites australis from the Tweefonteinspruit wetland downstream should be undertaken to supply plantings for the rehabilitated wetland. Sediment removal activities should commence at the upstream end and progress downstream. This will allow rehabilitation activities to commence as soon as carbonaceous sediments have been removed and will prevent rehabilitated areas being impacted by increased turbidity and sediment loads generated during removal of sediments. The point of discharge of the temporary diversion should be protected against erosion if the diversion is expected to be in place and operational during a period likely to experience rainfall, e.g. outside the period June to September. Regular inspections of the temporary diversion will need to be undertaken to monitor for signs of erosion, with any erosion damage repaired immediately and preventative actions taken to ensure no further erosion damage occurs.					**4**	**1**	**2**	**3**

	Wetlands	Erosion within the wetland		**-**	**6**	**1**	**5**	**3**	**36**	**2**	**2**	**1**	Prevent erosion in adjacent wetlands		All construction activities should be undertaken during, and ideally limited to, the dry season between June and September. A temporary diversion will be required to ensure no flows pass through the valley bottom wetland during construction activities. Should construction activities within the wetland extend over an extended period (more than a month), the activities should be phased and rehabilitation commence as soon as construction activity within an area has been completed. Rehabilitation should include the landscaping of soils to prevent any preferential flow paths through the wetland that could result in channel incision. Revegetation of the wetland will likely proceed on its own, but will need to be carefully monitored to ensure success. Should revegetation not commence on its own, selective harvesting of Typha capensis and Phragmites australis from the Tweefonteinspruit wetland downstream should be undertaken to supply plantings for the rehabilitated wetland. Sediment removal activities should commence at the upstream end and progress downstream. This will allow rehabilitation activities to commence as soon as carbonaceous sediments have been removed and will prevent rehabilitated areas being impacted by increased turbidity and sediment loads generated during removal of sediments. The point of discharge of the temporary diversion should be protected against erosion if the diversion is expected to be in place and operational during a period likely to experience rainfall, e.g. outside the period June to September. Regular inspections of the temporary diversion will need to be undertaken to monitor for signs of erosion, with any erosion damage repaired immediately and preventative actions taken to ensure no further erosion damage occurs.					**4**	**1**	**2**	**2**

	Wetlands	Erosion within stream diversions		**-**	**6**	**1**	**5**	**3**	**36**	**1**	**2**	**1**	Minimise erosion within the stream diversion		The gradient of the stream diversion should be kept as low as possible. The diversion itself should be broad (the base of the diversion should be at least 30m wide, with gently sloping sideslopes) and should incorporate rip rap steps (rock-packed steps) at regular intervals to protect against erosion and to allow for the required fall in the stream diversion. Following construction activities the entire diversion floor should be landscaped to remove all obstacles and ruts that could lead to the formation of preferential flow paths. Re-vegetation of the stream diversion floor should proceed naturally and establish rapidly (based on experience from the Goedgevonden main river diversion) if sufficient flow through the wetland is available. Should exceptionally low flows be encountered due to drought conditions, seeding of the diversion might be required to ensure rapid vegetation establishment. Regular, monthly monitoring of the stream diversion will thus be required until vegetation cover has been established across the full stream diversion. More terrestrial areas such as the sideslopes will not re-vegetate naturally and should be seeded with a suitable mix of indigenous highveld grasses.					**4**	**1**	**2**	**3**
	Wetlands	Sedimentation due to erosion of diversion side slopes		**-**	**4**	**1**	**5**	**5**	**50**	**1**	**2**	**1**	Minimise erosion of diversion side slopes		The profile of the stream diversion should be designed so as minimize the erosion risk, and should be trapezoidal to parabolic in cross section with side slopes not less that 1:5. They should be seeded/hydro-seeded immediately following completion of construction activities. Regular monitoring with follow up and repair of any erosion damage observed and problems areas identified should be implemented.					**4**	**1**	**5**	**3**
	Wetlands	Increase in alien vegetation		**-**	**6**	**2**	**5**	**4**	**52**	**1**	**2**	**1**	Prevent establishment of alien vegetation		An alien vegetation management plan must be compiled for all river diversions within the Tweefontein MRA. Such a management plan should include regular surveys of the river diversions to identify alien species, followed by immediate clearing of such species. At no time should wattle saplings be allowed to develop to greater than 1m in height. Alien vegetation surveys and clearing will thus need to be undertaken at least once a year along the river diversions for at least the first 5 years following completion of construction. If after 5 years the alien vegetation situation is under control, clearing activities could be reduced to once every 2 years. Such an alien vegetation management plan could be incorporated into the alien vegetation management plan for the greater Tweefontein MRA.					**2**	**1**	**1**	**3**

	Wetlands	Increased water loss along stream diversion		**-**	**4**	**2**	**3**	**3**	**27**	**2**	**2**	**2**	Minimise loss of water from stream diversions		Construction activities should aim to keep impeding soil horizons in place as far as possible, with sufficient soil cover over these impeding layers to allow for vegetation establishment. Flow within the wetland should also meet the requirements of the wetland reserve study (completed in 2012). If flow requirements cannot be met due to proposed activities within the wetland and within the upper catchment, the discharge of treated water from the water treatment plant into the wetland area should be considered.					**4**	**2**	**3**	**2**
	Wetlands	Improvement in wetland habitat integrity		**+**	**6**	**1**	**5**	**4**	**48**	**1**	**1**	**1**	Maximise improvement in wetland habitat integrity		Regular monitoring of the wetland and proposed interventions should be undertaken by a wetland specialist (twice yearly). Any identified problem areas should be addressed.					**6**	**1**	**5**	**4**
	Wetlands	Improvement in water quality		**+**	**8**	**2**	**4**	**5**	**70**	**1**	**1**	**1**	Maximise improvement in water quality		Continue with water quality and biomonitoring programs to ensure that any deterioration in water quality can be quickly picked up and addressed. Maintain the Tweefonteinspruit system as a clean water system by ensuring effective seperation of clean and dirty water at all mining operations. Construct and maintain all water management infrastructure according to industry best practice and requirements of legislation.					**8**	**2**	**4**	**5**
3.22 Golf course																							
	Wetlands	Increased sediment transport into wetlands		**-**	**6**	**2**	**2**	**5**	**50**	**2**	**2**	**2**	Minimise sediment transport into adjacent wetlands		Vegetation clearing and earthworks should be limited to as small an area as possible, preferably no larger than the direct footprint of the proposed development. Bare soil areas falling outside the direct footprint should be landscaped to the original landscape profile and re-vegetated as soon as possible. Hydroseeding with a mix of indigenous species should be done. Where practically possible, the major earthworks should be undertaken during the dry season (roughly from June to September) to limit erosion due to rainfall runoff. A low berm should be constructed between the proposed opencast footprint and the downslope wetlands to prevent sediment rich runoff from the construction site entering the wetlands. These berms should thus be constructed prior to the commencement of construction on the opencast pits.					**4**	**2**	**2**	**3**
	Wetlands	Water quality deterioration		**-**	**8**	**3**	**2**	**5**	**65**	**2**	**2**	**2**	Minimise water quality deterioration, specific focus on turbidity		Implement a construction stormwater management plan that aims to limit sediment movement of site and prevents the concentrated discharge of flows and high velocity discharges off site. All clean water from upslope should be diverted around the opencast area. Surface run-off from the opencast area should also be discharged into the downstream environment in a controlled manner. Discharge points should incorporate sediment traps and should encourage low velocity, diffuse flows through the receiving wetland. Sediment barriers or low berms should be installed along the downslope edge of the opencast areas to trap sediments.					**4**	**2**	**2**	**3**
	Wetlands	Increased seepage within wetlands		**-**	**4**	**2**	**4**	**2**	**20**	**2**	**1**	**2**	Prevent increased flows within adjacent wetlands		Strictly control irrigation activities within the golf course to prevent overwatering. Make use of grass species adapted to the local climatic conditions, i.e. tolerant of extended dry periods. U					**4**	**1**	**4**	**2**

	Wetlands	Water quality deterioration		**-**	**6**	**2**	**4**	**3**	**36**	**2**	**2**	**2**	Minimise water quality deterioration, specific focus on fertilisers and pesticides		Strictly control fertiliser and pesticide use on site. Include sites adjacent to the golf course within the surface water quality and biomonitoring plans. Any sign of water quality deterioration that could be attributed to fertiliser runoff (e.g. increased nutrient loads) should be investigated and corrective measures implemented.					**4**	**2**	**4**	**1**

8. WETLAND OFFSETS

A useful and widely accepted definition of biodiversity offsets is provided by the Business and Biodiversity Offsets Programme (BBOP):

> "Biodiversity offsets are measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate prevention and mitigation measures have been taken. The goal of biodiversity offsets is to achieve no net loss and preferably a net gain of biodiversity on the ground with respect to species composition, habitat structure, ecosystem function and people's use and cultural values associated with biodiversity." (BBOP, 2009).

Wetland offsets fall under the broader umbrella of biodiversity offsets, and from the definition above, the goal of wetland offsets can be said to achieve a ***measurable*** "No Net Loss" or "Net Gain" in conservation outcomes as a means of compensating for residual adverse impacts to wetlands.

The "No Net Loss" principle requires that the gains provided by an offset program equal or exceed the losses that have occurred as a result of the project impacts. There is thus a need for an accounting system to accurately quantify and calculate the losses and gains – in the draft SANBI offset guidelines (Macfarlane *et al.,* 2012) this is achieved through the use of hectare equivalents. The gains provided by the offset should be equivalent to the losses in terms of type (e.g. wetland type or condition), time and space. What this means for wetland offsets is that generally the following concepts apply (exceptions are possible if well motivated):

- Offsets should be like for like (e.g. the loss of a pan would require a pan as offset, while offsetting a highly degraded wetland system to compensate for the loss of a pristine system would not generally be acceptable)
- Ideally offset gains should materialise before, or at the same time, as wetland losses
- All values of the lost wetland system should be targeted (e.g. if a wetland supports African Grass Owls and plays an important role in flow regulation, both these functions should be provided for in the offset target. This might require increasing the offset target area to cater for both functions).
- To ensure that "No Net Loss" is realised, an offset strategy needs to be accompanied by rehabilitation and enhancement of the target functions and values, as protection alone does not provide the gains that count towards "No Net Loss". Where offsets are done on a 1:1 basis (i.e. 1ha of wetland is offset to compensate for the loss of 1ha of wetland), a net loss of 50 % would result, unless interventions are put in place to enhance the functions and values of the offset target.
- Offset multipliers are generally applied to take into account risks and uncertainties about the success or performance of planned offset measures.

The SANBI guidelines recognise five types of offsets:

<u>Protection-based offset:</u> Refers to the implementation of legal mechanisms (e.g. declaration of a Protected Environment or Nature Reserve under the National Environmental Management:

Protected Areas Act, , a legally binding conservation servitude, or a long term Biodiversity Agreement under NEMA) and putting in place appropriate management structures and actions to ensure that conservation outcomes are secured and maintained in the long-term.

Averted loss offset: Refers to physical activities which prevent the loss or degradation of an existing wetland system and its biodiversity, where there is a clearly demonstrated threat of decline in the system's condition.

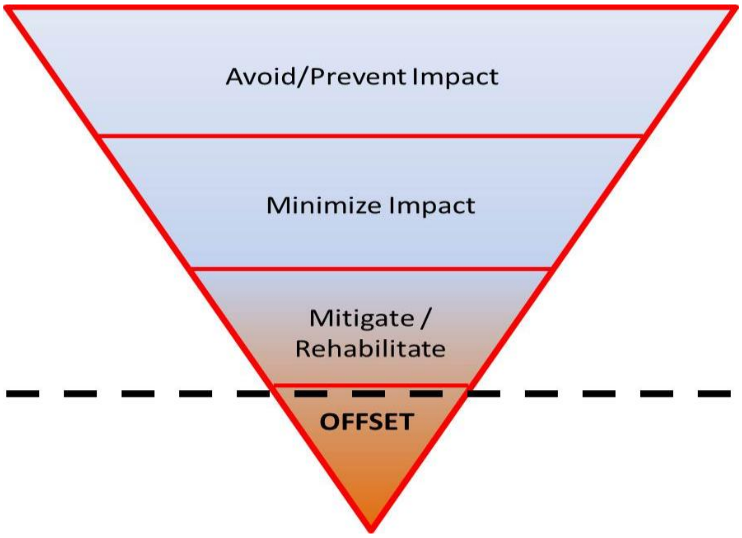
Rehabilitation/restoration offset: Refers to activities which result in an improvement in wetland condition, functions, and associated biodiversity. Rehabilitation / restoration involves the manipulation of the physical, chemical, or biological characteristics of a degraded wetland system in order to repair or improve wetland integrity and associated ecosystem services. By increasing the condition of a wetland system and its biodiversity, a positive contribution is made towards the goal of no net loss.

Wetland Establishment: This involves the development (i.e. creation) of a new wetland system where none existed before by manipulating the physical, chemical, or biological characteristics of a specific site.

Direct Compensation: Direct compensation involves directly compensating affected parties for the ecosystem services lost as a result of development activities. This is ideally done by providing an equivalent substitute form of asset or in some cases may take the form of monetary compensation. This form of offset action is generally most relevant to direct services.

The BBOP definition of biodiversity offsets is clear that offsets should only be undertaken for 'significant residual adverse biodiversity impacts arising from project development ***after appropriate prevention and mitigation measures have been taken***'.

The application of the mitigation hierarchy to all aspects of the project impacting on wetlands is key.



It is important that wetland offsets are not seen as a means of obtaining authorisation for mining within wetlands, but rather as a final step within the mitigation hierarchy to deal with residual impacts to wetlands that cannot be avoided, reduced or mitigated in any other way. Implementing an offset strategy should in no way reduce the 'standard' mitigation measures required as part of a mining application, i.e. the need for water treatment or the need to optimize mine and infrastructure layout plans so as to avoid sensitive areas.

In the case of the proposed TOPA project the most significant residual impact to wetlands remaining after avoidance, minimization and mitigation of impacts is the loss of wetland habitat. The impact to water quality can to a large degree be effectively mitigated through engineered solutions such as water treatment and controlled discharge of treated water. However, wetland habitat does not generally reform on rehabilitated opencast areas due to the complete destruction of the natural soil profile and underlying strata that control water movement through the landscape and thus also wetland formation. Wetlands falling within the proposed opencast footprints will thus be permanently lost. It is the impact of the loss of this wetland habitat that is targeted by wetland offsets.

No National or provincial guidelines currently exist for wetland offset projects despite a few such projects already having been tried/undertaken in South Africa, including the commitment to offset the loss of wetland habitat at the adjoining XSA Goedgevonden Colliery. Each of these projects has had its own approach which has been project specific depending on objectives, requirements of the authorities and the willingness of the proponent to pursue and/or embrace the approach.

Recognising the need for such guidelines, the SANBI Grasslands Programme recently funded a project entitled: *Towards a best-practice guideline for wetland offsets in South Africa*. A draft version of these guidelines has been released. The document is referenced as:

Macfarlane, D., von Hase, A. and Brownlie, S. (2012). *Towards a best-practice guideline for wetland offsets in South Africa*. SANBI Grasslands Programme, Pretoria, South Africa, Final Report.

The release of this draft guideline has evoked strong debate within especially the coal mining industry, and due in large part to criticism of the draft guidelines from the coal mining industry, the guidelines are currently being revised. The chief concern with the draft SANBI guidelines revolves around the offset multipliers which are unlikely to be achievable in the coal mining areas of the Highveld, putting existing as well as future coal mining projects at risk. The concern from the industry is that in its current form, the guideline is unlikely to be practically or financially implementable.

However, the methodology detailed in the draft SANBI guidelines is considered to be the best currently available and it is recommended that the draft SANBI guidelines be used to develop an offset project for the TOPA project, but that a motivation be developed to potentially apply site and wetland specific offset multipliers. Such an approach will also be adopted in the revised SANBI Offset guidelines which will likely be released towards then end of 2013/beginning of 2014.

The opencast mining activities proposed as part of the TOPA project will result in the loss of approximately 137.54 hectares of wetland, as detailed in Table 12 below. The offset multiplier currently proposed by the draft SANBI guidelines for wetlands in the TOPA area is 30:1. Table 12 however shows what we would consider a more applicable offset ratio given the degraded state of the wetlands and their catchment on site, namely 3:1 (such a multiplier would however need to be strongly motivated for; it is used here for illustrative purposes only). This would result in an offset requirement of 233.35 hectare equivalents.

Table 12. Details of the wetland extent and likely extent of wetland loss at Tweefontein.

Wetland Type	Wetlands to be lost	Hectare equivalent	Offset Multiplier	Offset requirement	Offset Multiplier	Offset requirement
Channelled valley bottom	0.98	0.22	3	0.66	30	6.61
Unchannelled valley bottom	0.71	0.50	3	1.50	30	14.93
Hillslope seepage	135.85	77.03	3	231.09	30	2310.94
TOTAL	**137.54**	**77.75**	**n/a**	**233.25**	**n/a**	**2332.48**

The implications of the above results are that wetland rehabilitation work will need to be undertaken to ensure that the loss of 77.75 hectare equivalents is compensated for through the gain of at least 77.75 hectare equivalents. A gain in hectare equivalents would be obtained where the present ecological status (PES) of a wetland is increased

This would ensure that the '*no net loss*' principle is achieved. Such rehabilitation work should ideally be done within the same sub-catchments as are affected by the proposed mining activities so that eco-services gained through rehabilitation work can replace the eco-services lost through mining within the same wetland systems. Where this is however not possible, alternative sites within the same greater catchment and wetland ecosystem type should be considered. Rehabilitation of wetlands falling within the target of the protection based offset could also be considered and will likely be required to meet the target of hectare equivalents gained.

In addition to the rehabilitation work, a protection based offset of just more than 230 ha would also be required and its protection secured in the long-term. This will likely entail the purchasing of land that includes the required 230 ha of wetland and having the land formally protected/declared a protected area.

If we extrapolate using the percentage wetland cover recorded in the TOPA study area, just under 30 % of surface area, the requirement for a 230 ha wetland offset would then imply a land purchase of around 800 ha to ensure that the purchased land contains enough wetlands to meet the 230 ha offset requirement.

A further option to consider would be a consolidated wetland offset strategy for all of XSA's collieries on the highveld, as it is known that proposed expansions at Goedgevonden and Impunzi might also trigger wetland offset requirements.

9. CONCLUSION & RECOMMENDATIONS

Wetland Consulting Services (Pty.) Ltd. (WCS) was appointed by Clean Stream Environmental Consultants (CSEC) to compile a specialist wetland assessment report for the proposed Tweefontein Optimisation Project Amendment application. The proposed amendment includes expansions to both underground and opencast mining within the Tweefontein Mineral Rights Area (MRA), as well as changes and additions to the associated infrastructure.

Numerous wetlands, linked to the presence of both surface water and perched groundwater, were identified within the study area. Four types of natural wetlands systems, differentiated on the basis of their hydro-geomorphic (HGM) characteristics occur within the study area, namely:

- Channelled valley bottom wetlands;
- Unchannelled valley bottom wetlands;
- Hillslope seepage wetlands; and
- Pans/Depression wetlands.

Wetlands cover approximately 3 486.4 ha of the study area, equal to just over 29.5 % of the surface area of the site.

The PES assessment results show that overall, the majority of wetlands (67.65 %) are considered moderately modified (PES category C). In terms of the various wetland types:

- More than 45 % of wetlands are considered moderately modified with a PES (C), though a significant number are also considered largely modified (PES D);
- Hillslope seepage wetlands are generally moderately to largely modified with a PES (C) or (D);
- Most of the valley bottom wetlands are considered largely modified with a PES (D);
- Only 170ha of hillslope seepage wetlands, roughly 5 % of the total wetland habitat on site, are still considered largely natural with a PES (B); and
- More than 50 % of the pan habitat within the study area is considered seriously modified with a PES (E).

15 % of the wetlands on site, mostly hillslope seepage wetlands and pans, but also including the Klippoortjiespruit valley bottom wetland are considered to be of high ecological importance and sensitivity.

Following completion of the baseline specialist studies, the proposed mine plan was amended to exclude most of the identified high EIS wetlands, specifically the hillslope seepage wetlands in the extreme east of the study area and the cluster of three pans to the north west of Makou Pan.

A detailed impact assessment study as per the methodology supplied by CSEC was undertaken for each project activity identified by CSEC, with recommended mitigation and management measures.

It is important to point out that any activity which is contemplated and which will impact on the wetlands within the study area is subject to authorisation under Section 21 of the National Water Act (Act 36, 1998). As such, all proposed wetland crossings will require a Water Use License.

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11. APPENDIX A

List of diatom species and associated abundances per site in May 2012.

Taxa	TFN-US	WTP2	TFN4	TFN6	WTP-US
ACHNANTHIDIUM F.T. Kützing	0	0	41	2	14
Achnanthidium minutissimum (Kütz.) Czarnecki	155	234	0	0	0
ACHNANTHES J.B.M. Bory de St. Vincent	3	0	10	0	16
Amphora veneta Kützing	0	0	0	0	8
Brachysira neoexilis Lange-Bertalot	0	4	0	0	0
Caloneis bacillum (Grunow) Cleve	3	0	0	0	0
Craticula halophila (Grunow ex Van Heurck) Mann	0	0	0	1	4
Cyclotella meneghiniana Kützing	0	0	6	8	0
COCCONEIS C.G. Ehrenberg	0	0	0	1	0
Cocconeis placentula Ehrenberg var.lineata (Ehr.)Van Heurck	0	0	0	0	6
CYCLOTELLA F.T. Kützing ex A de Brébisson	0	0	4	0	2
Diadesmis confervacea Kützing var. confervacea	2	0	0	0	0
DIPLONEIS C.G. Ehrenberg ex P.T. Cleve	0	0	1	0	0
Encyonopsis minuta Krammer & Reichardt	1	0	0	1	0
Encyonopsis subminuta Krammer & Reichardt	2	0	0	0	0
Fragilaria fasciculata (C.A. Agardh) Lange-Bertalot sensu lato	0	0	1	151	0
Fragilaria pulchella (Ralfs ex Kütz.) Lange-Bertalot (Ctenophora)	0	0	10	5	0
Fragilaria tenera (W.Smith) Lange-Bertalot	0	0	0	0	4
Gomphonema acuminatum Ehrenberg	1	0	0	0	2
Gomphonema affine Kützing	0	0	0	1	0
Gomphonema gracile Ehrenberg	2	0	0	0	0
GOMPHONEMA C.G. Ehrenberg	0	0	0	0	6
Gomphonema parvulum (Kützing) Kützing var. parvulum	3	0	1	0	0
Gyrosigma scalproides (Rabenhorst)Cleve	1	0	0	0	0
Gyrosigma acuminatum (Kützing)Rabenhorst	4	0	0	0	0
Hantzschia amphioxys (Ehr.) Grunow in Cleve et Grunow 1880	1	0	0	0	0
Mayamaea atomus (Kützing) Lange-Bertalot	2	0	0	0	2
Mayamaea atomus var. permitis (Hustedt) Lange-Bertalot	0	0	1	0	16
Nitzschia acicularis(Kützing) W.M.Smith	0	0	0	55	0
Nitzschia agnita Hustedt	0	0	0	0	2
Nitzschia amphibia Grunow f.amphibia	1	0	0	0	14
Navicula antonii Lange-Bertalot	3	0	3	0	6
Navicula arvensis Hustedt var.maior Manguin in Bourrelly & Manguin	0	0	0	0	2
NAVICULA J.B.M. Bory de St. Vincent	3	0	0	0	4
Navicula cryptocephala Kützing	37	126	6	0	0
Navicula cryptotenella Lange-Bertalot	0	0	1	0	0

Taxa	TFN-US	WTP2	TFN4	TFN6	WTP-US
Neidium productum (W.M.Smith)Cleve	5	0	0	0	0
Nitzschia fonticola Grunow in Cleve et Möller	1	0	0	0	16
Navicula germainii Wallace	2	0	0	0	0
Navicula gregaria Donkin	15	0	0	0	0
Nitzschia archibaldii Lange-Bertalot	26	0	91	62	159
Nitzschia frustulum(Kützing)Grunow var.frustulum	2	0	0	0	0
Nitzschia inconspicua Grunow	0	0	3	0	0
Nitzschia pusilla(Kützing)Grunow	0	0	0	0	6
NITZSCHIA A.H. Hassall	18	0	19	20	10
Nitzschia liebetruthii Rabenhorst var.liebetruthii	1	0	0	2	4
Navicula longicephala Hustedt var.longicephala	0	0	4	0	2
Navicula libonensis Schoeman	6	2	1	0	0
Nitzschia linearis(Agardh) W.M.Smith var.linearis	1	4	0	0	0
Nitzschia microcephala Grunow in Cleve & Moller	0	0	17	0	0
Nitzschia nana Grunow in Van Heurck	2	1	109	0	2
Nitzschia paleacea (Grunow) Grunow in van Heurck	0	0	0	0	46
Nitzschia palea (Kützing) W.Smith	19	15	7	1	28
Nitzschia reversa W.Smith	0	0	38	0	0
Navicula riediana Lange-Bertalot & Rumrich	1	0	0	0	0
Navicula rostellata Kützing	0	0	2	0	0
Nitzschia sigma(Kützing)W.M.Smith	0	0	0	0	2
Nitzschia terrestris (Petersen) Hustedt	2	0	0	0	0
Navicula vandamii Schoeman & Archibald var. vandamii	10	0	4	0	0
Navicula veneta Kützing	17	2	3	0	4
Nitzschia valdecostata Lange-Bertalot et Simonsen	2	0	0	0	0
Navicula zanoni Hustedt	31	10	5	0	6
Nitzschia supralitorea Lange-Bertalot	1	0	6	0	6
Planothidium frequentissimum(Lange-Bertalot)Lange-Bertalot	2	0	2	0	0
Pinnularia subbrevistriata Krammer	3	0	0	0	0
Stauroneis phoenicenteron (Nitzsch) Ehrenberg	0	2	0	0	0
Sellaphora pupula (Kützing) Mereschkowksy	3	0	0	0	2
Sellaphora seminulum (Grunow) D.G. Mann	0	0	1	0	0
Stephanodiscus minutulus (Kützing) Cleve & Moller	0	0	0	90	0
Tryblionella debilis Arnott ex O'Meara	5	0	0	0	0
Tryblionella hungarica (Grunow) D.G. Mann	0	0	2	0	0
Thalassiosira weissflogii (Grunow) Fryxell & Hasle	0	0	1	0	0

12. APPENDIX 2

Any of the wetlands impacted during the construction process (and again during the decommissioning and closure phase) on site should be rehabilitated according the a well defined wetland rehabilitation plan compiled by a registered wetland specialist. The following measures are proposed to serve as broad guidelines to prevent unnecessary damage to the wetlands adjacent to the proposed development area. All measures detailed below should be implemented in consultation with a wetland specialist to ensure site and activity specific recommendations can be implemented.

12.1 Fencing or demarcation of affected area

Prior to any activities in the wetland areas, limits of construction related activities must be clearly demarcated so as to avoid unnecessary direct impacts to the vegetation beyond the limits of construction.

12.2 Re-vegetation/ rehabilitation

Bare soil areas within the wetlands resulting from construction/decommissioning activities should be re-vegetated as soon as possible following the disturbance. Wetland specialist must assist during re-vegetation and must prescribed the suitable species for re-vegetation of disturbed wetland areas. Typical species that should be considered include a mix of pioneer and climax species such as the following:

- *Digitaria eriantha*
- *Chloris gayana*
- *Eragrostis curvula*
- *Eragrostis tef*
- *Cynodon dactylon*
- *Setaria spp.*
- *Panicum maximum*
- *Melinis repens*

Suitable seed mixes are available from Sakata Seed (Biomosome Grassveld Reclamation Mixture) and Advanced-Seed (Indigi Mix).

Soil compaction should be alleviated through ploughing/ripping and scarifying, followed by landscaping to the natural/surrounding landscape profile. Where ploughing/ripping takes place on slopes leading towards wetland areas or water courses, sediment barriers (see below) should be installed along the lower edge of the ploughed area.

Once soil preparation is complete, ***seed beds should be prepared as per the guidelines supplied by the seed supplier or appointed rehabilitation specialists***, or as follows: Furrows should be made in the soil by hand using hoes. Furrows must be made horizontally in the soil (parallel to slope) and should be spaced 0.4 meters (maximum) apart and at least 10 cm deep. Work should commence from the top of the slope and be conducted downwards and any loose soil and rocks from the process should be removed to prevent siltation of the wetlands downwards. The beds should follow the contours of the land and not in any way allow water to collect or flow in high volumes, thus creating erosion gullies. Larger clumps of soil and stones should be removed to prevent impeded flow of water. On steep slopes and high erosion risk areas the use of hessian blankets is recommended to increase erosion protection.

Seeding should commence as soon as the hessian is in place and seed bed preparation has been completed. Either hand or hydro-seeding can be considered, depending on the area required to be planted. Both hand and hydro-seeding must be done by professionals only. If any fertilizers are recommended these should be applied to the side slopes only and not within the wetland. If hydro seeding is selected for the seeding process the hydro-seeders used must run for 10 minutes at least before the commencement of the seeding project. This is to ensure adequate mixing of the seed and water. Water extraction for the hydro-seeding from the wetlands and pans is not allowed unless authorization is received from the Department of Water Affairs. A good rehabilitation grass mix can be obtained from Advanced-seed or African grass seeds, but must contain indigenous grass species which are conspicuous in the Highveld grassland.

Once the initial rehabilitation has been completed the rehabilitated areas should be checked for erosion at the end of the first summer. If erosion is observed, appropriate action should be taken to limit its extent.

12.3 The eradication of invasive plant species

Alien plants are likely to colonise the areas disturbed during the construction/decommissioning process. Areas disturbed during the construction process should be checked on a 6 monthly basis and any undesirable plants encountered in the areas immediately upstream and downstream of the rehabilitated areas should be removed, ideally by hand so as to reduce the risk of herbicides being transferred further into the wetlands.

The removal of Category 1, 2 and 3 Declared Weeds is compulsory in terms of the regulations formulated under “The Conservation of Agricultural Resources Act” (Act No. 43 of 1983).

Exotic plantations should be checked for breeding owls and breeding raptors. If there are any, then these trees should be left as is, if at all possible.

12.4 Guide to installing erosion and siltation preventing devices:

Sediment transport during the construction/decommissioning period is likely. Efforts must be made to limit sediment transport beyond the limits of actual construction. Consult with wetland specialist to assist during installation of the below erosion and siltation devices.

Various methods are available to achieve this, some of which are described below.

It is important to note that these structures must be inspected regularly and replaced if any are found to be worn out or damaged. If sediments accumulate erosion barriers must be regularly cleaned.

Bidim™ Walls

These are made up of Bidim™ and /or shade cloth held in place with poles every 1 meter (maximum) apart. The Bidim should be placed against the y-poles and an extra length of about 1 meter should lie on the bottom of the stream facing upstream to ensure no sediment can escape underneath the wall. The height of the Bidim walls should be 10cm above the water level. These walls must cover the whole breadth of the gully and should not allow any water through that has not passed through the Bidim wall. These sediment barriers must be inspected every week to ensure they are still functioning. If a build-up of sediment occurs then the sediment must be removed. If the barriers are washed away by a flood or damaged in any way the replacement should occur as soon as possible.

Figure 25: A siltation screen below a construction site to prevent the movement of sediment downstream (image from www.wikipedia.com)

Fibre rolls:

These should be placed horizontal to the flow direction and should cover the whole length of the slope or preferential flow path. Firstly a trench about 20cm (about half the height of the fibre roll) should be made in the flow path fibre roll placed in the trench. The trench should then be filled around the roll and compacted- using hand tools. The roll should then be permanently attached to the gully using wooden stakes leaving no more than 50mm of the stake protruding from the top of the roll. If high flow volumes are expected a double stake should be placed on both sides of the roll. These two stakes should then be tied together using wire and pulled taught.

Figure 26: Photograph of fibre rolls from EPA erosion control website

Straw bales:

These should be placed in their length across areas where erosion gullies have formed. Excavation of soil should be done to a depth half that of the bales. The bales should then be placed in the trench and secured using stakes. If any of the bales being used disintegrates it should be replaced. Broken bales will break up even further once in free flowing water. Surrounding soil needs to be replaced and compacted using hand tools.

Stake specification:

The stakes should all preferably be made from treated wood. The standard length of the stakes should be 800mm long and 40mm wide to ensure a wide variety of applications. To ensure the stakes are properly used they should all be installed a minimum of 500mm below the surface. Any protrusions above any structures should not exceed 50mm.

Hessian or fibre netting:

Netting should be used that allows 60% of the surface to be open to allow for the germination of seeds through the netting. These nets come in widths of 1.3 and 1.5 meters. These should be anchored to the bank walls with wooden stakes 1.5-2 meters apart. The hessian should also be applied vertically. The hessian should not be placed as far as the bottom or aquatic zone but should still reach the fibre rolls. Before the installation of the hessian, proper soil preparation by hand using a hoe must be done to ensure the proper seed beds are formed.