8 IMPACT IDENTIFICATION

8.1 Introduction

As required in section 31(2) of the NEMA EIA Regulations, 2010, this section includes a description of the manner in which the biophysical, social, economic and cultural aspects of the environment may be affected by the proposed activity as well as a description of the environmental issues identified during the impact assessment process.

These impacts were identified in accordance with the proposed process (Disposal of Dry Ash) and are not linked to any of the proposed alternatives specifically. The impacts are applicable to the land forming part of the proposed alternative sites (hereafter referred to as the "Study Area") The Identified Impacts were assessed against all the site alternatives separately in the next chapter.

8.2 Topography

8.2.1 Potential Impacts

Due to the fact that the natural topography of the study area is already disturbed by agriculture, two potential impacts are considered to be significant in terms of this project. The first impact considers the potential change of drainage patterns due to construction related earthworks and newly introduced stormwater patterns. Without mitigation the impact is considered to be of medium significance, however, with the implementation of mitigation measures, specifically regarding stormwater control, the impact significance reduces to low.

The second impact is related to the planning phase of the project in terms of the design of the facility which will need to take the existing topography into account with regards to allowing for effective stormwater and seepage collection systems.

8.2.2 Recommended Mitigation and Management Measures

The following recommended mitigation and management measures are applicable:

- The contractor must ensure that adequate measures are put into place to control surface water flows across and around the site during earthworks.
- The quantity of uncontaminated stormwater entering cleared areas will be minimised by appropriate site design and by installation of control structures and drains which direct such flows away from cleared areas and slopes to stable (vegetated) areas or effective treatment installations.
- Areas susceptible to erosion must be protected by installing the necessary temporary and/or permanent drainage works as soon as possible. Areas susceptible to erosion must also be rehabilitated (re-vegetated) as quickly as possible.

- Any erosion channels developed during the construction period or during the vegetation establishment period shall be backfilled and compacted, and the areas restored/rehabilitated to a proper condition.
- Anti-erosion compounds shall consist of an organic or inorganic material to bind soil particles together and shall be a proven product able to suppress dust and erosion. The application rate shall conform to the manufacturer's recommendations. The material used shall be of such quality that grass seeds may germinate and not prohibit growth.
- These erosion control measures, including stormwater drainage systems, will be installed before construction commences.
- Installed erosion control measures will be appropriate to site conditions to handle a one-in-two-year storm event for temporary structures, and a one-in-fifty year storm event for permanent structures which provide ongoing sediment control after a site has been rehabilitated.
- Contingency plans will be in place for extreme storm events.
- Blocking of stormwater drainage systems must be prevented and storm water must be managed to prevent soil erosion.
- All cleared areas will be promptly rehabilitated and in accordance with specific instructions from the Construction Manager.
- Soil must be exposed for the minimum time possible once cleared of invasive vegetation. The timing of clearing and grubbing must be co-ordinated as much as possible to avoid prolonged exposure of soils to wind and water erosion.

More detailed mitigation and management measures can be found in the Environmental Management Programme (EMPr) included in **Appendix D**.

8.3 Climate and Air Quality

The Air Quality Report has been included in **Appendix I**.

8.3.1 Potential Impacts

The main pollutant of concern associated with the current and proposed continuous ash disposal operations is particulate matter. Particulates are divided into different particle size categories with Total Suspended Particulates (TSP) associated with nuisance impacts and the finer fractions of PM10 (particulates with a diameter less than 10 µm) and PM2.5 (diameter less than 2.5 µm) linked with potential health impacts. PM10 is primarily associated with mechanically generated dust whereas PM2.5 is associated with combustion sources. Gaseous pollutants (such as sulphur dioxide, oxides of nitrogen, carbon monoxide, etc.) derive from vehicle exhausts and other combustions sources.

Table 8.1 provides a list of all sources of air pollution associated with the proposed project. The subsequent sections provide a generic description of the parameters influencing dust generation from the various aspects identified.

Table 8.1: Activities and aspects identified for the construction, operational and closure phases of the proposed operations

Pollutant(s)	Aspect	Activity
Construction		
Particulates	Construction of continuous ash disposal facility site	Clearing of groundcover
		Levelling of area
		Wind erosion from topsoil storage piles
		Tipping of topsoil to storage pile
	Vehicle activity on-site	Vehicle and construction equipment activity during construction operations
Gases and particles	Vehicle and construction equipment activity	Tailpipe emissions from vehicles and construction equipment such as graders, scrapers and dozers
Continuous ash disposal		
Particulates	Wind erosion from ash disposal facility	Exposed dried out portions of the ash disposal facility
	Vehicle activity on-site	Vehicle activity at the ash disposal facility
Gases and particles	Vehicle activity	Tailpipe emissions from vehicle activity at the ash disposal facility
Rehabilitation		
Particulates	Rehabilitation of ash disposal facility	Topsoil recovered from stockpiles
		Tipping of topsoil onto ash disposal facility
	Wind erosion	Exposed cleared areas and exposed topsoil during rehabilitation
	Vehicle activity on unpaved roads and on-site	Truck activity at site during rehabilitation
Gases and particles	Vehicle activity	Tailpipe emissions from trucks and equipment used for rehabilitation

i. Construction Phase

The construction phase normally comprises a series of different operations including land clearing, topsoil removal, road grading, material loading and hauling, stockpiling and compaction. Each of these operations has their own duration and potential for dust generation. It is anticipated that the extent of dust emissions would vary substantially from day to day depending on the level of activity, the specific operations, and the prevailing meteorological conditions.

ii. Operation Phase

Wind erosion is a complex process, including three different phases of particle entrainment, transport and deposition. It is primarily influenced by atmospheric conditions (e.g. wind, precipitation and temperature), soil properties (e.g. soil texture, composition and aggregation), land-surface characteristics (e.g.

topography, moisture, aerodynamic roughness length, vegetation and non-erodible elements) and land-use practice (e.g. farming, grazing and mining) (Shao, 2008).

Windblown dust generates from natural and anthropogenic sources. For wind erosion to occur, the wind speed needs to exceed a certain threshold, called the threshold velocity. This relates to gravity and the inter-particle cohesion that resists removal. Surface properties such as soil texture, soil moisture and vegetation cover influence the removal potential. Conversely, the friction velocity or wind shear at the surface, is related to atmospheric flow conditions and surface aerodynamic properties. Thus, for particles to become airborne, the wind shear at the surface must exceed the gravitational and cohesive forces acting upon them, called the threshold friction velocity (Shao, 2008).

Estimating the amount of windblown particles to be generated from the proposed wet ash disposal facility is not a trivial task and requires detailed information on the particle size distribution, moisture content, silt content and bulk density. Dust will only be generated under conditions of high wind speeds (US.EPA, 1995).

iii. Closure Phase

It is assumed that all ash disposal activities will have ceased during the Closure Phase. The potential for impacts during the closure phase will depend on the extent of rehabilitation efforts on the ash disposal facility. The closure phase will mainly include materials handling activities, wind erosion and to a lesser extent vehicle and equipment movement on site.

8.3.2 Qualitative Evaluation

i. Construction Phase

It is not anticipated that the various construction activities will result in higher off-site impacts than the operational phase activities. The temporary nature of the construction activities, and the likelihood that these activities will be localised and for small areas at a time, will reduce the potential for significant off-site impacts.

According to the Australian Environmental Protection Agency on recommended separation distances from various activities, a buffer zone of 300 m from the nearest sensitive receptor is required when extractive industries occur without blasting and a distance of 500 m when blasting will take place (AEPA, 2007).

ii. Operational Phase

Wind erosion, will occur during strong wind conditions when wind speeds exceed the critical threshold required to lift and suspend the ash particles. This threshold is determined by the parameters that resist removal such as the particle size distribution of the bed material, moisture content and vegetation. A typical wind speed threshold is given as 5.4 m/s for storage piles (US.EPA, 1995). Wind data for the proposed ash disposal facility site are as follows:

The co-dominant wind directions are easterly and west-north-west with a frequency of occurrence approaching 12% for each direction. Winds from the southern and south-western sectors occur relatively infrequently (<4% of the total period). Calm conditions (wind speeds <1 metres per second (m.s-1)) occur for 8.5% of the time.

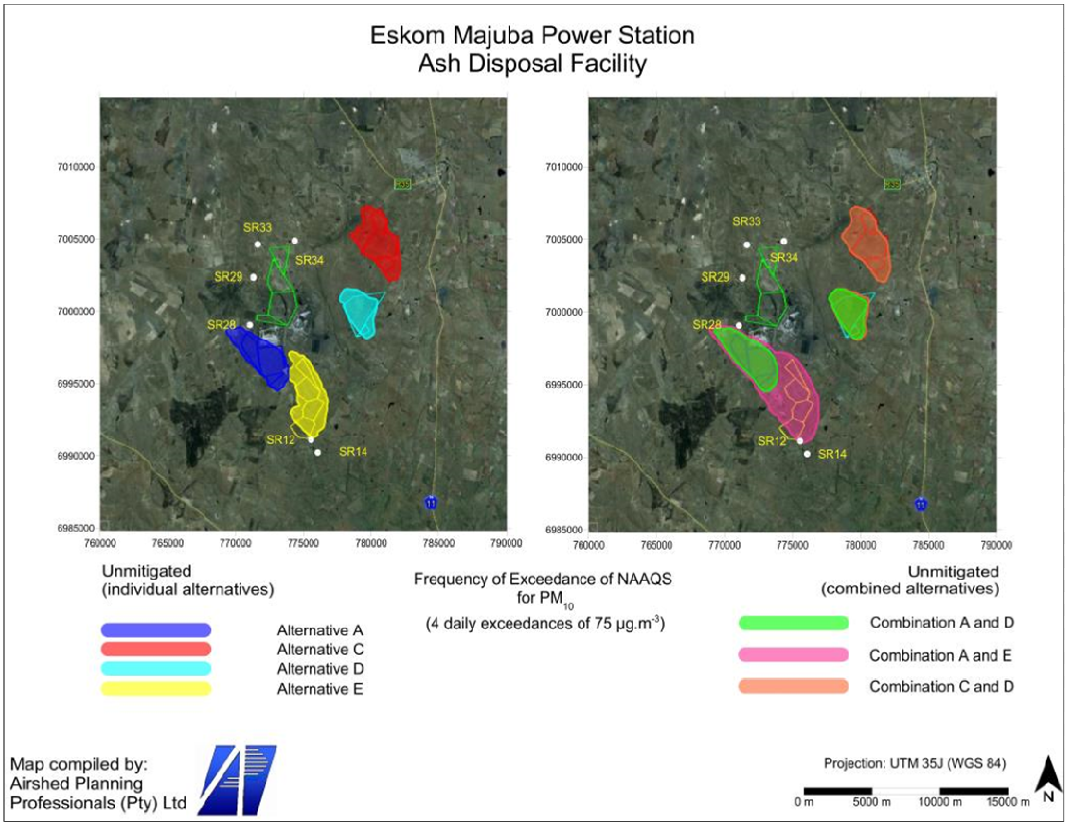

Figure 8.1: Provides a graphic representation of the frequency of exceedences of the PM10 ground level concentrations at set distances from the proposed ash disposal facilities (All Proposed Alternatives). This is with no mitigation in place.

According to the Australian National Pollution Inventory (NPI) wind erosion can be reduced by 50% through water sprays and up to 30% by installing wind breaks. With water sprays enduring 50% reduction from wind erosion, windblown dust will be below the NAAQS limit of 75 μg/m³ at a distance of ~2km from the source.

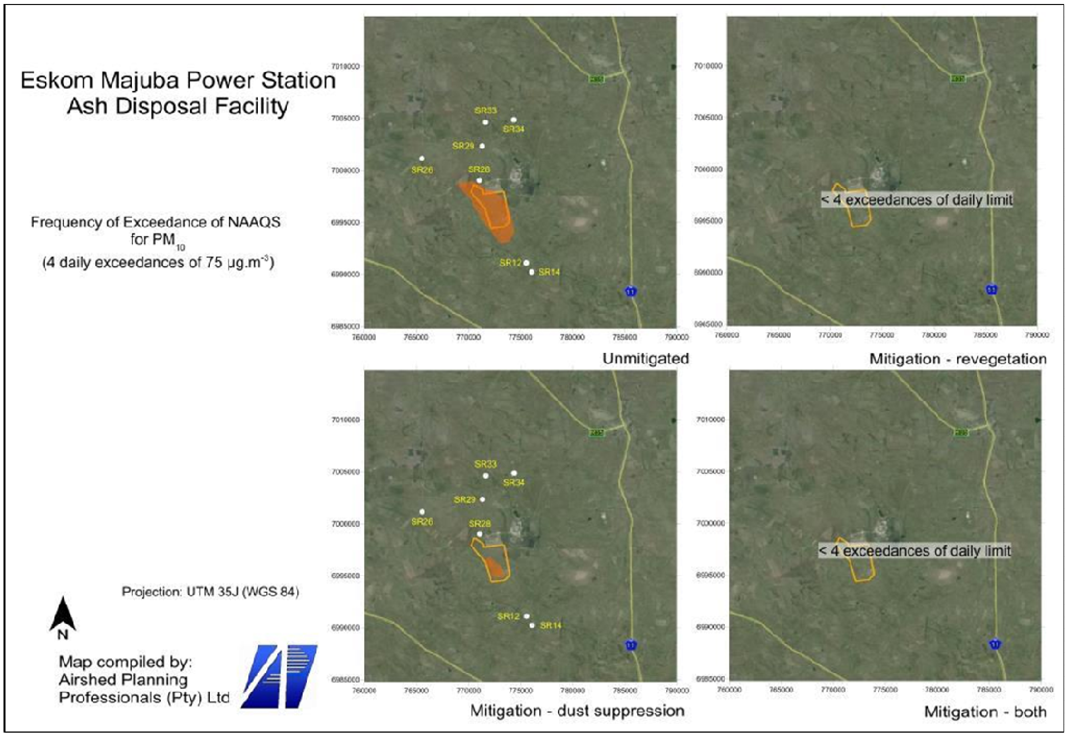

Figure 8.2: Provides a graphic representation of the frequency of exceedances of the PM10 ground level concentrations at set distances from the proposed ash disposal facilities (**Alternative A Extension**). This is with and without different types of mitigation in place.

iii. Closure Phase

The significance of the closure phase is likely to be linked to impacts from windblown dust. Windblown dust is likely to only impact off-site under conditions of high wind speed with no mitigation in place. If rehabilitation as indicated takes place i.e. vegetation cover, the impacts should be limited to be within the site boundary. As vegetation cover increases, the potential for wind erosion will decrease.

8.3.3 Conclusion

- Particulate matter, categorised as dust fall-out, PM_{10} and $PM_{2.5}$, was identified as the pollutants of concern.
- Annual average ground-level concentrations of PM_{10} and $PM_{2.5}$ simulated by dispersion modelling did not exceed ambient standards.
- Daily limits for PM_{10} and $PM_{2.5}$ are expected to be exceeded only within the near vicinity of the facility boundary. Compliance with daily NAAQS (i.e. fewer than 4 days exceeding the applicable limit value) is likely to be achievable with the recommended mitigation measures: rehabilitation and/or dust suppression.
- Effective and continuous application of the mitigation measures will be essential to maintaining compliance with the NAAQS.

- Alternatives Extended A, or individual sites C and D (or the combination of C and D), are the most preferred sites.

8.3.4 Recommended Mitigation and Management Measures

Fugitive dust can easily be mitigated. It is recommended that the dust management measures as stipulated in **Table 8.2** be applied to ensure the proposed activities have an insignificant impact on the surrounding environment and human health. It is also recommended that single dust fallout buckets be installed downwind of the Ash Disposal Facility in order to monitor the impacts from this source.

Based on the qualitative evaluation of the proposed operations, management objectives are considered as summarised in **Table 8.2**.

Table 8.2: Air Quality Management Plan (Construction, Operational and Closure Phases)

Aspect	Impact	Management Action / Objective	Responsible Person
Construction Phase			
Land clearing activities such as dozing and scraping of vegetation and topsoil	PM_{10} concentrations and dust fallout	• Water/Chemical sprays at area to be cleared • Moist topsoil will reduce the potential for dust generation when tipped onto stockpiles • Ensure travel distance between clearing area and topsoil piles to be at a minimum	Environmental Manager Contractor(s)
Wind erosion from exposed areas at ash disposal facility	PM_{10} concentrations and dust fallout	• Ensure exposed areas remain moist though regular water spraying • Dust fallout bucket to be placed to the east and to the west of the new ash disposal facility with monthly dust fallout rates not exceeding 1200 $mg/m^2/day$[(a)]	Environmental Manager Contractor(s)
Operational Phase			
Wind erosion	PM_{10} concentrations and dust fallout	• Ensure water sprays at and around the ash disposal facility • Dust fallout bucket to be placed to the west and to the southeast (dominant wind direction) of the ash disposal facility with monthly dust fallout rates not exceeding 1200 $mg/m^2/day$[(1)]	Environmental Manager
Closure Phase			

Wind erosion from exposed areas	PM_{10} concentrations and dust fall[1]out	• Cover ash disposal facility with previously collected topsoil • Apply water sprays to ensure the material remains moist • Ensure vegetation cover on the ash disposal facility	Contractor(s) Environmental Manager

More detailed mitigation and management measures can be found in the Environmental Management Programme included in **Appendix D**.

8.4 Soil and Agricultural Potential

The Agricultural Report has been included in **Appendix P.**

During the construction and operational phases of the proposed ash disposal facility a number of environmental impacts and issues with reference to soils and agricultural potential will take place. Potential impacts on soils and agricultural potential could include:

- Pollution of soil due to handling, use and storage of hazardous substances (Oils, Fuels and Lubricants), during construction and operation.
- The loss of available top soil.
- Key variables that determine the land capability of the study area such as soil fertility reduced and disturbed due to the potential activities related to the ash disposal facility.
- The loss of viable agricultural land.

8.4.1 Soil Analysis Results

Several soil map units were identified within the study area. The area has a mixture of different soil forms, ranging from yellow-brown, structure-less sandy clay loams (Av map unit) to areas of shallow, rocky soils (Ms map unit), as well as black clayey, structured soils (Ar map unit).

In Table 2, the soil depth refers to the depth (in mm) to a layer in the soil profile that is limiting for root and/or water infiltration, such as rock or greyed clay. The general potential of each map unit for arable agriculture is given, as well as the area in hectares occupied by each map unit within the study area.

[1] *South African Dust Fall limit of 1200 mg/m2/day for heavy commercial and industrial sites not to be exceeded for two sequential months and not more than three exceedances in a year*

8.4.2 Agricultural Potential

The general agricultural potential class of each map unit across the study area (identified site alternatives), and the main limiting factors, are given in **Table 8.3** below.

Table 8.3: Agricultural Potential

Agricultural Potential	Map Unit(s)	Limitations	Area %
Moderate	**Av**	• Restricted depth, leading to reduced infiltration, in places	***(14.5%)***
Low to moderate	**Ar**	Strong structure and high clay content with shrink-swell properties makes cultivation difficult despite natural fertility	***(9.5%)***
• **Low**	**Fw, Kd, Lo, Ss, Tu**	• Mixture of low fertility, bleached soils, some with restricted drainage (**Fw, Lo, Kd**) and subsurface structure causing restricted drainage (**Ss, Tu**)	***(43.7%)***
Very low	• **Ms**	• Extremely restricted soil depth and surface rockiness	***(24.8%)***
None	• **W, B**	• Wetlands and areas of farm infrastructure	***(7.5%)***
		•	•

From Table 4, it can be seen that the study area (site alternatives) is dominated by low potential soils, with only 14.5% occupied by moderate potential soils. There are no occurrences of high potential soils (generally red or yellow, deep, freely-drained, medium-textured) in the vicinity.

8.4.3 Recommended Mitigation and Management Measures

The following mitigations measures are recommended with regards to top soil management. More detailed mitigations measures with regards to soil management in general are included in the EMP (**Appendix D**).

- Topsoil[2] will be sourced from areas which are cleared for construction and spoil dumps, conserved and used judiciously in the rehabilitation of disturbed land and rehabilitation of the proposed continuous ash disposal facility.
- The Contractor is required to strip topsoil together with grass from all areas where permanent or temporary structures are located, construction related activities occur, and access roads are to be constructed. Topsoil must be stockpiled for later use.
- Topsoil stripping will be scheduled for the dry season, as far as possible.
- Topsoil is to be handled twice only - once to strip and stockpile, and secondly to replace, level, shape and scarify.

[2] *Topsoil is defined as the top layer of soil that can be mechanically removed to a depth of about 100mm without ripping or blasting.*

- Topsoil must not be compacted in any way, nor should any object be placed or stockpiled upon it. No vehicles may be allowed access onto the stockpiles after they have been placed
- Land to which topsoil has been applied will be vegetated as soon as possible after application. Re-vegetation should be undertaken as soon as possible once topsoil has been applied to minimise erosion potential
- Stockpiled topsoil must be either vegetated with indigenous grasses/vegetation or covered with a suitable fabric to prevent erosion and invasion by weeds.
- As far as possible, stored topsoil will be free of deleterious matter such as large roots, stones, refuse, stiff or heavy clay and noxious weeds which would adversely affect its suitability for planting.
- Topsoil stockpiles are expected to be similar to the existing Eskom topsoil stockpiles. Topsoil, which is to be stockpiled for periods exceeding 28 days, must be treated with mulch, roughened and seeded with an approved grass mixture or ground cover specified by the ECO. The mulch cover must kept free of alien vegetation/seeds

8.5 Geology

8.5.1 Potential Impacts

The construction and operation of the facilities and infrastructure associated with the continuous ash disposal facility project is not anticipated to impact the underlying geology of the area due to the fact that it entails the establishment of mainly surface infrastructure. However, the following potential impacts on the geological features of the study area have been identified, specifically with regards to surface geological features:

- Impacts associated with the construction related earth works
- Impacts associated with the pollution of geological features in case of spillage / leakage of hydrocarbon and other hazardous material as a result of the activities associated with the continuous ash disposal facility

Due to the existing disturbed nature of the study area, both these impacts are considered to have a medium significance without the implementation of mitigation measures

8.6 Surface Water

The Surface Water / Aquatic Ecology Report has been included in **Appendix Q**.

Impacts on the aquatic ecology may be summarised under three main drivers: (1) alteration to surface water quality, (2) alteration to hydrology, and (3) alteration in geomorphology. Changes to any of the abiotic drivers, due to activities related to the proposed continuous ashing project, will elicit biological responses in the receiving aquatic communities. The potential impacts identified consider five main impacts which are listed and discussed below:

- Impacts on surface water quality;
- Impacts on hydrology;
- Impacts related to erosion and sedimentation;
- Impacts on wetland vegetation and the disturbance of wetland habitat; and
- Impacts related to an increase in alien and pioneer species in disturbed areas.

i. Heavy Metal Contamination

The contents of coal ash may vary depending on where the coal was mined and the ash may potentially contain toxic metals, which include arsenic, lead, mercury, cadmium, chromium and selenium (Gottlieb *et al*., 2010). These contaminants may enter the receiving environment via leachate from the ash disposal facility and the leaching rate may be affected by a number of factors, namely:

- the size and depth of the disposal ponds, and the pressure created by the waste;
- the underlying geology;
- the slope of the landscape; and
- the most vital factor being whether the disposal site is lined (Gottlieb *et al*., 2010).

ii. Increases in Sediment Loads and Turbidity

The implication of increased sediment loads may directly or indirectly be the result of construction and/or operational activities for the proposed continuous ashing project. Ash may become airborne and find its way into the aquatic ecosystems in the area, changing the pH of the water and smothering the substrate. Even though the increase in sediment loads will impact on water quality, it will also result in changes in the in-stream and riparian habitat templates. Increased sediment loads act as an abiotic driver that alters water quality and aquatic habitat. Increased turbidity, total suspended solids and siltation in the aquatic ecosystem, stemming from the increased sediment deposition due to construction activities is considered an issue.

iii. Toxicants

Construction material, hydrocarbons (oil, diesel, etc.), solvents and other pollutants spilling/leaking from construction machinery and equipment during the construction phase may have a severe impact on the receiving aquatic environment.

iv. Hydrology

Potential groundwater issues that should to be taken into consideration are as follows:

- Contamination of ground water due to hydrocarbon spillage and seepage into groundwater reserves, affecting groundwater quality.
- Further construction of infrastructure and compaction of the area will further contribute to reduced water infiltration rates to replenish groundwater aquifers.

The proposed continuous ashing project will result in the loss of the Mean Annual Runoff (MAR) associated with the surface area of the area to be covered by the Ash Disposal Facility and associated infrastructure. Subsequently, the seasonal hydrological patterns in associated streams and rivers will be disrupted. Changing the hydrology of a river or stream also results in other environmental problems, and is usually accompanied by increased rates of erosion, decreased substrate diversity, channel incision and uniform velocity-depth classes (Rosgen, 1993; Simon & Thorne, 1996; Rosgen 1996; Johnson, 2006).

v. Altering Environmental Flows

In a study carried out by Lloyd *et al.* (2004) ecological responses to flow modifications in rivers were examined, where 86 % of the studies recorded ecological changes in community structure. In a similar study by Poff & Zimmerman (2010) 92 % of the studies examined had reported negative ecological changes in response to a range of different types of flow alterations. In addition, fish consistently responded negatively to changes in flow, irrespective of whether the magnitude of the flow increased or decreased (Poff & Zimmerman, 2010).

vi. Alterations in Base Flows

The hydrological regime associated with the rivers/streams in the study area are characterised by peak flows during the summer months and lower base flows during the winter months. The continuous ashing project may possibly result in lowered base flows in the receiving systems due to the loss of the catchment area. Base flow is important as it defines habitat availability.

8.6.1 Impacts Related to Erosion and Sedimentation

Changes in the rates of erosion and sedimentation are often associated with changes in land use. Typical sources of sediment during the construction phase are in-stream activities, stockpiles, excavation and clearing of vegetation. Changes to erosion and sedimentation rates, during the operational phase, are more related to alteration in hydrology. Increased turbidity and sedimentation resulting from erosion have several adverse effects on the aquatic environment. Sedimentation will alter the water quality (increased turbidity) and substrate composition of the receiving aquatic environments, as well as the marginal habitats due to excessive reed growth and alien vegetation encroachment as a result of the deposited sediment.

i. Increases in Turbidity

Suspended sediment will result in an increase in turbidity. This, in turn, will result in a decrease in primary production, increased bacterial activity and a decrease in oxygen saturation. Fine sediment suspended within the water column can potentially reduce the rate of photosynthesis; affect macro-invertebrate community structures; decrease the feeding efficiency and growth rates of fish populations and increase the incidence of disease (CMA, 2008). Studies have shown that an increase in turbidity impedes fish reproduction, particularly where breeding requires visual mate recognition and visual stimuli for breeding behaviour (Bash *et al.,* 2001; Zeynep, 2007). Similarly, some predators require clear water for hunting and might be adversely affected by decreased visibility due to increased turbidity. This might have a significant impact on aquatic ecology, as changes in predation pressure will alter aquatic communities.

ii. Decreases in Habitat Diversity

Any sediment that is more than the natural sediment transport capacity of a watercourse will be deposited; this depositing process is called sedimentation and might smother more suitable habitat structures, such as woody debris or cobble sections. A loss in habitat diversity, due to sedimentation, will inevitably translate into a loss of aquatic organisms with specific habitat requirements. Conversely high-velocity water, from discharge structures or flood water management systems, may scour natural substrates downstream of receiving watercourses, degrading habitat for fish and other wildlife.

iii. Impacts on Aquatic Biota

Aquatic biota consist of in-stream communities (periphyton, macrophytes, invertebrates and fish) and riparian and wetland communities. Impacts on aquatic biota may manifest in a number of different ways, but will nearly always be the result of alteration in natural hydrology, water quality or geomorphology. Some exceptions are alien introduction, as well as direct removal of riparian- and wetland vegetation (Dudgeon *et al.,* 2006).

iv. Decreases in Habitat Diversity and Habitat Fragmentation

The direct loss of river and wetland areas through clearing of riparian and wetland habitat will result in a complete, but localised, loss of aquatic habitat. Aquatic habitat fragmentation may be the result of chemical (water quality) or physical (hydrology, erosion and sedimentation) migration barriers. Any of the impacts listed under water quality, hydrology and erosion and sediment might result or contribute to habitat fragmentation.

v. Alterations in Aquatic Community Structure

The alteration in aquatic community structures might directly be attributed to changes in water quality, quantity and timing, or indirectly, due to changes in habitat availability. Changes in community structures are typically characterised by a decrease in diversity and higher abundances of more tolerant species. Specialised species (like reophilic fish and niche feeders) are the first to respond negatively to changes in the aquatic environment.

vi. Acute and Chronic Toxicity

Hazardous and toxic compounds might enter surface water systems at acute toxicity concentrations. This impact might present itself during construction and operational phases. The prolonged exposure of aquatic biota to sub-lethal contaminants that may find their way into surface water systems might result in chronic toxicity and may manifest itself through a number of different ways i.e. carcinogenic, mutagenic and teratogenic effects on exposed communities.

vii. Alien Encroachment and Infestation

In places where wetland and riparian habitats may be removed, opportunistic alien pioneers might encroach. Alien vegetation increases biomass, potential for fire intensity and evapo-transpiration, decreases river flows, surface water run-off and groundwater recharge (Görgens & Van Wilgen, 2004; Chamier *et al*., 2012).

viii. Removal of Riparian and Wetland Vegetation

Riparian and wetland vegetation provides cover, breeding habitat and migration corridors for wildlife, serves to trap sediment and fine silt, and helps with energy dissipation during flood events (Levick *et al.,* 2008; Howe *et al.,* 2008). The proposed activities, particularly during the construction phase, will impact on riparian and wetland vegetation. Disturbances of the riparian and wetland areas will lead to a decrease in ecosystem services and will also lead to the possible establishment of alien vegetation. In addition, the removal of riparian vegetation may increase the amount of sediment entering the system. Vegetation removal may lead to some specific issues, which are:

- Compaction of soils;
- Dispersal of exotic plant species;
- Decrease water infiltration, resulting in increased flow volumes and peak run-off rates;
- Acceleration of erosion rates; and
- Solar radiation could result in an increase in water temperature, thus affecting primary production (Kleynhans et al., 2007b).

ix. Species with Conservation Status

A few species with conservation status may potentially occur in the study area. According to South African Bird Atlas Project 2, the Blue Crane has been recorded in the PENTAD grid squares associated with the study area and may potentially breed in wetland areas:

• Blue Cranes (*Anthropoides paradiseus*) are listed as Vulnerable according to the IUCN database (IUCN, 2012). A. paradiseus breeds in natural grass- and sedge-dominated habitat and may infrequently breed near or within wetland areas (Barnes 2000).

Additional species that may potentially occur within the rivers and wetlands associated with the study area (Cook, 2011) include:

- Giant Bullfrogs (*Pyxicephalus adspersus*) are Near Threatened (NT) in South Africa (Minter et al. 2004) due to anthropogenic activities resulting in habitat loss.
- Grey Crowned Cranes (Balearica regulorum) are listed as Endangered according to the IUCN database (IUCN, 2012) and inhabit wetlands (Hockey et al., 2005), riverbanks (Meine & Archibald, 1996), shallowly flooded plains (Urban et al., 1986) and temporary pools (del Hoyo et al., 1996).
- Wattled Cranes (*Bugeranus carunculatus*) are listed as Vulnerable according to the IUCN database (IUCN, 2012). In South Africa *B. carunculatus* breed on undisturbed permanent wetlands (small) that are surrounded by grassland (Hockey et al. 2005) where disturbance from humans are minimal (Archibald & Meine, 1996). They may opportunistically breed on ephemeral/seasonal wetlands which may also be used essential post-breeding dispersal areas (Archibald & Meine, 1996).

Larger tributaries receiving runoff from the study area provides potential refuge for four fish families represented by approximately 12 species, none of which have conservation status and are listed as Least Concern (LC) by the IUCN (2012) (**Error! Reference source not found.**). *Barbus neefi* and *Barbus pallidus* are expected to occur in the study area (IUCN, 2012) and both species are moderately intolerant to alterations in water quality making them good indicators of ecosystem health.

8.6.2 Impacts on Aquatic Ecosystem Functions and Services

The degree to which impacts, discussed in previous sections, will influence aquatic ecosystem functions and services will depend on the nature of the impact and the nature of the receiving watercourse (i.e. the ability to provide a particular service, which is different for lakes, wetlands and streams) (Kotze et al., 2009). Some ecosystem services are indirectly beneficial to local society and pertain to sustaining ecological functionality, such as flood and erosion control, water purification, biodiversity and carbon storage.

At some sites, the continuous Majuba Ash Disposal Facility may result in the alteration or destruction of aquatic habitat and subsequent loss of associated functions, which include flood attenuation; stream flow augmentation; enhancement of water quality and biodiversity. Wetland functions associated with each hydro-geomorphic (HGM) type is summarised in **Table 8.4**.

Table 8.4: Preliminary ratings of the hydrological benefits likely to be provided by wetlands (Kotze et al., 2009)

Wetland HGM	**Regulatory Benefits Potentially Provided by the Wetland**							
	Flood Attenuation		**Stream flow regulation**	**Enhancement of Water Quality**				
	Early wet season	**Late wet season**		**Erosion control**	**Sediment trapping**	**Phosphates**	**Nitrates**	**Toxicants**
Floodplains	++	+	0	++	++	++	+	+
Valley-bottom: Channelled	+	0	0	++	+	+	+	+
Valley-bottom: Un-channelled	+	+	+	++	++	+	+	++
Hillslope seep: Connected to a stream channel	+	0	+	++	0	0	++	++
Hillslope seep: Connected to a stream channel	+	0	0	++	0	0	++	+
Pan / depression	+	+	0	0	0	0	+	+
Rating: 0 Benefit unlikely to be provided to any significant extent; + Benefit likely to be present at least to some degree; ++ Benefit very likely to be present (and often supplied to a high level)								

The sections below provide a general overview of the available and indirect aquatic ecosystem services:

i. Flood Attenuation

Floodplain systems provide an important service related to flood attenuation. The importance of the service is a function of the size and location of the floodplain in its catchment. Valley bottom wetlands, reflecting seasonal variation in wetness might also play a role in flood attenuation, particularly during the early wet season before their seasonal zones become saturated. Flood attenuation services might be impaired or lost through canalisation or any other activity that will inhibit the ability of the watercourse to retain and slowly release flood water.

ii. Stream Flow Regulation

In seasonal streams and rivers, surrounding wetlands play an important role in stream flow regulation. The ability of surface water systems, and particularly wetlands, to provide a stream flow regulation service might be inhibited or lost through any activity that will decrease surface roughness (loss of vegetation cover or soil compaction), increase impermeable surfaces or any other activity that will influence the permeability and soil-resident time of surface water run-off.

iii. Enhancement of Water Quality

This service is mostly limited to wetland systems, where surface water is exposed to a number of purification processes like reduction, adsorption, mineralisation and ion exchange. Natural water purification processes typically require low energy environments with sufficient surface area for adsorption and carbon for reduction. Activities that result in a change in energy of a particular system (i.e. channelisation or entrenchment caused by erosion) will inhibit this ecosystem service.

iv. Erosion Control

River ecosystems may provide the function of the retention of soil within the ecosystem, thereby preventing the loss of soil by means of the riparian vegetation cover and soil retention (Costanza et al., 1997).

v. Refugia

River and wetlands associated with the study area may provide different micro habitat types, cover units, flows and depths, and thus may potentially house different fish and invertebrates with different habitat preferences. Wetland and riparian vegetation is adapted to tolerate reducing environments and play an important role in providing habitat for other aquatic species.

vi. Maintaining longitudinal and lateral connectivity

Rivers and their associated riparian zones provide migratory connectivity for both aquatic and terrestrial species and thereby maintain both aquatic and terrestrial biodiversity (Costanza et al., 1997).

8.6.3 Project Specific Impacts

i. Extended Alternative A

Construction Phase

Construction activity on Alternative A will impact directly on Wetlands 1, 2, 4, 5, 6, 33, 35, 36, 37 and 38, while downslope Wetlands 3 and 7 might also be affected (**Figure 8.3**). Main activities during the construction period will be vegetation clearing and top soil removal. Subsequent impacts relate to direct loss of wetland habitat and functionality for previously mentioned wetlands and changes to the hydrology, water quality and sediment loads of downstream receiving wetlands.

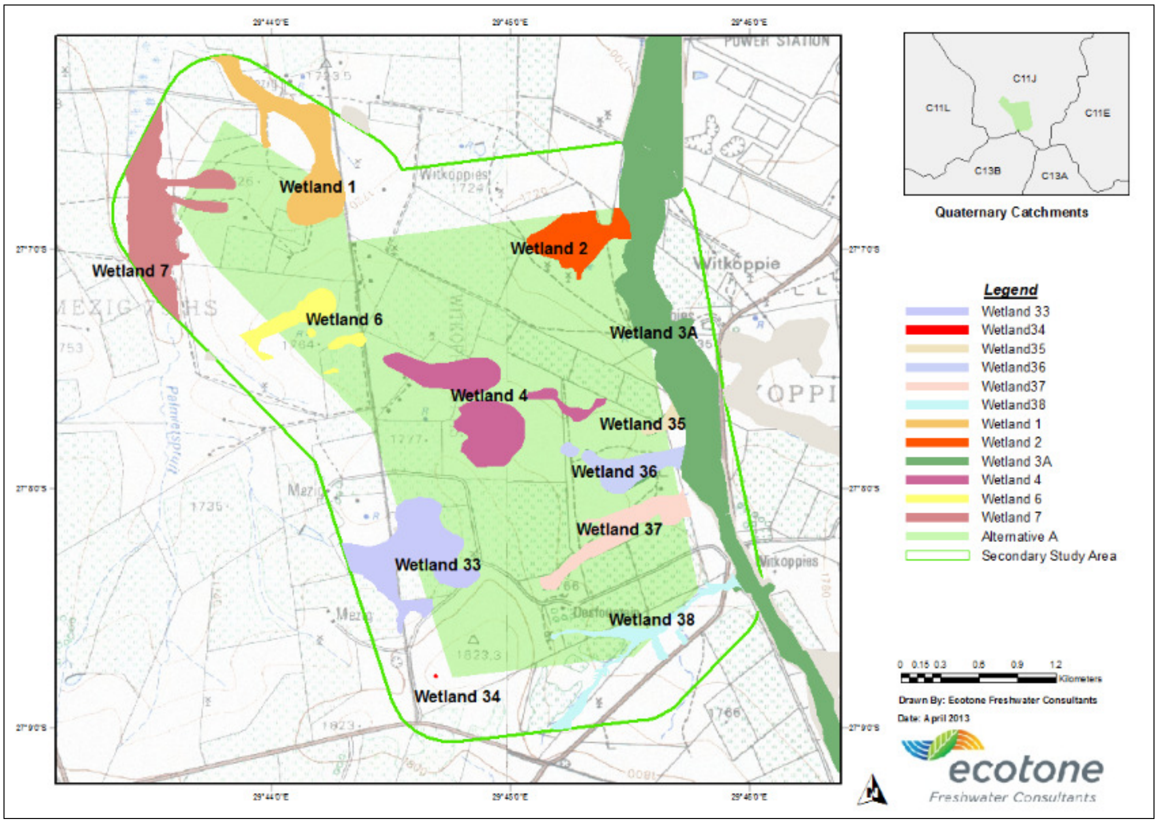

Figure 8.3: Map showing the different wetlands associated with the primary (Alternative A) and secondary study area.

Operational- and De-commissioning Phase

The residual hectare extent of functional wetlands associated with Alternative A scores second to Alternative E (Alternative E yielded the greatest extent of wetlands, compared to the other Alternatives. Wetland 29, located within the eastern portion of the Alternative and its 500 m radius fell into an A Ecological Category) refer to the Aquatic Specialist Report **Appendix Q**. The floodplain systems (Wetland 3A and 7), located within the secondary study area of Alternative A, contribute mostly to the higher ecosystem services score obtained for this Alternative. The loss of wetland functions will mostly be expressed during the operational phase.

It is assumed that runoff generated by the footprint will be treated as polluted water and redirected to a pollution control facility. This will reduce the runoff received by Wetlands 1, 3 and 7. Wetlands 3 and 7 are notably more important systems than the other wetlands on Alternative A, due to the extensive catchments drained by both. The loss of hydrological contributions from Wetlands 2, 4, 6, 33, 35, 36, and 37 to the receiving floodplain systems (Wetlands 3 and 7) are anticipated to be of Low to Moderate significance. The extent of vertic soils on this Alternative associated with the presence of local depressions (Wetlands 2, 4 and 6) suggests a relatively lower importance to stream flow augmentation. The hydrological contributions of wetlands 2, 4, 6, 33, 35, 36, and 37 are marginal considering the relatively large catchments of Wetlands 3 and 7.

Additional consideration should be given to the likelihood of surface water pollution due to runoff, leachate or malfunctioning of the pollution control system, in which case receiving water bodies will be at risk. Current water quality for Wetland 3 and 7 is considered good and impacts related to water quality thus scored a higher magnitude for these two wetlands.

Activities that will take place during the de-commission phase have not been disclosed. It is assumed that the dry ash disposal facility will be stabilised pre-decommissioning, with the aim of increasing surface roughness. Changes to the drainage system are also expected. The long term impacts of the decommissioned disposal facility on surface water quality will rely on leachate and/or runoff quality.

Cumulative Impacts

As previously mentioned two thirds of Alternative A drain into Wetland 3A, which in turn drains into an unchannelled valley bottom (3B) located on Alternative B. Wetland 3B is already expressing upslope land use impacts and will be at greater risk for cumulative impacts. Extended Alternative A forms part of the upper catchment of a tributary flowing into the Witbankspruit. The Witbankspruit reflects a Moderate loss in ecological integrity and additional catchment alterations pose a cumulative impact risk. The probability of cumulative impacts associated with Alternative A is less than for Alternative B. This is mostly due to a higher frequency of localised depressions and a smaller extent of directly affected valley bottom systems which will allow more containment of pollution from the proposed activities.

ii. Alternative B

Construction Phase

Construction phase impacts for Alternative B also relate to direct loss of wetland habitat, erosion, downstream sedimentation and water pollution. The magnitude of these impacts is relatively low for most wetlands on Alternative B, but will be greatest for Wetland 3B and associated downslope wetlands.

Operational- and De-commissioning Phase

Alternative B differs from Alternative A in a few critical ways: (1) Even though this Alternative is occupied by the same wetland extent as that of Alternative A, the associated sub-catchments are more transformed. Functional integrity is estimated at 171 ha; 60 ha less than for Alternative A. (2) In contrast with Alternative A, the more important wetland on Alternative B (Wetland 3B) are situated within the proposed footprint. This wetland will be destroyed and dependent downslope wetlands will be impacted upon. Wetland 3B drains the largest catchment of all wetlands (approximately 2500 ha), plugging this system with an ash disposal facility will also have implication for upslope connected systems. The most important wetland on Alternative B is Wetland 3B, which currently plays an important role in water purification, stream flow regulation, erosion control, sediment trapping and flow augmentation.

The nature and extent of Wetland 3B also creates a suitable corridor connecting aquatic habitat upslope and downslope of the existing power station and ashing facilities.

Post-closure impacts on Alternative B will mostly be linked to possible water pollution through leachate and runoff from the Ash disposal facility. The likelihood of this impact is higher for Alternative B than for Alternative A for two reasons: (1) Alternative B consists of a number of reasonably sized sub-catchments, while more than two thirds of Alternative A drains into one catchment. Containing and managing leachate, runoff and accidental spillage are thus more complicated for Alternative B. (2) Placing the ash disposal facility on Alternative B will result in the destruction of Wetland 3B which drains a relatively large catchment and which is connected to downslope channelled systems. Isolating this system will result in upstream ponding which will affect flood plain systems (Wetland 3A) and will deprive the downslope wetlands from their ecological flow requirements.

Cumulative Impacts

Even though wetlands on Alternative B (directly affected by the proposed footprint), are more transformed than wetlands on Alternative A, their longitudinal connectivity is greater. This increases the likelihood of downslope cumulative impacts. The magnitude of cumulative impacts remain mostly unchanged for the different alternatives as they all drain into one or two large watercourses which reflect a Moderately transformed desktop PES.

iii. Alternatives C&D (Similar in impacts through all phases)

Construction Phase

Construction on Alternatives C and D will pose similar impacts anticipated for the previously discussed alternatives. Construction phase activities will result in the partial destruction of Wetlands 14, 16 and 19 on Alternative C and Wetlands 17, 21, 22, 23 and 26 on Alternative D. Systems to be impacted include seeps, channelled and unchannelled valley bottom wetlands. In most instances wetlands are associated with headwater reaches and small catchments. Furthermore, most of the wetlands in question are already in a Moderately to Largely modified state and jointly retain less functional integrity than any of the other alternatives assessed. The most noteworthy wetland to be directly impacted on by the proposed development is Wetland 16; an unchannelled valley bottom system located on Alternative C. This system retains a large portion of its functional integrity and contributes mostly towards the ecosystem services score for Alternative C. Wetland 16 occupies the largest sub-catchment draining more than 50% of Alternative C. Its catchment reflects a reasonable amount of transformation and the dominant functions of this wetland related to water purification, erosion and sediment control. Anticipated construction phase impacts include: direct loss of wetland habitat, erosion, downstream sedimentation and water pollution.

Two additional considerations should be mentioned: (1) The nature and extent of Wetland 16 on Alternative C assigns a greater sensitivity to this Alternative and development thereon should be avoided. (2) Linear infrastructure will be required to transport ash from the power station to these alternatives over a distance of 3 to 9 km. In order to do so a number of watercourses will have to be crossed. The construction of linear infrastructure will require instream activities which will pose hydrological, erosion, sedimentation and water quality risks. These activities will also require additional legal consideration in terms of an Integrated Water Use Licence and additional specialist studies.

Operational- and De-commissioning Phase

Operational phase impacts for Alternatives C and D relate to a loss in wetland services and downslope impacts on hydrology, habitat and water quality. Considering the location and sizes of respective sub-catchments, the extent and magnitude of these impacts are considered marginal. However, Wetland 16 requires special mention due to its PES and hydrological contribution to downslope wetlands.

Cumulative Impacts

Both Alternatives C and D are located on water sheds and as such drain relatively small sub-catchments of headwater areas. Potentially affected wetlands located to the western side of these alternatives drain into the Witbankspruit, while wetlands on the eastern side drain into a tributary of the Skulpspruit. Both the Witbankspruit and the Skulpspruit retain Moderate ecological integrity. As such development on Alternatives C and D poses a risk of further impairing the ecological integrity of receiving systems. Moreover, linear infrastructure will further add to aquatic impacts on a number of additional watercourses.

iv. Alternative E

Construction Phase

Alternative E is considered the most sensitive alternative in terms of wetlands. Its direct footprint contains the second largest extent of wetlands (next to Alternative B), while the retained functionality of its wetlands are more than that of the other alternatives. Construction activities will directly impact on a number of large seep areas which form the head-drainage of the floodplain system to the west (Wetland 3A and B) and a channelled valley bottom system to the east. Seeps draining to the east retain most of their functional integrity, while seeps draining to the west retain Moderate functional integrity. Direct loss of relatively large, intact seep habitat will be cleared within the direct footprint. Anticipated downslope impacts include: erosion, sedimentation, increased runoff volumes and water pollution. These impacts have an increase likelihood of occurring due to the steeper topography associated with Alternative E (see **Error! Reference source not found.**).

Operational Phase- and De-commissioning Phase

The loss of headwater seeps on Alterative E will have serious consequences for downslope valley bottom systems during the operational phase. Anticipated impacts during the operational phase pertain to a loss in ecosystem services of affected seeps and include a possible loss in flood attenuation and stream flow regulation, increase erosion rates and water pollution.

Cumulative Impacts

Wetlands to the north-east of Alternative E form the headwaters of the Witbankspruit. Wetlands to the east drain into a relatively large tributary, which in turn drains into the Skulpspruit. Concurrently, wetlands to the west also form the upper reaches of Wetland 3A, B and C. In most instances receiving watercourses are already subjected to catchment impacts which have resulted in a departure from reference conditions. At the same time, the hydrological contributions of the upper catchments of these systems are considered to be significant. It follows that the placement of the proposed infrastructure on Alternative E will prompt a further loss in functional integrity for receiving wetlands.

V. ***No Go Alternative*** – The section below explains how the existing impacts (unrelated to the project) will influence the various site alternatives should the Ash Disposal Facility not be constructed.

Extended Alternative A

Current land use pressures are linked to overgrazing and ashing activities, particularly to the centre and western sections of the Alternative. Wetlands 1, 2, 4 and 6 are likely to deteriorate slightly over the next 5 years, while Wetlands 3, 5, 7, 33, 35, 36, 37 and 38 will remain stable.

Alternative B

Alternative B receives runoff from agriculture, the power station and ashing facility. Wetland 8 and 9 show active headcut erosion which is likely to result in a slight deterioration over the next 5 years. The extent of Wetlands 3A, 9 and 11 appears consistent in historical aerial images and are likely to remain unchanged for the medium term.

Alternative C

Wetlands 14, 15 and 19 on Alternative C showed channel formation and channel alteration. These systems are prone to erosion and are likely to further deteriorate over the next 5 years. Catchment uses for sub-catchments of Wetlands 13, 16, 18 and 17 remained constant, for at least the past 40 years, and it appears as if these wetlands have adjusted accordingly. No changes in PES are expected for Wetlands 13, 16, 18 and 17.

Alternative D

Wetlands on Alternative D have been subjected to extensive historical and existing agricultural activity. Most of the wetlands showed erosion features; however little advances in erosion features could be observed when historical aerial images were compared to more recent ones. It is therefore anticipated that these systems will remain stable over the next 5 years.

Alternative E

Historical land uses on Alternative E include agriculture and mining (noted in the upper northern parts on the historical image for 1990) (**Error! Reference source not found.**). More recently a railway line was constructed and old agricultural fields have been left fallow for a number of years. The extent of affected wetlands remained unaffected before and after these activities. The majority of wetlands on this Alternative are expected to remain stable in their functional integrity following the next 5 years.

The No-go alternative assessment thus ascertained that some wetlands on Alternatives A, B and C are likely to experience a slight deterioration in PES over the next five years. Most wetlands on Alternatives D and E appear to have adjusted to their catchment transformation and are likely to remain unchanged. Opting for the No-Go alternative will therefore have low Bio-physical impacts on the study area.

8.6.4 Recommended Mitigation and Management Measures

The Ecological Importance and Sensitivity (EIS) assessment indicated that the loss of wetland habitat and associated contributions to biodiversity linked to Alternative A and its Extension, is of local significance. It is unlikely that any significant residual impacts to biodiversity will be incurred if the wetlands on this Alternative are affected permanently. However to compensate for the loss in wetland habitat, possible mitigation measures were adapted from Douglas *et al.* (2012) and include the following:

- Avoid the disturbance of wetlands on the preferred alternative as far as possible by considering them when designing the ash disposal facility. This will decrease the overall impact linked to the loss on wetland habitat.
- <u>Where economically and ecologically viable,</u> create new wetland system where none existed before by manipulating the physical, chemical, or biological characteristics of a specific site. Successful establishment would result in gains in wetland area, functions and biodiversity values.
- Rehabilitate similar impaired systems in the surrounding areas and conserve these systems to compensate for the loss of wetland habitat induced by the proposed development.
- Add to existing protection based rehabilitation efforts. This may involve 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 the National Environmental Management Act) and putting in place appropriate management structures and actions to ensure that conservation outcomes are secured and maintained in the long-term.

The viability of the above mentioned rehabilitation efforts will be confirmed through the additional feasibility assessment focussing on the respective: (1) technical feasibility, (2) cost-benefit, and (3) environmental impact associated with different rehabilitation/mitigation strategies. A combination of rehabilitation strategies may also be possible.

i. General Recommendations

General recommendation mainly considers mitigating risks factors pertaining to hydrology water quality, sedimentation and erosion linked to the downslope receiving aquatic resources during the construction and operational phases.

- Minimize both the area that will be exposed to and the exposure time during construction (LRRB, Mn/DOT and FHWA, 2003).
- Pollution prevention, minimisation of impacts, water reuse and reclamation, water treatment and discharge activities should be according to the DWAF Best Practise Guidelines (DWAF- H series, 2007). Storm water management, water and salt balancing, water monitoring and water treatment plans should, be consistent with DWAF best practise guidelines (DWAF- G-series, 2006). Pollution control dams, water management for residue deposits and water management for surface activities should be in line with DWAF Best Practise Guidelines (DWAF- A series, 2007).
- Discharge into surface water systems, for whatever reason and withstanding water quality restraints, should consider the hydrological capacity and seasonality of associated watercourses. Maximum hydrological capacity of systems should not be exceeded. It is also pertinent that base flows should not be altered by discharge activity. This will result in a change in bed load capacity of the system and will ultimately result in system instability.
- Erosion control measures should be implemented as the primary means of sediment control throughout the construction and operational phase. Increased turbidity and sedimentation resulting from erosion have several adverse effects on the aquatic environment.
- Surface water systems should be protected from contamination with volatile hydrocarbons and lubricants at all times.
- Contingency plans need to be established in case of fuel or hazardous waste spills, storm water run-off and flood events.
- No dumping of any building rubble, soil, litter, organic matter or chemical substances may occur within the associated wetland. Dumping and temporary storage of the above should only occur at predetermined and approved/authorised locations.
- All excavated material should be deposited and stabilised in an approved area.

ii. Construction Phase

During the design phase, considerations should be given to environmental least cost options for the proposed activity. The strategic placement of related infrastructure and the proper design thereof will be the first course of action in impact mitigation. Before construction is initiated, a detailed construction method statement should be provided in accordance with all the applicable authorisations, for all of the proposed activities. The method statement should address the following components related to wetlands:

- Highlight the presence, extent and sensitivity of associated watercourses, as well measures to avoid any unnecessary damage or loss to these systems during construction. Physical demarcation of wetlands, and general "wetland" awareness should be included;
- Provide a biophysical description of the construction site and potentially affected wetlands (vegetation cover and biotic composition etc.);
- Provide a list of the typical types of equipment that will be used for the construction activity and for the control of water if it present;
- Provide a detailed course of action for accidental spills or surface water contamination and describe detailed measures to control risks related to suspended sediment and turbidity (e.g. berms, hay bales, silt curtains, river diversions, and settling ponds), damage to riparian vegetation and spillage of fuels and oils, cement and other foreign materials;
- Provide details for environmental monitoring during the construction phase. It should provide information on what environmental aspects are to be monitored (*in situ* water quality, erosion, soil and slope stability), how it should be monitored (quantitative or qualitative), at what frequency it should be monitored (daily, weekly, monthly), who is responsible for the monitoring and how to communicate and respond to information generated by the monitoring reports;
- Provide details of appropriate responses for monitoring results. The end of the construction phase should be marked by a clean-up and rehabilitation program for all wetlands located adjacent to the construction servitudes. The extent of which should be to the periphery of the secondary study area, as indicated in this report.

Hydrology

- The lateral extent of wetlands should be physically delineated prior to construction and the temporary access roads to cross points should be designed to minimise soil compaction, thus not impeding the horizontal movement of water through the soil;
- Reinstate hydrological functionality of affected systems after construction activity, as far as possible. This will require rehabilitation of disturbed downslope areas were attention is paid to increase surface roughness and energy dissipation.

Water Quality

- No dumping of any building rubble, soil, litter, organic matter or chemical substances should occur within watercourses. Dumping and temporary storage of the above should only occur at predetermined and appropriately authorised locations;
- Construction workers should not use watercourses for sanitation purposes;
- In the case of dewatering of a construction site, water should be treated and all suspended particles should be removed. Water removed from a construction site should not be released directly into a watercourse. The discharge should occur onto a well vegetated area, which will help trap sediment and residual contaminants; and
- Construction equipment should not be serviced or refuelled near watercourses.

Erosion and Sedimentation Impacts

- Erosion and silt control mechanisms must be in place prior to the onset of construction within any watercourse. This includes the elimination of surface flow through the construction site. Silt fences or hay bales or appropriate systems need to be placed near the base of a slope in order to limit the amount of silt entering the watercourse;
- Similarly, the erection of silt barriers along all of the drainage lines must be undertaken to curb any sediment and silt run-off in the preparation activities. Ideally, the amount of land that will be disturbed should be kept to an absolute minimal;
- Non-erodible materials should be used for the construction of any berms, coffer dams or any other isolation structures to be used within a flowing watercourse;
- Spoil piles should be placed above the high water mark in distinct piles and adequate erosion measures need to be implemented in order to minimise and reduce erosion and siltation into the watercourse from spoil piles;
- It is also recommended that construction activities should make use of the dry seasonal construction window as far as practically possible. This will further reduce the risk associated with erosion / siltation; and

- Erosion control measures should be inspected regularly during the course of construction and necessary repairs need to be carried out if any damage has occurred.

iii. Operational Phase

General recommendations applicable to operational activities include the environmental education and awareness associated with the importance and value of wetlands, and wetland monitoring:

- All employees should be educated regarding environmental risks and proper cause of action should such risks be presented during day to day activities; and
- A wetland monitoring plan should be implemented for all operational activities possibly impacting on wetland systems. The monitoring plan should provide details on strategic test- and control sites, uniform and repeatable sampling efforts, response metrics to be used, data processing and dissemination of monitoring results.

Hydrology

The hydrological functions associated with wetlands that fall within the footprint of the preferred alternative will be lost. In most instances this impact was not considered of High significance, due to the location of the alternatives.

Water Quality

- Isolate contaminated water. Any water with a chemical signature different to that of the receiving aquatic environment should be considered contaminated and should be isolated. Ashing processes and activities should make a clear distinction between clean and contaminated water and systems to deal with both should be in place;
- Pollution prevention, minimisation of impacts, water reuse and reclamation, water treatment and discharge activities should be according to Best Practise Guidelines (DWAF- H series, 2007);
- Storm water management, water and salt balancing, water monitoring and water treatment plans should be consistent with Best Practise Guidelines (DWAF- G-series, 2007);
- Pollution control dams, water management for residue deposits and water management for surface activities should be in line with Best Practise Guidelines (DWAF- A series, 2007);
- Threshold criteria for water quality should not just consider potable standards. Background concentrations of TDS, in particular, should be considered. It is

pertinent that receiving surface systems do not incur TDS variations greater than 15 % of that of background concentrations;

Erosion and Sedimentation Impacts

- Routine monitoring of turbidity in receiving watercourses should not yield values greater than background values;
- Wetland buffer zones should be pre-determined and placed on all of the drainage lines associated with the proposed ash disposal development;
- Place access roads and ashing-related infrastructure on natural topography and avoid side hill cuts and grades. Roads should be designed with natural reclamation in mind; and
- Design runoff control features to minimize soil erosion and avoid placement of infrastructure and sites on unstable slopes and consider conditions that can cause slope instability, such as groundwater aquifers, precipitation and slope angles.

iv. De-commissioning Phase

In conjunction with the appropriate authorisation process a detailed activity description for de-commissioning phase should be provided prior to the onset of de-commissioning. Highlighted risks after decommissioning mainly relate to long term leachate and surface water contamination. This impact will be mitigated by procedures already in place during the operational phase. Lining of the ash disposal facility will be one of the main recommendations for curtailing long term, chronic impacts of this nature.

8.7 Groundwater

The Ground Water Report has been included in **Appendix N**.

8.7.1 Site Specific Impacts

The five alternative areas identified from scoping are located in similar environments from a groundwater point of view (see **Error! Reference source not found.**) and all five sites are discussed together in this section. The relatively low permeability of the underlying rocks and the dry ash disposal technique implies that additional recharge of potentially contaminated water will be limited, and that potential contaminant plumes (see **Error! Reference source not found.** to **Error! Reference source not found.**) will be limited to the immediate vicinity of the ash disposal sites. Use of liners, compaction, and cementation of the dry ash will most likely further reduce leachate infiltration. Unmapped permeable geological structures (e.g. dykes) and abandoned mine workings may however lead to higher rates of plume development and different patterns of spreading if present (but there is currently NO indication that either of these things are present).

i. Construction phase

The dry ash disposal system that is being used at Majuba implies that no slurry will be used in the construction of the new ash disposal facility. If ash-based or other slurry is used (for example to settle an underdrain system) then it is possible that increased downward migration of potentially contaminated water will occur. The use of earth-moving plant also brings a risk of hydrocarbon spillages during the construction phase. This can be mitigated by careful storage and handling of hydrocarbons (e.g. diesel, lubricants, hydraulic fluids, etc), preferably in appropriately bunded areas. The soil zone is an important barrier to the downward migration of potential groundwater contaminants (both a physical barrier and a microbiological and chemical barrier). Removal of topsoil during the construction phase can worsen any spillages that may occur during this phase. Local mounding of groundwater due to increased recharge may start to occur during the construction phase, with possible changes of local groundwater flow directions.

ii. Operational phase

A dry ash stacking system will be used and it is considered unlikely that a significant rise in the water table beneath the ash disposal facility will occur as a direct result of the ash itself, due to relatively low downward flux of leachate. The use of toe drains, stormwater dams and other surface water impoundments close to the proposed ash disposal facility is more likely to lead to local water table rise. Mounding of groundwater in the vicinity of the ash disposal facility can also imply a possible change in groundwater flow direction, compared with the original groundwater gradients. The quality of groundwater beneath the site is likely to deteriorate, since natural groundwater will be mixing with the poorer quality ash leachate (either directly draining from the ash disposal facility, or more likely leaking from surface water impoundments). Even if an under-drain system is used to convey any excess water away from the ash disposal facility to the return water dam a portion of the water will likely percolate downwards into the aquifer. Contaminated water impounded at the surface is probably a bigger risk to local surface water resources than a groundwater leachate plume. It is important that infrastructure designed to minimize and contain contaminated runoff from the ash disposal facility and surrounds is maintained in good condition. Diesel spills from equipment or plant (e.g. ash stackers) carry a risk of hydrocarbon contamination, and standard precautions (e.g. availability of appropriate sorbent material and prompt clean-up) should be taken to minimize this risk. There is also a possible risk to groundwater in the local area from contaminated water discharging from holding dams or toe drains to surface water courses in the vicinity of the ash disposal facility (rivers and streams), and later infiltrating into the subsurface some distance away from the ash disposal facility.

iii. De-commissioning phase

Decommissioning of the ash disposal facility will involve halting ash disposal and removing ash disposal equipment (e.g. stackers). Changes to toe drains and underdrain systems may also be made. This may be done on part of the ash disposal facility, whilst other parts are still in use (as the facility advances the area that has been disposed on is rehabilitated). The ash disposal facility may also undergo some degree of shaping and re-vegetation, usually with the addition of a layer of topsoil and planting of indigenous vegetation. The immediate effect will be to reduce the volume of leachate available for percolation into the ground, but this is unlikely to cease altogether – natural precipitation falling onto the decommissioned ash disposal facility and collecting in toe drains or holding ponds will most likely mean that some leachate will continue to percolate downwards, leading to a persistent water quality impact (albeit possibly a relatively mild impact, due to possible cementation of the ash). It is important that infrastructure designed to contain contaminated runoff from the ash disposal facility is maintained in good condition. Decommissioning of the ash disposal facility may also involve added diesel-powered plant on site, with attendant risks of hydrocarbon spills. The normal precautions should be observed to mitigate these.

iv. Cumulative impacts

The likely cumulative impacts of all three phases (ash disposal facility construction, operation and decommissioning) are likely to be a long-term rise in water table in the vicinity of the site, accompanied by a deterioration in groundwater quality. These impacts will most likely gradually reverse once the ash disposal facility is fully decommissioned (it is acknowledged that parts of the ash disposal facility will be decommissioned whilst other parts are in use), but are unlikely to completely disappear for many years. In the event that highly toxic or persistent pollutants are inadvertently disposed onto the ash disposal facility (it is acknowledged that Eskom has no intention of doing this), then the long-term cumulative impacts on local groundwater could be more serious. However, the dry ash stacking system combined with the relatively low permeability of the underlying geology mean that impacts on groundwater are likely to be relatively limited please refer to the Surface and Ground Water Reports **Appendices Q and N** It is likely that other activities at Majuba power station (for example the coal storage yard discussed by GHT (2013)) have more potential to pollute groundwater compared to the ash disposal facility. Care should be taken to prevent any discharge of polluted water into local surface water courses, from where it could potentially pollute groundwater in the local area.

8.7.2 No-go Alternative:

If the ash disposal facility is not constructed ("no-go" option) then there will be no additional impacts on groundwater at the site, provided no other activities are carried out at the site which could affect the groundwater.

8.8 Biodiversity

The Biodiversity Report has been included in **Appendix M**.

Results of the floristic and faunal investigations were interpreted holistically in order to assess the potential impact on the ecological environment. The impact assessment is aimed at presenting a description of the nature, extent, significance and potential mitigation of identified impacts on the biological environment.

8.8.1 Identification of Impacts

The following development alternatives are considered in the assessment:

- Alternative A+ E
- Alternative A+ D
- Alternative C+D
- Alternative A extended

These, and their infrastructure, are what has been assessed and concluded in the EIA phase specialist studies.

Not all of the impacts are likely to occur; an assessment of the likelihood that respective impacts would occur is addressed in the following section. Based on this likelihood, the relevant impact is therefore omitted or included in the assessment section. Furthermore, not all impacts are likely to occur in all aspects of the proposed development. Impacts will therefore be included in a case-by-case scenario.

8.8.2 Potential Impacts

No impacts were identified that could lead to a beneficial impact on the biological environment since the proposed development is largely destructive, involving the alteration of natural habitat.

Impacts resulting from the proposed development on ecological attributes are largely restricted to the physical effects. Direct impacts include any effect on populations of individual species of conservation importance and on overall species richness. This includes impacts on genetic variability, population dynamics, overall species existence or health and on habitats important for species of conservation consideration. In addition, impacts on sensitive or protected habitat are included in this category, but only on a local scale. These impacts are mostly measurable and easy to assess, as the effects thereof are immediately visible and can be determined to an acceptable level of certainty.

In contrast, indirect impacts are not immediately evident and can consequently not be measured at a specific moment in time; the extent of the effect is frequently at a scale that is larger than the actual site of impact. A measure of estimation, or extrapolation, is therefore necessary in order to evaluate the importance of these impacts. Lastly, impacts of a cumulative nature place direct and indirect impacts of this projects into a regional and national context, particularly in view of similar or resultant developments and activities.

A list of potential and likely impacts was compiled from a generic list of impacts derived from previous projects of this nature and from a literature review of the potential impacts of this type of development on the natural environment. The following impacts were identified:

- Impacts on flora species of conservation importance (including habitat suitable for these species);
- Impacts on fauna species of conservation importance (including habitat suitable for these species);
- Impacts on sensitive or protected flora & fauna habitat types (including loss and degradation);
- Displacement of fauna species, human-animal conflicts & interactions;
- Impacts on ecological connectivity and ecosystem functioning;
- Indirect impacts on surrounding habitat;
- Cumulative impacts on conservation obligations & targets (including national and regional);
- Cumulative increase in local and regional fragmentation/ isolation of habitat; and
- Cumulative increase in environmental degradation, pollution.

8.8.3 Nature of Impacts

Impacts that are likely to result from the development activities are described briefly below. This list was compiled from a generic list of possible impacts derived from previous projects of this nature and from a literature review of the potential impacts of this type of development on the floristic environment.

i. Impacts on flora species of conservation importance (including suitable habitat)

Development activities frequently result in direct impacts or destruction of conservation important plant species, communities of these species, areas where these species are known to occur or areas that are considered particularly suitable for these species. Plant species of conservation importance, in most cases, do not contribute significantly to the biodiversity of an area in terms of sheer numbers, as there are generally few of them, but a high ecological value is placed on the presence of such species in an area as they represent an indication of pristine habitat conditions. Conversely, the presence of pristine habitat conditions can frequently be accepted as an indication of the potential presence of species of conservation importance, particularly in moist habitat conditions.

Red Data species are particularly sensitive to changes in their environment, being adapted to a narrow range of specific habitat requirements. Changes in habitat conditions resulting from human-related activities is one of the greatest reasons for these species being in danger of extinction. Surface transformation/ degradation activities within habitat types that are occupied by flora species of conservation importance will ultimately result in significant impacts on these species and their population dynamics. Effects of this type of impact are usually permanent and recovery or mitigation is generally not perceived as possible.

One of the greatest limitations in terms of mitigating or preventing this particular impact, is the paucity of species specific information that describe their presence, distribution patterns, population dynamics and habitat requirements. To allow for an accurate assessment, it is usually necessary to assess the presence/ distribution, habitats requirements, etc. associated with these species in detail and over prolonged periods; something that is generally not possible during EIA investigation such as this. However, by applying ecosystem conservation principles to this impact assessment and subsequent planning and development phases, potential impacts will be limited largely.

The presence of several plants of conservation importance was established during the brief survey period, while habitat within most of the proposed areas is considered suitable for a number of other taxa that were not recorded during the survey. This impact will therefore likely be severe. Exclusion of Red Data habitat is the only sensible manner in which this impact can be mitigated.

ii. Impacts on fauna species of conservation importance (including suitable habitat)

Similarly, animal taxa of conservation importance generally do not contribute significantly to the species richness of a region, but do contribute significantly to the ecological diversity of a region as their presence usually provides an indication of a relatively pristine environment. Because animals are mostly mobile and are ultimately able to migrate away from impacts, developments rarely affect them directly. However, significant impacts result from losses and degradation of suitable habitat that is available to them. This represents a significant direct impact on these animals. Additional aspects that will be affected include migration patterns and suitable habitat for breeding and foraging purposes. Habitat requirements and preferences of conservation important species are much stricter than for common or generalist species and a higher conservation obligation is placed on these areas. Even slight changes to habitat in which these species persist are therefore likely to have significant effects on the presence and status of these taxa within the immediate region.

The presence of Red Data fauna species within as well as near to the proposed development areas was established during the survey period. Considering the brief period over which the survey was conducted, and taking cognisance of the habitat status and availability, the likelihood that other conservation important species would occur in the study area is regarded high. Exclusion of Red Data habitat is the only manner in which this impact can be totally mitigated, while search and rescue operations (relocation of RD species), although not preferred, does allow for some mitigation. Such operations are however species-specific and typically problematical with certain taxa, such as invertebrates and animals that cannot readily be captured.

iii. Impacts on sensitive or protected flora & fauna habitat (including loss & degradation)

The loss or degradation of natural vegetation or habitat that are regarded sensitive as a result of restricted presence in the larger region, represents a potential loss of habitat and biodiversity on a local and regional scale. Sensitive habitat types might include mountains, ridges, koppies, wetlands, rivers, streams, pans and localised habitat types of significant physiognomic variation and unique species composition. These areas represent centres of atypical habitat and contain biological attributes that are not frequently encountered in the greater surrounds. A high conservation value is generally ascribed to floristic communities that occupy these areas as they contribute significantly to the biodiversity of a region.

Natural faunal habitat of the study area will be affected adversely by direct impacts resulting from construction and operational activities. Particular reference is made to the loss of habitat resulting from surface clearing activities, the construction of infrastructure and contamination of natural habitat through the leaching of chemicals into the groundwater and surface water and generation of huge amounts of dust and spillages. Also of importance is the loss of habitat that are not necessarily considered suitable for Red Data species, but where high endemic species richness is likely to be recorded.

All wetland related habitat within the proposed development areas are regarded sensitive, particularly in view of the presence of several conservation important plant and animal taxa that were recorded within these areas during the survey period. In addition, particularly sensitive habitat was identified in proximity to some of the development alternatives, which will ultimately affect the preference rating and impact significance ascribed to the site alternatives.

This impact also includes adverse effects on any processes or factors that maintain ecosystem health and character, including the following:

- Disruption of nutrient-flow dynamics;
- Introduction of chemicals into the ground- and surface water through leaching;
- Impedance of movement of material or water;
- Habitat fragmentation;
- Changes to abiotic environmental conditions;

- Changes to disturbance regimes, e.g. increased or decreased incidence of fire;
- Changes to successional processes;
- Effects on pollinators; and
- Increased invasion by plants and animals not endemic to the area.

Changes to the natural habitat may lead to a reduction in the resilience of ecological communities and ecosystems and changes in ecosystem function. Furthermore, regional ecological processes, particularly aquatic processes that is dependent on the status and proper functioning of the wetland habitat types, is particularly important. A high conservation value is generally ascribed to faunal assemblages that persist in these areas as they contribute significantly to the biodiversity of a region.

iv. Displacement of fauna species, human-animal conflicts & interactions

Activities that are known to transpire from human–animal conflicts are likely to affect animals that utilise surrounding areas. Unwanted activities might include poaching, snaring, killing by accidental contact, capturing, effects of domestic cats and dogs, escalation in numbers of exotic and non-endemic species, roadkills, etc. While the tolerance levels of common animal species is generally of such a nature that surrounding areas will suffice in habitat requirements of species forced to move from the area of impact, some species would not able to relocate, such as ground living and small species. It should be noted that animals generally avoid contact with human structures, but do grow accustomed to structures after a period. An aspect that is of concern is the presence of vehicles on access roads, leading to accidental death of animals, particularly concerning nocturnal animals.

The presence of personnel within the development area during construction and operational phases will inevitably result in some contact with animals. Therefore, encounters with dangerous animals (such as snakes) remain likely. In addition, the presence of domestic dogs and cats is generally associated with humans. These animals are frequently accountable for killing of natural fauna. It is also regarded moderately likely that the natural faunal component might be attracted to the artificial habitat that is created by the development. The establishment of human abodes generally result in the presence of foraging rodents, which is likely to attract smaller predators, raptors, owls, and snakes. The lack of understanding from personnel frequently results in the unnecessary killing of these animals.

v. Impacts on ecological connectivity & ecosystem functioning

The larger region is characterised by highly transformed and fragmented grassland habitat. This is also reflected in the study area and immediate surrounds. Therefore, the ecological connectivity that natural habitat provides within this regional setting of habitat fragmentation and isolation, is therefore particularly important in the effective functioning of the regional and local ecological processes. Evidence obtained during the investigation period revealed that the biodiversity aspects recorded within both the terrestrial grassland types and wetland related habitat is much higher than would be expected when looking at the study area in isolation, providing insight into the regional importance of these habitat types. It is therefore reasonable to assume that the animals that utilises these habitat types migrate extensively across the region for various reasons. Foraging, available water, food sources, breeding patterns and seasonal climate changes include some of the more obvious explanations for migration of animals. In order to ensure the persistence of animals within this system on a local and regional scale, it is critical that the basic characteristics of the system, such as a natural species composition, physiognomy, aquatic principles, contributions from surrounding habitat types, etc. are preserved. This is also particularly relevant for plant species of conservation consideration that could potentially occupy the area.

The ecological interconnectivity of terrestrial and wetland related habitat types is important for the functioning; without terrestrial grasslands, the reservoirs of water that feed wetland habitat types will disappear and the characteristics and features that makes these features suitable for a high biodiversity will disappear, effectively destroying the remaining biodiversity to a large extent.

While most of the larger mammal species (ungulates) are restricted in their movement by fences, small and medium sized animals, that include predators, burrowing species, small mammals, invertebrate species, reptiles, amphibians, etc. utilises all available natural habitat as either corridors, 'stepping stones' or habitat. Loss of current migration routes or connectivity areas ('stepping stones') within the study area will likely affect the migration pattern of some species on larger scale. Particular reference is made to the disruption of migration patterns of flightless animals.

vi. Indirect impacts on surrounding habitat

Surrounding areas and species present in the direct vicinity of the study areas will likely be affected adversely by indirect impacts resulting from construction and operational activities. These indirect impacts also include adverse effects on any processes or factors that maintain ecosystem health and character, including the following:

- Disruption of nutrient-flow dynamics;
- Introduction of chemicals into the ground- and surface water through leaching;
- Impedance of movement of material or water;
- Habitat fragmentation;
- Changes to abiotic environmental conditions;
- Changes to disturbance regimes, e.g. increased or decreased incidence of fire;
- Changes to successional processes;
- Effects on pollinators; and
- Increased invasion by plants and animals not endemic to the area.

These impacts lead to initial, incremental or augmentation of existing types of environmental degradation, including impacts on the air, soil and water present within available habitat. Pollution of these elements might not always be immediately visible or readily quantifiable, but incremental or fractional increases might rise to levels where biological attributes could be affected adversely on a local or regional scale. In most cases, these effects are not bound and is dispersed, or diluted over an area that is much larger than the actual footprint of the causal factor.

These impacts lead to a reduction in the resilience of peripheral ecological communities and ecosystems or loss or changes in ecosystem function. Furthermore, regional ecological processes, particularly aquatic processes that is dependent on the status and proper functioning of drainage lines, is regarded important. It is well known that the status of a catchment is largely determined by the status of the upper reaches of the rivers. Small drainage lines might be insignificant on a regional scale, but the combined impact on numerous such small drainage lines will affect the quality of larger rivers further downstream adversely.

vii. Cumulative impacts on conservation obligations & targets (national and regional)

This is regarded a cumulative impact since it affects the status of conservation strategies and targets on a local as well as national level and is viewed in conjunction with other types of local and regional impacts that affects conservation areas or threatened areas. The importance of vegetation types is based on the conservation status ascribed to regional vegetation types (Vegmap, 2006) and because impacts that result in irreversible transformation of natural habitat is regarded significant. The current conservation status is based on regional information relating to the status and availability of remaining natural habitat. This vegetation type is included in the 'Endangered' category.

It has been established that the available infobase inaccurately displays the status and availability of natural grasslands. Poor quality (degraded) grasslands, and cultivated pastures are frequently included in this category. Additionally, developments that have taken place subsequent to the compilation of the Vegmap database have resulted in further decimation of natural grasslands, contributing to this cumulative impact. Ultimately, the current estimation of conservation level is therefore likely to be an underrepresentation of the conservation requirements that need to be applied to these vegetation types. The continued conservation of any area that is representative of these regional vegetation types should therefore be prioritised.

viii. Cumulative increase in local and regional fragmentation/ isolation of habitat

Uninterrupted habitat is a precious commodity for biological attributes in modern times, particularly in areas that are characterised by moderate and high levels of transformation. The loss of natural habitat, even small areas, implies that endemic biodiversity have permanently lost that ability of occupying that space, effectively meaning that a higher premium is placed on available food, water and habitat resources in the immediate surrounds. This, in some instances, might imply that the viable population of plants in a region will decrease proportionally with the loss of habitat, eventually decreasing beyond a viable population size.

The danger in this type of cumulative impact is that effects are not known or is not visible with immediate effect and normally when these effects become visible, they are usually beyond repair. Impacts on linear areas of natural habitat affect the migratory success of animals in particular.

The general region is characterised by high levels of transformation and habitat fragmentation.

8.8.4 Recommended Mitigation and Management Measures

i. Site Specific Mitigation Measures

Mitigation Measure 1 - Exclude all areas of high ecological sensitivity from the proposed development as far as possible;

Mitigation Measure 2 - Prevent all and any effluent from the ashing facility into wetland habitat;

Mitigation Measure 3 - Prevent contamination of natural habitat, wetland and seasonal pans from any source of pollution; and

Mitigation Measure 4 - Provide an adequate buffer between areas of development and surrounding natural habitat.

ii. General Aspects

Mitigation Measure 5 - Appoint an Environmental Control Officer (ECO) prior to commencement of construction phase. Responsibilities should include, but not necessarily be limited to, ensuring adherence to EMP guidelines, guidance of activities, planning, reporting;

Mitigation Measure 6 - Compile and implement environmental monitoring programme, the aim of which should be ensuring long-term success of rehabilitation and prevention of environmental degradation. Biodiversity monitoring should be conducted at least twice per year (Summer, Winter) in order to assess the status of natural habitat and effects of the development on the natural environment;

iii. Environmental Control Officer

Mitigation Measure 7 - Have overall responsibility for the implementation of the EMPr;

Mitigation Measure 8 - Ensure that the developer and contractors are aware of environmental specifications, legal constraints and general standards and procedures;

Mitigation Measure 9 - Ensure that all stipulations within the EMP are communicated and adhered to by the developer and contractors;

Mitigation Measure 10 - Monitor the implementation of the EMPr throughout the project by means of site inspections and meetings. This will be documented as part of the site meeting minutes;

Mitigation Measure 11 - Be fully conversant with the Environmental Impact Assessment for the project, the conditions of the integrated EA, all relevant environmental legislation and with the EMPr;

Mitigation Measure 12 - Ensure that periodic environmental performance audits are undertaken on the project implementation;

Mitigation Measure 13 - Convey the contents of the EMPr to the site staff and discuss the contents in detail with the Project Manager and Contractors;

Mitigation Measure 14 - Take appropriate action if the specifications contained in the EMP are not followed;

Mitigation Measure 15 - Monitor and verify that environmental impacts are kept to a minimum, as far as possible;

Mitigation Measure 16 - Compile progress reports on a regular basis, with input from the Site Manager, for submission to the Project Manager, including a final post-construction audit carried out by an independent auditor/consultant.

iv. Fences & Demarcation

Mitigation Measure 17 - Demarcate construction areas by semi-permanent means/ material, in order to control movement of personnel, vehicles, providing boundaries for construction and operational sites;

Mitigation Measure 18 - No painting or marking of rocks or vegetation to identify locality or other information shall be allowed, as it will disfigure the natural setting. Marking shall be done by steel stakes with tags, if required;

v. Fire

Mitigation Measure 19 - The Project team will compile a Fire Management Plan (FMP) and Contractors directed by the ECO will submit a FMP. The Project FMP shall be approved by local Fire Protection Association, and shall include *inter alia* aspects such as relevant training, equipment on site, prevention, response, rehabilitation and compliance to the National Veld and Forest Fire Act, Act No. 101 1998;

Mitigation Measure 20 - Prevent all open fires;

Mitigation Measure 21 - Provide demarcated fire-safe zones, facilities and suitable fire control measures;

Mitigation Measure 22 - Use of branches of trees, shrubs or any vegetation for fire making purposes is strictly prohibited;

vi. Roads & Access

Mitigation Measure 23 - Access is to be established by vehicles passing over the same track on natural ground. Multiple tracks are not permitted;

Mitigation Measure 24 - A road management plan should be compiled prior to the commencement of construction activities;

Mitigation Measure 25 - Dust control on all roads should be prioritised;

Mitigation Measure 26 - No roads should be allowed within ecologically sensitive areas.

vii. Workers & Personnel

Mitigation Measure 27 - Provide sufficient on-site ablution, sanitation, litter and waste management and hazardous materials management facilities;

Mitigation Measure 28 - Abluting anywhere other than in provided toilets shall not be permitted. Under no circumstances shall use of the veld be permitted;

viii. Vegetation Clearance & Operations

Mitigation Measure 29 - The landowner must immediately take steps to remove alien vegetation as per Conservation of Agricultural Resource Act. This should be done based on an alien invasive management strategy that should be compiled by a suitable ecologist. The plan must make reference to:

- Uprooting, felling or cutting;
- Treatment with a weed killer that is registered for use in connection with such plants in accordance with the directions for the use of such a weed killer;
- The application of control measures regarding the utilisation and protection of veld in terms of regulation 9 of the Act;
- The application of control measures regarding livestock reduction or removal of animals in terms of regulations 10 and 11of the Act;
- Any other method or strategy that may be applicable and that is specified by the executive officer by means of a directive.
- According to the Conservation of Agricultural Resource Act (No. 43 of 1983) as amended, the person applying herbicide must be adequately qualified and certified as well as registered with the appropriate authority to apply herbicides.

Mitigation Measure 30 - The size of areas subjected to land clearance will be kept to a minimum;

Mitigation Measure 31 - Only areas as instructed by the Site Manager must be cleared and grubbed;

Mitigation Measure 32 - Cleared vegetation and debris that has not been utilised will be collected and disposed of to a suitable waste disposal site. It will not be burned on site;

Mitigation Measure 33 - All vegetation not required to be removed will be protected against damage;

Mitigation Measure 34 - Removal of vegetation/ plants shall be avoided until such time as soil stripping is required and similarly exposed surfaces must be re-vegetated or stabilised as soon as is practically possible;

Mitigation Measure 35 - Monitoring the potential spread of declared weeds and invasive alien vegetation to neighbouring land and vice versa and protecting the agricultural resources and soil conservation works are regulated by the Conservation of Agricultural Resources Act (No 43 of 1983) and must be addressed on a continual basis, through an alien vegetation control and monitoring programme;

Mitigation Measure 36 - Remove and store topsoil separately in areas where excavation/ degradation takes place. Topsoil should be used for rehabilitation purposes in order to facilitate regrowth of species that occur naturally in the area. Removal of topsoil should be done to a depth of at least 1m;

Mitigation Measure 37 - Stored topsoil will be free of deleterious matter such as large roots, stones, refuse, stiff or heavy clay and noxious weeds, which would adversely affect its suitability for planting;

Mitigation Measure 38 - No spoil material will be dumped outside the defined site;

Mitigation Measure 39 - Disturbance of vegetation must be limited to areas of construction;

Mitigation Measure 40 - The removal or picking of any protected or unprotected plants shall not be permitted and no horticultural specimens (even within the demarcated working area) shall be removed, damaged or tampered with unless agreed to by the ECO;

Mitigation Measure 41 - Ensure proper surface restoration and resloping in order to prevent erosion, taking cognisance of local contours and landscaping;

Mitigation Measure 42 - Exposed areas with slopes less than 1:3 should be rehabilitated with a grass mix that blends in with the surrounding vegetation;

Mitigation Measure 43 - The grass mix should consist of indigenous grasses adapted to the local environmental conditions;

Mitigation Measure 44 - Revegetated areas should be fenced to prevent damage by grazing animals;

Mitigation Measure 45 - Re-vegetated areas showing inadequate surface coverage (less than 30 % within eight months after re-vegetation) should be prepared and re-vegetated from scratch;

Mitigation Measure 46 - Damage to re-vegetated areas should be repaired promptly;

Mitigation Measure 47 - Exotic weeds and invaders that might establish on the re-vegetated areas should be controlled to allow the grasses to properly establish;

More detailed mitigation and management measures can be found in the Environmental Management Plan and the Ecology Study report included in **Appendices D & M**.

8.9 Avifauna & Bats

8.9.1 Predicted Impacts of Ash Disposal Facilities

The greatest predicted impacts of ash disposal facilities on avifauna are the destruction of habitat and disturbance of birds during construction. During the construction phase, habitat destruction and alteration inevitably takes place. Habitat destruction is anticipated to be the most significant impact in this study area. However, this can be minimized and mitigated to some extent by avoiding more sensitive areas and keeping the land to be impacted as minimal as possible. Similarly, the above mentioned construction and maintenance activities impact on birds through disturbance, particularly during bird breeding activities. Disturbance of birds is anticipated to be of lower significance than habitat destruction. Leachate from fly ash disposal facilities can contain heavy metals (Theism and Marley, 1979) which could result in contamination of surrounding water sources, used by water birds in the study area.
In addition to the continuous disposal of ash at the ash disposal facility the project will also include the expansion/extension of the associated infrastructure associated with the ashing system, such as pipelines, storm water trenches, seepage water collection systems, pump stations, seepage dams etc. The impacts of such associated infrastructure on avifauna are predicted to be minimal, so long as the infrastructure is within the proposed ash disposal facility footprint.

8.9.2 Potential impacts of ash disposal facilities on bats

A number of factors influence the potential impacts of ash disposal facility developments on bats;

- fatality through destruction of roosts
    - if structures that are used by bats as roost sites are destroyed during the construction phase bats using those structures may be killed.
- displacement through destruction of potential roost sites
    - if structures that may potentially be used by bats as roost sites are destroyed during the construction phase bats returning to the area may be displaced as suitable roost sites are no longer available.
- loss of food source or prey-base through destruction of foraging habitat
    - if foraging habitat is destroyed during the construction phase bats may be displaced due to a loss of their prey-base
- change in behaviour through creation of dams (drinking and potential foraging sites)

- some aspects of construction may actually attract some bat species, such as the construction of clean water dams where bats can drink.

8.9.3 Recommended Mitigation and Management Measures

i. Avifauna

Impact	*Mitigation*
Construction Phase	
Habitat destruction	Strict control should be maintained over all activities during construction, in particular heavy machinery and vehicle movements, and staff. It is difficult to mitigate properly for this as habitat destruction covering the entire wet ash disposal facility footprint is inevitable. However, it is important to ensure that the construction **Environmental Management Programme** incorporates guidelines as to how best to minimize this impact, and ensure that only designated areas are impacted upon, as per the design.
Disturbance	Strict control should be maintained over all activities during construction. It is difficult to mitigate properly for this as some disturbance is inevitable. **During Construction, if any of the "Focal Species" identified in this report are observed to be roosting and/or breeding in the vicinity, the EWT is to be contacted for further instruction.**
Operational Phase	
Leachate contamination of surrounding water sources	Ensuring that the construction Operational Management Programme incorporates guidelines as to how best to minimize this impact. Eskom must implement it existing Environmental procedures accordingly.

ii. Bats

Disturbance and/or removal of vegetation should be kept to a minimum.	Developer	To be in place during planning phase and implemented during construction phase
Disturbance and/or destruction of existing bat roosts should be avoided	Developer	To be in place during planning phase and implemented during construction phases
	Developer	To be in place during planning

Minimal lighting should be considered, alternatively low pressure sodium lamps or UV filters should be used	phase and implemented during construction and operational phases

The Avifauna and Bat study Reports has been included in **Appendices J &L.**

8.10 Visual Aspects

The Visual Impact Assessment has been included in **Appendix S.**

Visibility of an object is one of the primary attributes by which visual impact can be concluded. This is determined by a line of sight where nothing obscures the view of an object. Exposure is defined by the degree of visibility, in other words "how much" or "which part" of an object is visible to the observer. This is influenced by topography and the incidence of objects such as trees and buildings that obscure the view partially or in total. Visibility can be modelled by making use of a digital terrain model (DTM), created from contour data, and performing a viewshed analysis using GIS software. It must be noted that the viewshed analysis only accounts for topographical influences, and that the screening effect of vegetation is not included. This indicates a worst-case scenario, where the possibility of visual exposure is mapped, from which possible sensitive viewer locations can be identified.

In addition to viewshed analyses as described above, a proximity analysis is required to incorporate the effect of reduced visibility over distance. By integrating the two types of analyses, an index of possible visual impact is generated, as shown on the map in **Figure 8.4**.
The map indicates a core area of high visibility and a high degree of visual exposure within 3km from the ash disposal facility. The continuous ashing activities in a southern direction are expected to impact on a number of sensitive receptors within 3km from the site. Permanent residents within this zone need to be identified and requirements with regard to mitigation measures investigated during the EIA phase.

8.10.1 Issues Relating to Visual Impact

As a facility on its own, as well as a feature associated with the Majuba Power Station, the current ash disposal facilities form part of the current visual landscape. This provides a large degree of visual absorption capacity for the continuation of the ash disposal facilities, provided it is not segregated from its current position within the footprint of the power station at large.

A number of sensitive receptors, particularly residents on farmsteads, might be impacted upon by the continuous ashing project. Issues of concern will relate to the design of the facility, particularly the footprint and vertical dimensions thereof. Whereas the above viewshed and proximity analyses were based on a conceptual design and an assumed maximum height of 70m, detailed information with regard to the design of the ash disposal facilities, together with detailed information gathered from site visits was used in a detailed assessment of the nature and significance of visual impact.

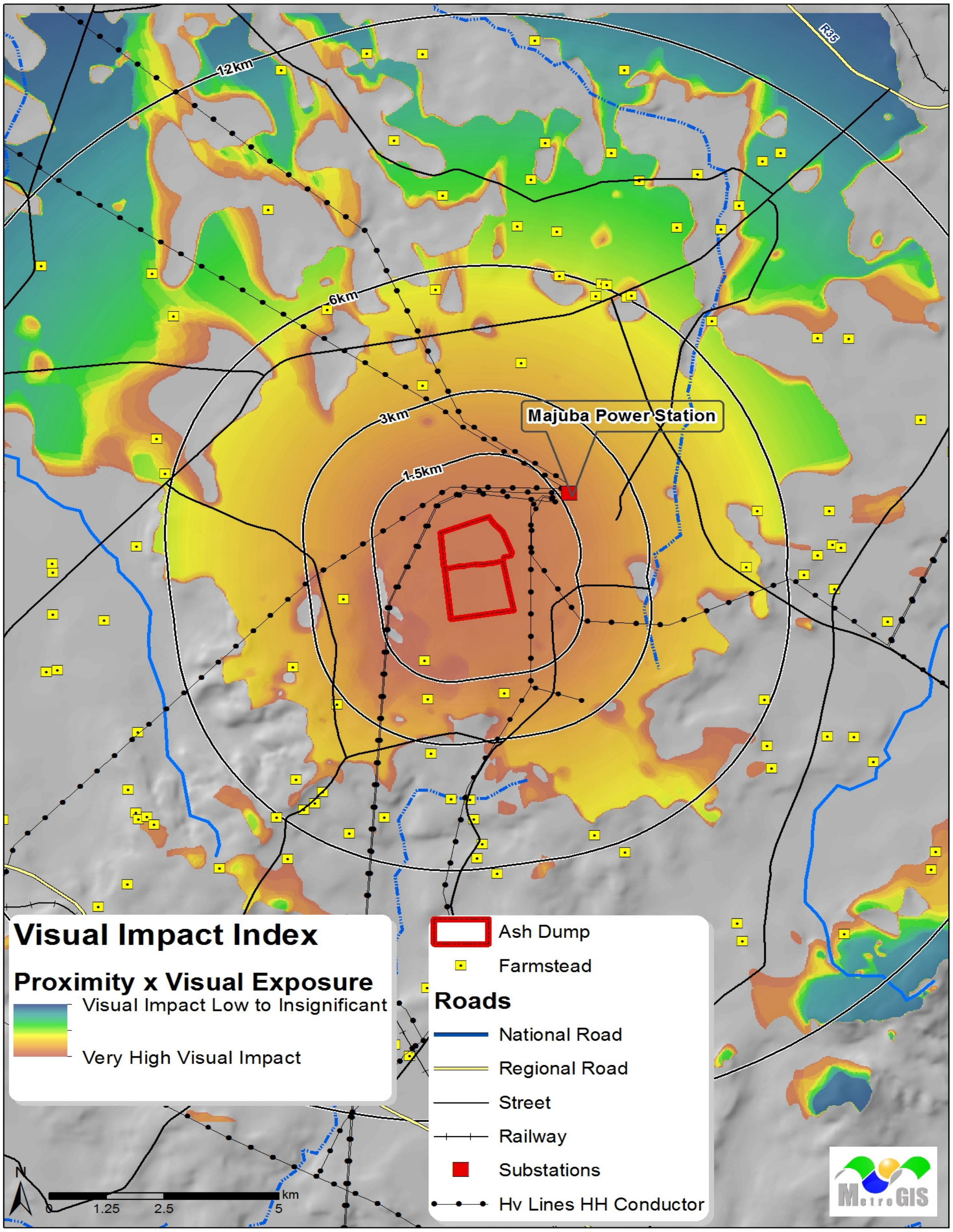

Figure 8.4: Integrated proximity and visual exposure index. (Only included as an example of how the visual index is calculated – the object causing the visual impact is irrelevant). For further details please refer to the Visual Impact Assessment report **Appendix S**

8.10.2 Cumulative Impacts

Cumulative visual effects can arise in three reasonably distinct ways.

First there is the effect of the extension of an existing development, or the positioning of a new development such that it would give rise to an **extended** and/or **intensified** impression of pre-existing stockpiles in the landscape, as seen from fixed or transitory locations. This type of cumulative effect is categorised as '*static combined/simultaneous*', and is relevant in the case where the proposed development would be viewed as an extension of the existing ash disposal facility. Alternatives 1, 2 & 3 would fall into this category.

Secondly, cumulative impacts can arise through an **increase in the perceptions** of sensitive receptors where ash disposal facilities are observed from locations from which more than one facility would now be seen in different parts of the landscape. This distinction becomes relevant when the observer faces or visualises one ash disposal facility with another in the opposite direction behind her/his back. Alternatives 4 & 5 would fall into this category.

Third, an increase in the incidence of sequential perceptions of different power stations with associated infrastructure can occur through the **recurrence of images** and impressions arising from power stations at various points in the landscape and which are continuously encountered when moving through it. Since the proposed development is an extension of an existing facility, this effect is unlikely to happen.

8.10.3 Recommended Mitigation and Management Measures

Given the large vertical and horizontal dimensions of an ash disposal facility, mitigation possibilities are few and limited to the following:

- Minimizing the height and footprint of the facility, bearing in mind the volume that is required. In reality none of the five alternatives provide sufficient capacity on their own, hence the combination of alternatives that are being considered. It is therefore unlikely that this mitigation measure would be practical;
- The only effective mitigation measure is the rehabilitation of the facility by actively vegetating the slopes with grass, shrubs and trees similar to what is found in the surrounding area, in order to increase the visual absorption capacity of the landscape in terms of colour and texture,
- Concurrent rehabilitation, as is being practiced at the existing ash disposal facility, must be continued and accelerated where possible.

- Avoid the unnecessary removal of vegetation and topsoil. When removal of the topsoil from the impacted area is required for construction of the facility, create only enough space for ash disposal for a certain period, for example a month. This should be considered as standing operational procedure together with concurrent rehabilitation. Topsoil can immediately be replaced on top of the ash in areas where the maximum height has been reached subjected and in accordance with the existing Eskom internal procedures.
- Topsoil is also removed to decrease the slope of the impacted area, thereby reducing the elevation of the facility.

As mentioned above, the impact will be further mitigated by its absorption into the landscape of a power station with existing ash disposal operations.

8.11 Sites of Archaeological, Historical and Cultural Interest

The Heritage Report has been included in **Appendix O**.

8.11.1 Stone Age

No information about Stone Age habitation of the area is available. There might be two reasons for this. Firstly, it is unlikely that Stone Age people would have occupied the area specific, as it would have been too cold and no shelters or caves exists locally that could be used to shelter in. Secondly, no systematic survey of the area has been done and, as a result, no sites have been reported.

8.11.2 Iron Age

Iron Age people started to settle in southern Africa c. AD 300, with one of the oldest known sites at Silver Leaves, south east of Tzaneen dating to AD 270. However, Iron Age occupation of the eastern highveld area (including the study area) did not start much before the 1500s. Some sites dating to the Late Iron Age is known to exist to the north, south and west of the study area.

8.11.3 Historic period

- Farmsteads

Farmsteads are complex features in the landscape, being made up of different yet interconnected elements. Typically these consist of a main house, gardens, outbuildings, sheds and barns, with some distance from that labourer housing and various cemeteries. In addition roads and tracks, stock pens and wind mills complete the setup. An impact on one element therefore impacts on the whole.

By the early 19th century white settlers took up farms. An investigation of the Title Deeds of most of the farms in the region indicates that they were surveyed as early as the 1860s, implying that they would have been occupied by colonists since then.

Many farmsteads in the region were destroyed during the Anglo Boer War. As a result most structures date to the period after that. The architecture of these farmsteads can be described as eclectic as they were built and added to as required over a period of time. In some cases outbuildings would be in the same style as the main house, if they date to the same period. However, they tend to vary considerably in style and materials used.

- Cemeteries

Apart from the formal cemeteries that occur in municipal areas (towns or villages), a number of these, some quite informal, i.e. without fencing, occur sporadically all over. Many also seem to have been forgotten, making it very difficult to trace the descendants in a case where the graves are to be relocated.

Most of these cemeteries, irrespective of the fact that they are for land owner or farm labourers (with a few exceptions where they were integrated), are family orientated. They therefore serve as important 'documents' linking people directly by name to the land.

- Infrastructure and industrial heritage

In many cases this aspect of heritage is left out of surveys, largely due to the fact that it is taken for granted. However, the land and its resources could not be accessed and exploited without the development of features such as roads, bridges, railway lines, electricity lines and telephone lines.

A variety of bridges, railway lines and other features that can be included in this category occur near the study area.

8.11.4 Recommended Mitigation and Management Measures

- *Impacts during construction*

Issue	Impact on heritage sites and features
Potential impact	Discovery of previously unknown heritage sites or features during construction can halt work in the vicinity of the finds
EMP	Management measures to be included in the EMP for actions to be taken on uncovering unknown sites and features

- *Impacts during operation*

Issue	Impact on heritage sites and features
Potential impact	Discovery of previously unknown heritage sites or features during construction can halt work in the vicinity of the finds
EMP	Management measures to be included in the EMP for actions to be taken on uncovering unknown sites and features

- *Impacts during decommissioning*

Issue	Impact on heritage sites and features
Potential impact	Discovery of previously unknown heritage sites or features during construction can halt work in the vicinity of the finds
EMP	Management measures to be included in the EMP for actions to be taken on uncovering unknown sites and features

More detailed mitigation and management measures as well as the site specific impacts can be found in the Environmental Management Plan included in **Appendix D**.

8.12 Noise Impact

A professional noise opinion was undertaken by Mr Francois Malherbe of Francois Malherbe Acoustic Consultants. This study was undertaken to identify the existing major noise sources and noise sensitive areas in the environment of the proposed continuous ash disposal facility; estimate the current ambient noise levels in the affected areas; carry out sample calculations in order to estimate the impact of noise emissions on ambient noise levels at the identified noise sensitive areas; and assess the noise impact in terms of the applicable regulations in Mpumalanga.

The major noise sources include a bulldozer, excavator, articulated truck and vibrating roller during construction; and a backhoe loader and vibrating compactor during operations.

The noise study report is included in **Appendix T**.

8.13 Socio-Economic

A Social impact assessment (SIA) may be defined as:

> *"the process of assessing or estimating, in advance, the social consequences that are likely to follow from specific policy actions or project developments, particularly in the context of appropriate national, state or provincial environmental policy legislation. Social impacts include all social and cultural consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one*

> *another, organise to meet their needs, and generally cope as members of society"* (International Committee on Guidelines and Principles, 1994, p. 108).

In general terms a Social Impact Assessment (SIA) can be described as the systematic appraisal before the project is started of the impact on the day-to-day quality of life of persons and communities when the environment is affected by development and in this case the development is not positive, an ash disposal facility is a waste dump. Seen from this viewpoint, "social impacts" include all the significant changes in the social environment that take place because of the actions of a development/project/ ash disposal facility that would not otherwise have occurred. The crucial thing is that any SIA should identify *undesirable* and *irreversible* consequences.

Specific attention should normally be given to vulnerable groups in the affected population(s), such as the poor, the elderly, women, and the unemployed. In this case, no large communities are affected in a different way than they already are affected by the existing ash disposal facility growth over many years. The social fabric of the existing environment was built around Majuba Power Station.

The key social issues that would were assessed during the SIA can be divided into:

- Perceptions and fears associated with the proposed project; and
- Local, site-specific issues (during construction and operation phases).

The local site-specific issues can in turn be divided into construction and operational related issues.

8.13.1 Perceptions and Fears

Social impacts are unique in that the mere introduction of information into the public domain can result in social impacts that manifest themselves in the form of perceptions, fears and expectations. In the case of the proposed continuous ashing project, the introduction of information into the public domain is likely to have resulted in social impacts, specifically for landowners and other stakeholders who may potentially be affected.

The extent and nature of these fears are likely to be linked to concerns related to the visual and sense of place impacts associated with the continuous ashing activities as well as fuelling existing issues and concerns that stakeholders have regarding the existing ash disposal facility in the study area.

These impacts could in turn have negative implications for property values, investments in tourism initiatives and the public's perception of Eskom in general etc. The SIA identified and assessed the potential extent and severity of these fears and perceptions as part of the assessment process.

8.13.2 Local, Site-specific Issues

The potential impacts could include:

- The potential risks to personal safety, specifically for farmers, increase in stock theft, trespassing, poaching and fires;
- The impact of dust pollution on surrounding areas;
- Damage to productive farm lands and crops due to construction related activities;
- Damage to natural vegetation and grazing due to construction related activities;
- Impact on tourism related activities due to construction related activities;
- The impact of the bigger ash disposal facility on the visual character of the area and sense of place. These impacts will be felt at both a local, individual landowner level, and also at a larger, landscape level that affects visitors to the area;
- The impact of the proposed continuous ashing activities on farming activities and land use potential.
- The impact on current and future tourism and conservation related activities and potential. This will be closely linked to the visual and sense of place impacts associated with the proposed alignments;
- Impact on property values.

The broader social benefits for South Africa associated with the ongoing supply of….

i. Construction/Implementation

The construction/implementation stage begins when a decision is made to proceed with the project and environmental authorisation is granted after the completion of an EIA. Construction involves clearing land, building access roads, developing construction camps, etc.

This is also the phase of the project where noise levels will be elevated from the construction machinery and trucks and increased traffic from the haul and access roads.

Resettlement and relocation of people, if necessary, typically occurs during this phase. Depending on the scale of the project, the build-up of a migrant construction work force may also occur. Due to the nature of this project none of the above is relevant in this case. Construction, operation and rehabilitation will run more or less parallel, as the facility advances. No additional staff will be employed, so no strain on any community will arise from a so-called influx of migrant workers.

ii. Operation

The operation stage occurs after construction is complete and the project becomes fully operational. In many cases this stage will require fewer workers than the construction phase. If operations continue at a relatively stable level for an extended period of time, effects during this stage can often be the more beneficial than those at any other stage. Communities seeking industrial development (and the accompanying opportunities for employment that arise) will often focus on this stage because of the long-term economic benefits that may follow from a development. It is also during this stage that the communities can adapt to new social and economic conditions and the expectations of positive effects, such as a stable population, a good quality infrastructure, and employment opportunities.

In this case the power station will continue its operations as normal. No changes will occur in communities due to the continuation of Majuba ash disposal operations. Due to the fact that the land is owned by Eskom no significant impact is expected. This issue also was never discussed or questioned during the public participation process.

iii. Decommissioning

Decommissioning begins when the proposal is made that the project and associated activity will cease at some time in the future. As in the planning stage, the social impacts of decommissioning begin when the intent to close down is announced and the community or region must again adapt, but this time to the loss of the project. At other times, the disruptions to the local community may be lessened or at least altered if one type of worker is replaced by another but employment has actually increased as environmental clean-up and/or rehabilitation specialists have been hired to help deal with the re-vegetation, for example. In the case of the ash disposal activity rehabilitation takes place as the facility advances.

The impacts during decommissioning vary depending on the nature of the project. The impacts of the decommissioning of a power line, for example, will not be of the same magnitude as the impacts of decommissioning of larger developments such as power stations. The closure, as mentioned above, occurs concurrently with the construction and operational phases, as the facility advances. The social impact of the power station closure is dealt with at another level and the closure of the final ash disposal facility will form part of the overall closure planning of the power station.

iv. No-go option

The no-go option will be when the proposed project has an impact on any of the following:

- Possible negative economic impact on the local towns due to the power station closure, in terms of direct job losses at the power station as well as the indirect requirement for ancillary services provided by the surrounding areas.
- Impact on health and cultural services;
- Impact on all other services, water, sanitation and electricity;
- Impact on Eskom workers at the power station, retrenchments etc. In the event that the power station should close many employees will loose their jobs. However, there are no unskilled employees at the power station and should find work eventually.

Lastly, it should be emphasised that no impact assessment – whether environmental or social – can supply wholly accurate results. This is due to the fact that the causes and effects of environmental and socio-economic changes are complex, and also because such an assessment deals with future uncertainties. An SIA is neither a technical nor an economical exercise; the focus rather falls on **concerns in and impacts on the social environment.** In addition, regardless of how good the data and the understanding of the affected environment are, an SIA (and an EIA, for that matter) always involves an element of subjective judgment. As a planning tool, the SIA can assist project management in understanding, implementing and managing a project in such a way that negative impacts are avoided or mitigated, and positive impacts are optimised.

8.13.3 Recommended Mitigation and Management Measures

i. Construction Phase

Social Interaction

- All neighbours must be notified and advised of the timing of the intended construction activities.
- The Majuba Power Station Environmental Officer will deal with community complaints.
- Contractors must prevent and prohibit their employees from entering neighbouring land and homes.
- All construction activities must take place within the demarcated footprint.
- Movement of construction personnel on site, outside of the demarcated development areas, must be strictly prohibited.

Labour

- Night-time activities should be limited as far as possible, and noisy? Activities must be contained to reasonable hours during the day and early evening.

Employment – Local Preference

As far as possible, Eskom should encourage its contractors to give employment preference to residents of the Amersfoort, Standerton and Majuba Areas in accordance with approved agreements and procedures.

ii. Operational Phase

Conduct of Employees

The following restrictions or constraints will be placed on the operation and maintenance staff in general:

- No indiscriminate disposal of rubbish or rubble.
- No littering.
- No collection of firewood for making fire.
- No interference with any fauna or flora outside demarcated areas (no animals on construction site).

- No use of facilities other than ablution facilities provided.
- All Eskom safety, health and environmental procedures will be complied with.

iii. Social Closure Objectives

The main objective of social closure is to ensure that issues will be addressed and managed so that the main objective and acceptable closure plan can be attained. The main objectives for social closure can be summarized as follows:

- Stakeholder engagement is undertaken and their views must be taken into account during closure planning;
- Permanent employees will be re-deployed and re-skilled to ensure minimum job losses;
- To stimulate the economy of the area by implementing viable projects that will enable some of the employees to be re-deployed within that sector;
- That rehabilitation work as well as other related work with regard to closure is not outsourced but that ex-employees can form part of this process ensuring job continuation after closure;
- That all ex-employees get priority on all Eskom property (Eskom houses) to be sold during closure of the station.