ARNOT Power Station

Proposed New Ash Disposal Facility

Aquatic and Wetland Ecology

Scoping Report

ecotone
Freshwater Consultants

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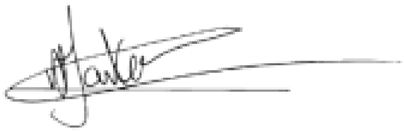

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Executive Summary

Introduction

Environmental Impact Management Services (Pty) Ltd (EIMS) has been awarded the tender to undertake the biophysical components of the Environmental Impact Assessment (EIA) project for the proposed new ash disposal facility at the ARNOT Power Station in Mpumalanga. Ecotone Freshwater Consultants CC (Ecotone) was then appointed by EIMS to undertake the wetland and aquatic ecology component for this Project. This report forms part of the Scoping component and aims to inform the client which of the two proposed 120 ha alternatives will have the least impact on the receiving aquatic environment at a scoping level of assessment.

Study Approach and Methodology

A desktop study was undertaken to determine applicable information with regards to the greater catchment area, associated Ecoregions, nature of the drainage systems and overall catchment utilisation.

Wetlands located within a Primary Study Area (PSA – 120 ha) and Secondary Study Areas (SSA – 1 km radius) were identified, delineated and assessed at a desktop level. Wetlands were classified into hydrogeomorphic (HGM) units.

A standardised risk-based impact assessment supplied by EIMS was applied to highlight the significance of impacts associated with the proposed ash disposal facility expansion in relation to the receiving aquatic environment.

Summary of Findings

The main finding obtained during the May 2018 scoping assessment of Alternative 1 (Alt1) and Alternative 2 (Alt 2) are briefly discussed below:

- Alt1 and Alt2 fall within quaternary catchments B12B, in the Olifants Water Management Area (WMA). The two main river systems that are associated with the proposed alternatives include the Rietkuilspruit (Alt2) and the Klein-Olifants (Alt1).
- The Rietkuilspruit SQR fell within an overall E PES category, inferring a *Seriously* modified state, while the Klein-Olifants is less impacted, falling into a C PES category, indicating a *Moderately* modified state.
- The Wetness Index (WI) was modelled for the study area. The WI reflects the propensity of an area to express wetness based on topographical variation and formed the basis of the sensitivity analyses. Based on the WI, Alt2 indicted a lower proportion of temporary/seasonal and permanent wetland areas when compared to Alt1.
- Overall, three different HGM units were identified during the scoping assessment. These include: hillslope seeps, depression wetlands and channelled valley bottom (CVB) systems.
- Based on the desktop delineation, a higher wetland extent within the PSA (120 ha) was recorded at Alt1, while Alt2 indicated a higher wetland extent within the SSA (1 km radius).

Impact Assessment

The main anticipated impacts on the receiving wetland / aquatic environment in relation to the proposed ash disposal facility are summarised in **Table 0-1**:

Table 0-1: Final Significance Ratings - Post Mitigation, Scoping Phase, May 2018

Perceived Impact	Final Significance Score							
	Construction				Operation			
	Alternative 1		Alternative 2		Alternative 1		Alternative 2	
	Score	Category	Score	Category	Score	Category	Score	Category
Impacts related to a decrease in surface water quality on wetland function	-3.33	Low	-2.92	Low	-5.33	Low	-4.67	Low
Impacts related to alteration in surface water hydrology on wetlands and aquatic biota	-4.67	Low	-4.08	Low	-4.67	Low	-4.08	Low
Impacts related to erosion and sedimentation on wetlands and aquatic biota	-6.00	Low	-6.67	Low	-8.25	Low	-7.33	Low
Loss of Wetland Habitat	-29.17	High	-21.00	High	N/A		N/A	

Conclusion

Based on the available desktop information, WI and desktop delineation, it is recommended that Alt2 should be assessed during the upcoming EIA Phase assessment. Alt2 represents less wetland areas within the primary (120ha) study area and is therefore considered the preferred alternative in terms of wetland /aquatic ecology (**Table 0-2**). Furthermore, Alt2 is closer to the existing infrastructure. It follows that it will require linear infrastructure over a shorter distance and will decrease the number of possible contamination pathways compared to Alt1. Risks pertaining to linear infrastructure have not been considered within this scoping assessment.

Table 0-2: Summary of the Ranking for the two proposed alternatives

	Alternative 1	Alternative 2
Rank	Restricted	Preferable

List of Abbreviations

ASPT	Average Score Per Taxa
BDI	Biological Diatom Index
C	Consequence
D	Duration
DEA	Department of Environmental Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
E	Extent
ECO	Environmental Control Officer
EI	Ecological Importance
EIS	Ecological Importance and Sensitivity
ER	Environmental Risk
ES	Ecological Sensitivity
FEPA	Freshwater Ecosystem Priority Areas
HGM	Hydrogeomorphic Units
M	Magnitude
MBCP	Mpumalanga Biodiversity Conservation Plan
MIRAI	Macroinvertebrate Response Assessment Index
N	Nature
NFEPA	National Freshwater Ecosystem Priority Areas
NSBA	National Spatial Biodiversity Assessment
NWA	National Water Act
P	Probability
PF	Prioritisation Factor
PR	Public Response
PSA	Primary Study Area
%PTV	% Pollution Tolerant Valves
R	Reversibility
S	Significance
SAGA	System for Automated Geoscientific Analyses
SPI	Specific Pollution Index

QR	Sub-quaternary Reach
SSA	Secondary Study Area
WI	Wetness Index
WMA	Water Management Area

1. Introduction

EIMS has been awarded the tender to undertake the biophysical components of the EIA project for the proposed new ash disposal facility at the ARNOT Power Station in Mpumalanga. Ecotone was then appointed by EIMS to undertake the wetland and aquatic ecology component for this Project. This report forms part of the Scoping component and aims to inform the client which of the two proposed 120 ha alternatives will have the least impact on the receiving aquatic environment at a scoping level of assessment.

2. Scope of Work

The scope of work encompassed an initial desktop study, focussing on the surface water systems linked to the proposed expansion of the ash disposal facility for the ARNOT power station, to provide a sensitivity rating for the study area. The scope of work was as follows:

- Desktop aquatic ecology baseline data collection (referring to potentially occurring aquatic macroinvertebrate and fish species) and a literature review of the area.
- Generation of a desktop delineation of the two proposed alternatives (primary study area) and a 1 km radius thereof (secondary study area), with a visual field verification.
- Generation of a desktop sensitivity map pertaining to aquatic ecosystems within the three proposed alternatives.
- Identification of potential impacts related to the receiving aquatic environment with reference to the proposed ash disposal facility.
- Providing preliminary management, action and monitoring plans.
- Presentation of a detailed plan of study for the EIA phase regarding the aquatic ecological assessment.

3. Methodology

3.1. Literature Review and Desktop Study

A desktop study was undertaken to determine applicable information with regards to the greater catchment area, associated ecoregions, nature of the drainage systems and overall catchment utilisation. Reference was made to the following desktop information to determine the preferred alternative:

- National Spatial Biodiversity Assessment (NSBA - Nel *et al*., 2004)
- Department of Water and Sanitation (DWS - DWS, 2014)
- National Freshwater Ecosystem Priority Areas (NFEPA - Nel *et al*., 2011)
- Mpumalanga Biodiversity Conservation Plan (MBCP- Ferrar & Lötter, 2007)
- Department of Environmental Affairs (DEA, 2015)
- The South African National Biodiversity Institute (SANBI – Macfarlane, 2012).
- Chief Directorate – Surveys and Mapping (1: 50 000)

3.2. Field Assessment

A brief site visit was carried out during May 2018 with the main aim of verifying the desktop delineation and Wetness Index (WI). This was carried out by visual observation and identifying key indicator wetland plant species.

3.3. Proposed Alternatives

A total of two alternatives were assessed as part of the scoping phase, namely: Alt1 and Alt2 (**Figure** 3-1). Each alternative is approximately 120 ha in size (primary study area- PSA) with a 1 km radius (secondary study area - SSA).

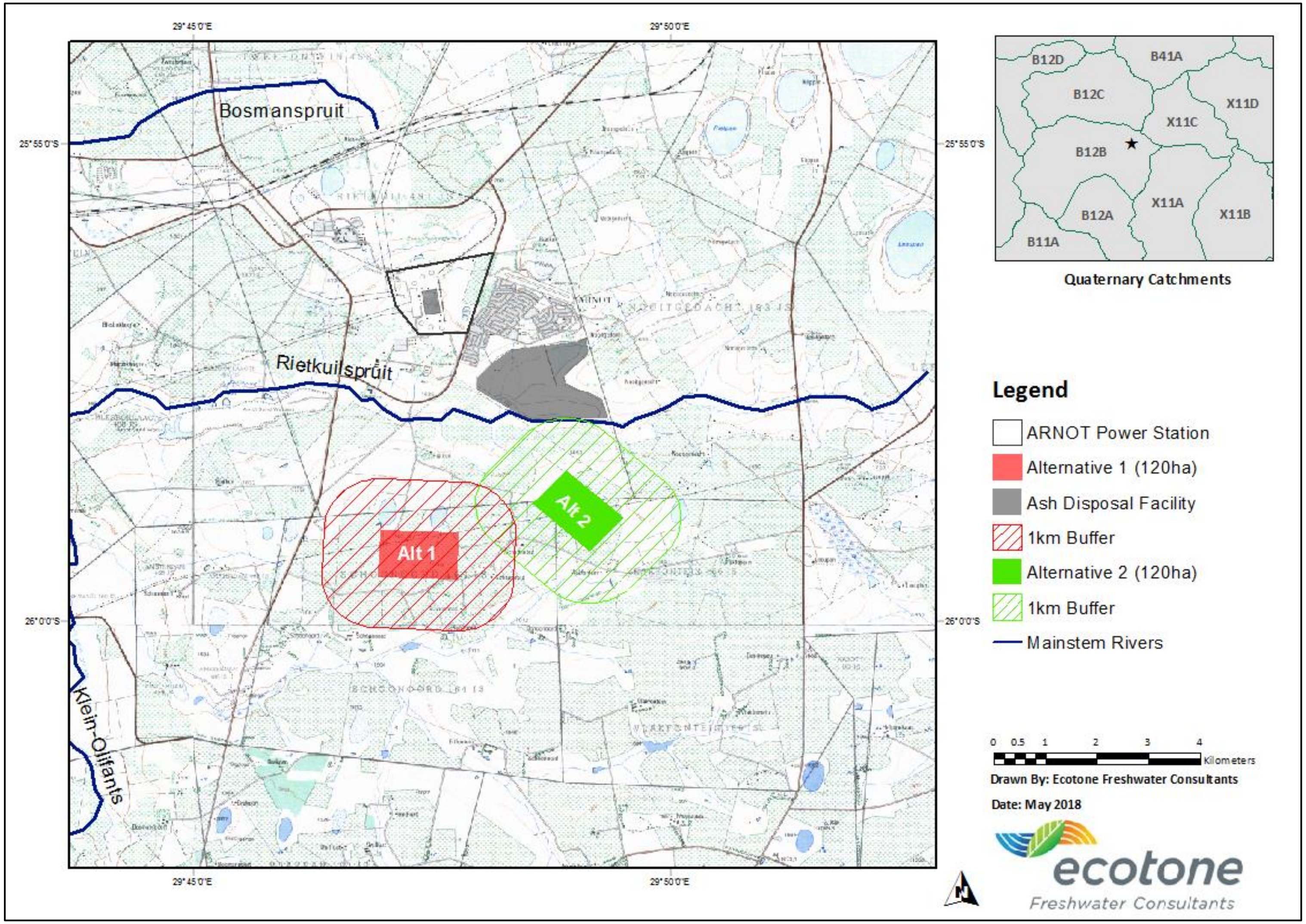

Figure 3-1: Map indicating the study area in relation to the two proposed alternatives to be assessed during the scoping phase. Data source: Chief Directorate – Surveys and Mapping, DWAF, 1995; Nel *et al.*, 2004; Nel *et al.,* 2011.

3.4. Sensitivity Analysis

3.4.1. Modelling

The System for Automated Geoscientific Analyses (SAGA) GIS standard terrain model was used to model the areas where water would accumulate in the landscape, and therefore increase the potential for wetlands to develop. This module models various topographic features related to hydrology, which include channels and the WI. The WI highlighted areas with a propensity for water to accumulate, thereby indicating areas of low to high sensitivity from a soil water or possible wetland perspective. The WI divided the study area into five difference categories as indicated in (**Table 3-1**). In addition, 1:50 000 rivers (Chief Directorate – Surveys and Mapping, 2529 and 2629), NSBA rivers (Nel *et al*., 2004) and NFEPA wetlands (Nel *et al*., 2011) were also considered and superimposed on the Wetness Index (WI).

Table 3-1: Wetness Index categories.

Class	Description	Soil moisture	Soil texture
1	Terrestrial - Rocky/ wilting point	Very low	Very coarse textured
2	Terrestrial - Wilting point/ field capacity	Low	Coarse textured
3	Transitional - Field capacity/ temporary (seep) wetlands	Moderate	Moderate textured
4	Wetland - Temporary/ seasonal wetlands	High	Fine textured
5	Aquatic - Seasonal/ permanent wetlands	Very High	Very fine textured

3.4.2. Sensitivity Ranking

The sensitivity methodology was provided by EIMS (**Table 3-2**) and focused on identifying sensitive/non-sensitive areas in terms of the development activity. The methodology makes provision for specialists to score areas/features that would be suitable or preferred for development. Features/areas are scored in terms of the proposed project context and not purely on "perceived sensitivity of landscape features".

Table 3-2: Sensitivity ratings and weighting

Sensitivity Rating	Description	Weighting	Preference
Least Concern	The inherent feature status and sensitivity and sensitivity is already degraded. The proposed development will not affect the current status and/or may result in a positive impact. These features will be the preferred alternative for mining or infrastructure placement.	-1	Preferable
Low / Poor	The proposed development will not have a significant effect on the inherent feature status and sensitivity.	0	Preferable
			Negotiable
High	The proposed development will negatively influence the current status of the feature.	+1	Restricted
Very High	The proposed development will negatively significantly influence the current status of the feature.	+2	Restricted

The rationale applied with the aquatic/wetland sensitivity assessment is based on the premise that all watercourses or potential watercourse areas are sensitive and were given a sensitivity rating category of +2 (**Table 3-3**).

Table 3-3: Description of the categories used during the sensitivity mapping

Rating Category	Weighting	Colour Coding	Description
Very High Sensitivity	+2		Wetland areas

3.5. Impact Assessment

3.5.1. Methods of Assessing Impacts

The impact assessment methodology carried out in this report is guided by the requirements of the National Environmental Management Act Environmental Impact Assessment Regulations (NEMWA, 2014). The broad approach to the significance rating methodology is to determine the Environmental Risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/likelihood (P) of the impact occurring. This determines the environmental risk. In addition, other factors including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S).

3.5.2. Determination of Environmental Risk

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER). The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and reversibility (R) applicable to the specific impact. For this methodology the consequence of the impact is represented by:

$$\mathbf{C} = \frac{(\mathbf{E} + \mathbf{D} + \mathbf{M} + \mathbf{R})}{\mathbf{4}} \times \mathbf{N}$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in **Table 3-4**.

Table 3-4: Criteria for determining impact consequence

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property boundary),
	3	Local (i.e. the area within 5 km of the site),
	4	Regional (i.e. extends between 5 and 50 km from the site
	5	Provincial / National (i.e. extends beyond 50 km from the site)
Duration	1	Immediate (<1 year)
	2	Short term (1-5 years),
	3	Medium term (6-15 years),

Aspect	Score	Definition
	4	Long term (the impact will cease after the operational life span of the project),
	5	Permanent (no mitigation measure of natural process will reduce the impact after construction).
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected),
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected),
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way),
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease).
Reversibility	1	Impact is reversible without any time and cost.
	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost.
	4	Impact is reversible only by incurring prohibitively high time and cost.
	5	Irreversible Impact

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/scored as per **Table 3-5**. The result is a qualitative representation of relative ER associated with the impact. ER is therefore calculated as follows (**Table 3-6**):

$$\mathbf{ER = C \times P}$$

Table 3-5: Determination of environmental risk

Consequence	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
	Probability					

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in **Table 3-6**.

Table 3-6: Significance classes

Environmental Risk Score	
Value	Description
< 9	Low (i.e. where this impact is unlikely to be a significant environmental risk),
≥9; <17	Medium (i.e. where the impact could have a significant environmental risk),
≥ 17	High (i.e. where the impact will have a significant environmental risk).

The impact ER will be determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/mitigated.

3.5.3. Impact Prioritisation

In accordance with the requirements of Appendix 3(2) (d) (ii) of the EIA Regulations (GNR 982), and further to the assessment criteria presented in the section above, it is necessary to assess each potentially significant impact in terms of:

- Cumulative impacts; and
- The degree to which the impact may cause irreplaceable loss of resources.

In addition, it is important that the public opinion and sentiment regarding a prospective development and consequent potential impacts is considered in the decision-making process. To ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impact ER (post-mitigation) (**Table 3-7**). This prioritisation factor does not aim to detract from the risk ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the ER score based on the assumption that relevant suggested management/mitigation impacts are implemented.

Table 3-7: Criteria for determining prioritisation

Public response (PR)	Low (1)	Issue not raised in public response.
	Medium (2)	Issue has received a meaningful and justifiable public response.
	High (3)	Issue has received an intense meaningful and justifiable public response.

Cumulative Impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.
Irreplaceable loss of resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.
	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented. The impact priority is therefore determined as follows:

$$\mathbf{Priority} = \mathbf{PR} + \mathbf{CL} + \mathbf{L}$$

The result is a priority score which ranges from 3 to 9 and a consequent PF ranging from 1 to 2 (**Table 3-8**).

Table 3-8: Determination of prioritisation factor

Priority	Ranking	Prioritisation Factor
3	Low	1
4	Medium	1.17
5	Medium	1.33
6	Medium	1.5
7	Medium	1.67
8	Medium	1.83
9	High	2

To determine the final impact significance, the PF is multiplied by the ER of the post mitigation scores. The ultimate aim of the PF is to be able to increase the post mitigation environmental risk rating by a full ranking class, if all the priority attributes are high (i.e. if an impact comes out with a medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential, significant public response, and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a high significance) (refer to **Table 3-9**).

Table 3-9: Final environmental significance rating

Environmental Significance Rating

Value	Description
< 10	Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
≥10 <20	Medium (i.e. where the impact could influence the decision to develop in the area),
≥ 20	High (i.e. where the impact must have an influence on the decision process to develop in the area).

4. Legislative Framework

The section below highlights some important legislation pertaining to wetlands and aquatic ecosystems in general on the property.

According to the National Water Act (Act No. 36 of 1998), a water resource is defined as: "a watercourse, surface water, estuary, or aquifer. A water course in turn refers to:

i. a river or spring;
ii. a natural channel in which water flows regularly or intermittently;
iii. a wetland, lake or dam into which, or from which, water flows; and
iv. any collection of water which the Minister may, by notice in the *Gazette,* declare to be a watercourse. Reference to a watercourse includes, where relevant, its bed and banks."

A wetland is defined as: "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances support or would support vegetation typically adapted to life in saturated soil."

Section 21 of the National Water Act (NWA; Act No. 36 of 1998) covers the following activities, which might be applicable to the conceptual layout plan for the proposed development. According to Section 21 of the NWA and in relation to aquatic ecosystems, the following activity is considered a use, and therefore requires a water use license:

a) taking water from a water resource;
b) storing water;
c) impeding or diverting the flow of water in a watercourse;
d) discharge water or water containing waste into a water resource through a pipe, sewer, sea outfall or other conduit;
e) disposing of waste in a manner which may detrimentally impact on a water resource;
f) altering the bed, banks, course or characteristics of a watercourse; and
g) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.

According to the Department of Water Affairs (DWA) any activity that falls within the temporary zone of a wetland or the 1:100 year flood-line (whichever is greater) qualifies as a Section 21(c) and/or (i) water use activity (depending on the use) and will thus require either a general authorization or Water Use License (WUL). According to the NWA, an application for a WUL should be submitted to the DWA if any of the above activities are to be undertaken.

For section 21(c) or (i) of the NWA (1998) water uses in terms of this Notice 509 of 2016 the following definitions are provided:

"*regulated area of a watercourse*"

a) The outer edge of the 1 in 100 year flood line and /or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam;
b) In the absence of a determined 1 in 100 year flood line or riparian area the area within 100m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench (subject to compliance to section 144 of the Act); or
c) A 500m radius from the delineated boundary (extent) of any wetland or pan.

"*extent of a watercourse*"

a) The outer edge of the 1 in 100 year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; and
b) Wetlands and pans: the delineated boundary (outer temporary zone) of any wetland or pan.

"pans"

a) any depression collecting water or that is inward draining or a flow through system with flow contributions from surface water, groundwater or interflow or combinations thereof.

Regulation 704 of 1999 of the NWA (1998) which regulates use of water for mining and related activities aimed at protection of water resources impose a restriction on locality under section 4:
No person in control of a mine or activity may:

a) locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year flood-line or within a horizontal distance of 100m from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water logged, undermined or cracked.

In terms of Section 19 of the National Water Act, a person who owns, controls, occupies or uses the land is responsible for the control and prevention of water resource pollution.

The activities listed in Appendix 1 of National Environmental Management Act, 1998 (Act No. 107 of 1998) are identified in terms of section 24(2) (a) of the Act as activities that may not commence without an environmental authorisation from the competent authority. In term of Activity 12 of Appendix 1, where such development occurs:

a) within a watercourse;
b) in front of a development setback; or
c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse.

5. Receiving Environment

5.1. Desktop Ecological Integrity

The study areas are associated with quaternary catchments B12B, within the Olifants Water Management Area (WMA). The two main river systems that are associated with the proposed alternatives include the Rietkuilspruit and the Klein-Olifants (**Figure 5-1**). The main characteristics are briefly discussed below:

- Rietkuilspruit - 1st order perennial system, drains east to west through the centre of the study area, along the existing ash disposal facility. The Rietkuilspruit is associated with SQR B12B- 01213 (**Figure 5-1**).
- Klein-Olifants – 2nd order perennial system, intersects a small section of the study area, towards the south-west portion. The Klein-Olifants is associated with SQR B12B- 01256 (**Figure 5-1**).
- Both the systems in the study area have a Highveld 2 river signature, which Nel *et al*. (2004) a critically endangered river signature. This conservation status indicates a limited amount of intact river systems carrying the same heterogeneity signatures nationally. This implies a severe loss in aquatic functioning and aquatic diversity in similar river signatures on a national scale (Nel *et al*., 2004).

The desktop PES categories for the two main river systems mentioned above are indicated in **Table** 5-1 (DWS, 2014). The Rietkuilspruit SQR fell within an overall E PES category, inferring a *Seriously* modified state, where most of the community characteristics are seriously modified and in an unacceptable state and is the most impacted of the three river systems (**Table 5-1**). The main driving variables responsible for the decline in ecological integrity in this reach include alteration to the instream habitat, flow, and physico-chemical characteristics (**Table 5-1**). The Klein-Olifants River is less impacted, falling into a C PES category, indicating a *Moderately* modified state where alteration of natural habitat has occurred, but the basic ecosystem functions are still mostly unchanged.

Table 5-1: PES categories for the different SQRs associated with the study area (DWS, 2014)

Sub-quaternary Reaches	B12B-01213	B12B-01256
System	**Rietkuilspruit**	**Klein-Olifants**
Instream Habitat Continuity Modification	Large	**Moderate**
Riparian/Wetland Zone Continuity Modification	**Moderate**	**Small**
Potential Instream Habitat Modifying Activities	**Serious**	**Moderate**
Riparian-Wetland Zone Modification	Large	**Small**
Potential Flow Modifying Activities	**Serious**	**Moderate**
Potential Physico-Chemical Modifying Activities	**Serious**	**Moderate**

General information including river characterization, overall PES and EIS categories and conservation status are provided in **Table 5-2**. The Klein-Olifants system (B12B-01256) reflected an overall *High* Ecological Importance (EI) and Ecological Sensitivity (ES) score (Desktop) while the Rietkuilspruit reflected *Moderate* scores. Justification for these scores are provided in **Table 5-3**. Neither the primary nor the secondary study areas are located within a river or NFEPA (**Figure 5-2**). The Mesic Highveld Grassland channelled valley bottom wetland, bordering the southern end of the 1 km radius of Alt1 (**Figure 5-3**) carries an NFEPA Wetland ID Rank of two (2). This ranking for wetlands indicates that the wetland has most of its area within a sub-quaternary catchment that has sightings or breeding areas for threatened Wattled Cranes, Grey Crowned Cranes and Blue Cranes. However, according to the MBCP (Ferrrar & Lötter, 2007) the study area is in an "Ecosystem Maintenance" sub-catchment (**Figure 5-4**).

Table 5-2: Summary of the literature review and desktop study for the aquatic system associated with the study area

General Site Information	**Study Area**	
Water Management Area	Olifants WMA	
Aquatic Ecoregion	Highveld	
Quaternary catchments	B12B	
River Signature (Nel *et al.,* 2004)	Highveld 2	
Threat Status (Nel *et al.,* 2004)	*Critically Endangered*	
NFEPA Areas (Nel *et al.,* 2011)	None associated with the three alternatives	
Vegetation Type	Eastern Highveld Grassland	
Information summary for SQR	**B12B-01213**	**B12B-01256**
Associated systems	Rietkuilspruit	Klein-Olifants
PES (DWS, 2014)	E	**C**
EI (DWS, 2014)	*Moderate*	*High*
ES (DWS, 2014)	*Moderate*	*High*

Table 5-3: Summary of the criteria used to determine the EI and ES per SQR (DWS, 2014)

Ecological Importance (EI)						Ecological Sensitivity (ES)		
Descriptor	**B12B-01213**	**B12B-01256**	**Descriptor**	**B12B-01213**	**B12B-01256**	**Descriptor**	**B12B-01213**	**B12B-01256**
Number of fish species estimated per SQR	3.00	6.00	Number of invertebrate taxa estimated per SQR	41.00	51.00	Fish: physico-chemical sensitivity	Low	High
Fish: average confidence	1.00	3.00	Invertebrate - average confidence	3.12	2.8	Fish: no-flow sensitivity	Low	High
Fish representation per secondary: class	Very Low	Low	Invertebrate representation per secondary: class	High	Very High	Invertebrate: physico-chemical sensitivity	Moderate	High
Fish rarity per secondary: class	Very Low	Low	Invertebrate rarity per secondary: class	Very High	Very High	Invertebrate: velocity sensitivity	Very High	Very High
Riparian/wetland-instream vertebrates (excl. fish) rating	Very Low	High	Riparian/wetland-instream vertebrates (excl. fish) rating	Very Low	High	Riparian/wetland-instream vertebrates (excl. fish) intolerance water level/flow changes	Very Low	High
Riparian-wetland natural VEG rating based on % natural VEG in 500m	Very High	Very High	Habitat diversity class	Low	Low	Stream size sensitivity to modified flow/water level changes	High	High
Riparian-wetland natural VEG importance based on expert rating	High	High	Habitat Size (Length) Class	Low	Low	Riparian/wetland VEG intolerance to water level changes	High	High
			Instream migration link class	Moderate	High			
			Riparian/wetland zone migration link	High	Very High			
			Riparian/Wetland Zone Habitat Integrity Class	Moderate	Very High			
			Instream Habitat Integrity Class	Low	High			

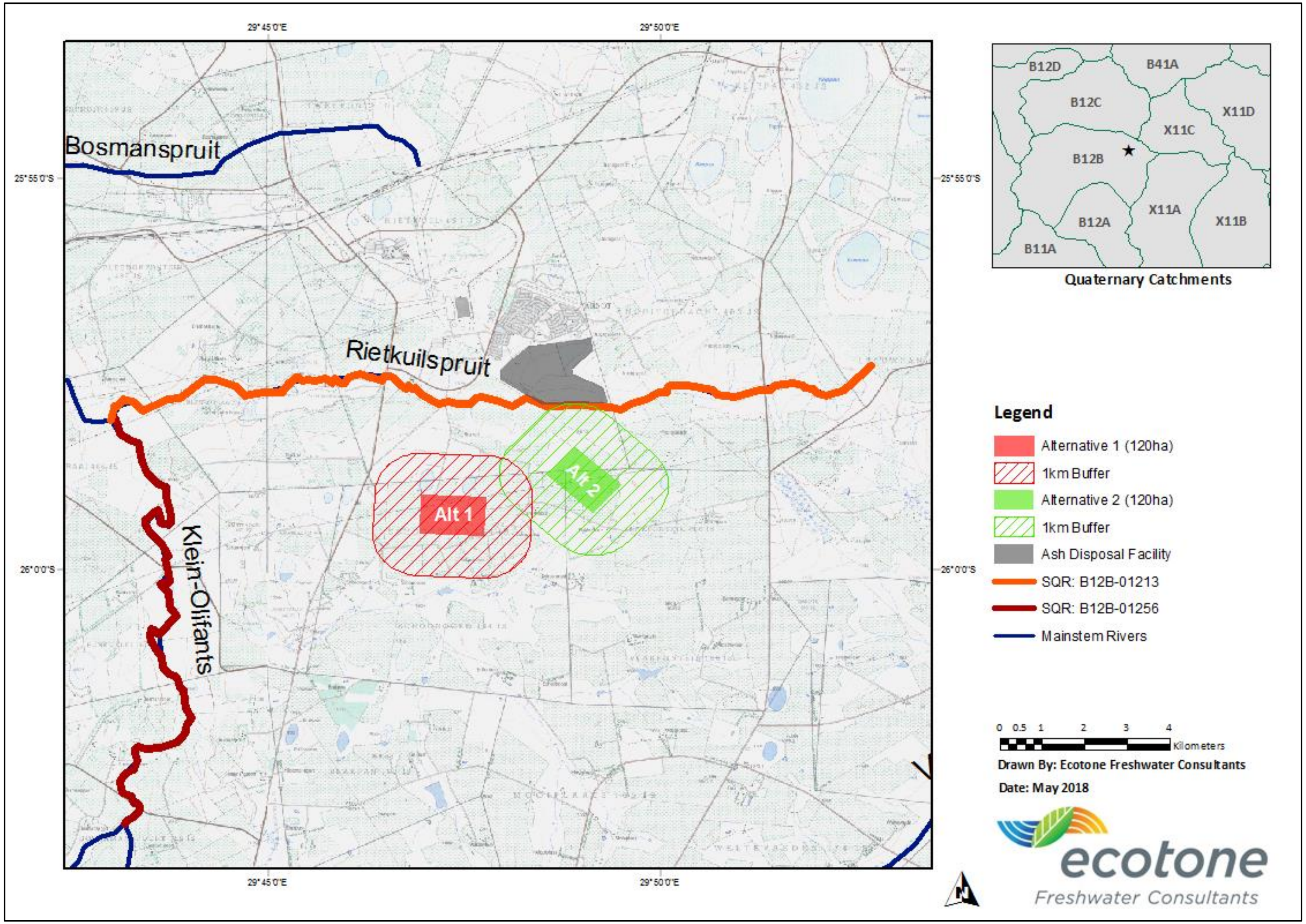

Figure 5-1: Map indicating the SQR and quaternary catchments associated with the study area. Data Source: DWAF, 1995; DWAF, 2004; Nel *et al.,* 2004; DWS, 2014.

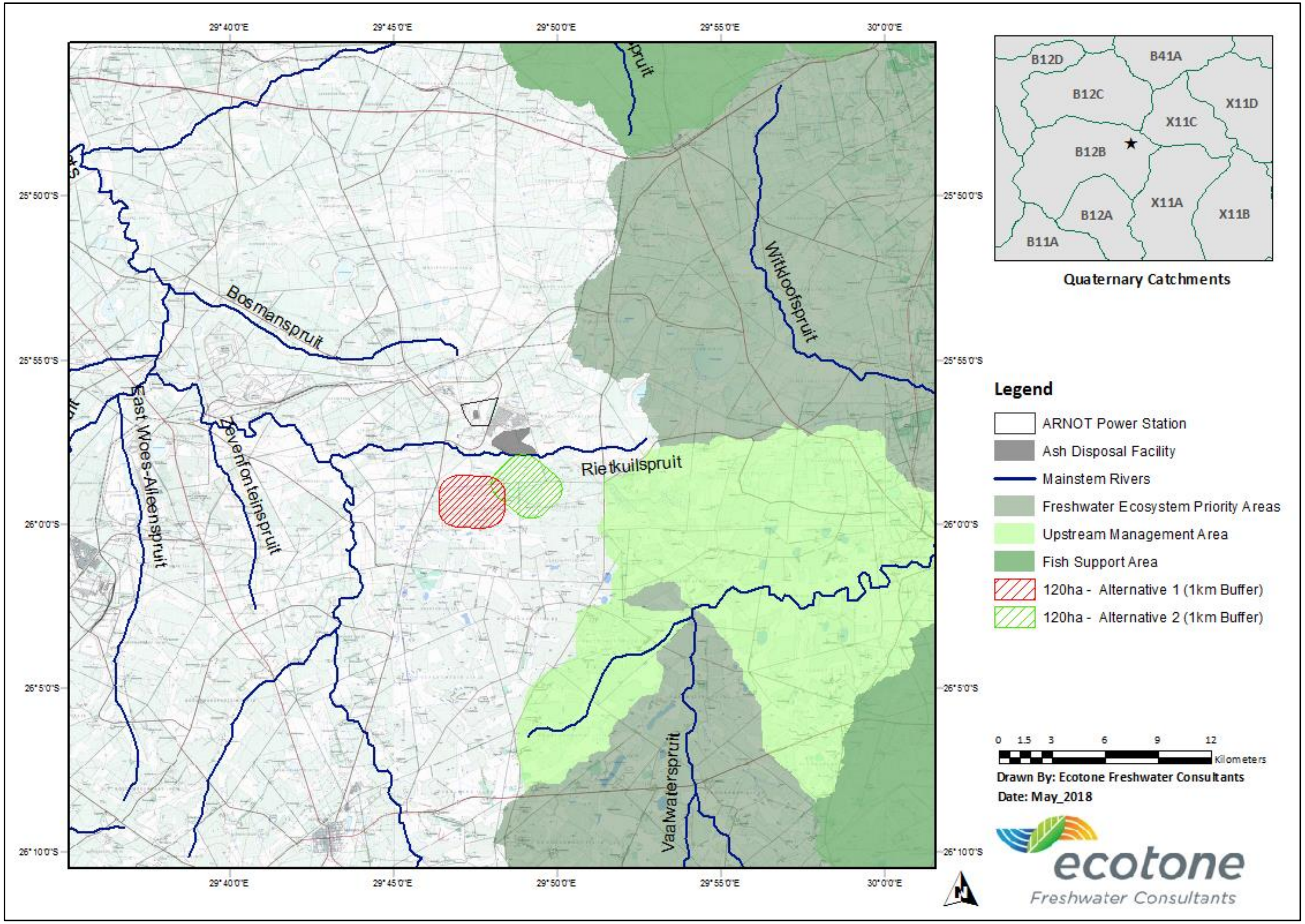

Figure 5-2: Map indicating the study area in relation to the River NFEPAs. Data source: DWAF, 1995; Nel *et al.*, 2004; Nel *et al.,* 2011.

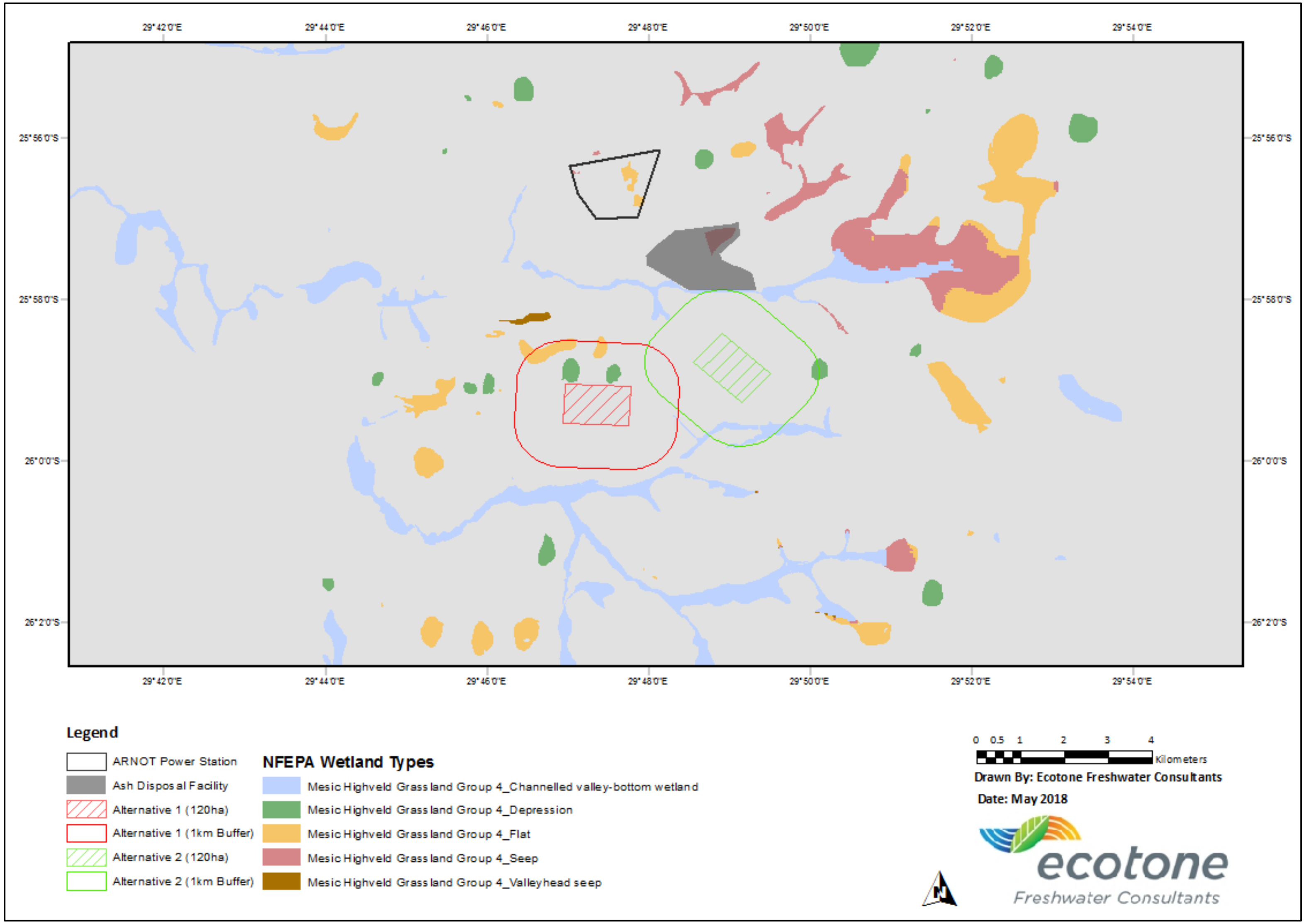

Figure 5-3: Map indicating the study area in relation to the NFEPA wetland types. Data source: Chief Directorate – Surveys and Mapping DWAF, 1995; Nel *et al.*, 2004; Nel *et al.*, 2011.

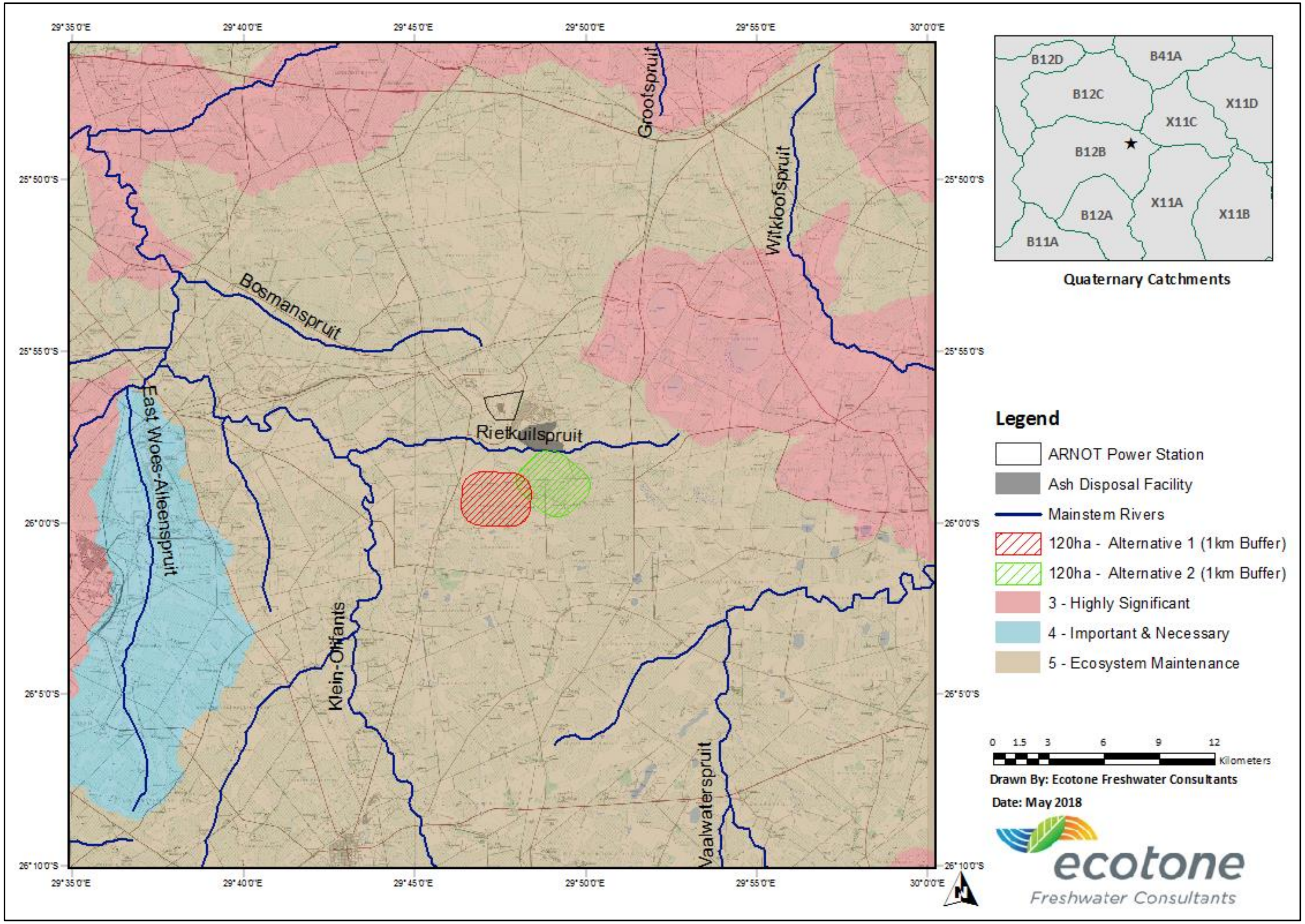

Figure 5-4: Map indicating the study area in relation to the MBCP. Data source: DWAF, 1995; Nel *et al.*, 2004; Ferrar & Lötter, 2007.

5.2. Catchment Drivers of Ecological Change

The ARNOT study area is impacted by several point and non-point source pollution associated with different land uses taking place in the surrounding and upstream catchments. Major land use impacts per SQR are summarised in **Table 5-4** (DWS. 2014).

Table 5-4: Major land use impacts as ascertained by the SQR analysis by DWS (2014)

Impact Rating	B12B-01213	B12B-01256
Critical Impacts	Mining Activities	None
Serious Impacts	Water Abstraction, increased surface runoff, mining effluent and vegetation removal	Mining activities
Large Impacts	Canalization, erosion and small farm dams	Mining runoff/effluent
Moderate Impacts	River crossings, exotic vegetation, runoff/effluent from urban areas	Abstraction, canalization, exotic vegetation, roads and small farm dams
Small Impacts	Agricultural activities and extent of Inundation	Agricultural activities, river crossings and erosion

6. Spatial Sensitivity Mapping

6.1. Wetland Extent

The extent of wetland areas (based on the desktop delineation) within the primary (120 ha) and secondary (1 km radius) study areas are shown in **Table 6-1**. Based on the desktop delineation, a higher wetland extent within the primary study area was recorded at Alt1, with approximately 29.49 % of the area demarcated as a wetland (**Figure 6-1**; **Figure 6-3**). Alt2 reflected a lower wetland extent, with approximately 8.86 % of the area demarcated as wetlands (**Figure 6-1**; **Figure 6-3**). For the secondary study area, Alt1 reflected less wetlands (**Table 6-1**;**Figure 6-3**). However, based on the field observations, the wetlands situated within the secondary study area of Alt2, were more degraded compared to that of Alt1. This will be further assessed during the EIA phase of the study.

Table 6-1: The extent of wetlands (ha) located within the primary (120 ha) and secondary (885 ha) based on desktop delineation and visual site inspection

HGM Units	Primary Study Area (120 ha)				Secondary Study Area 885 ha			
	Alt1		Alt2		Alt1		Alt2	
	ha	%	ha	%	ha	%	ha	%
Pans	0.79	0.66	7.10	5.92	39.71	4.58	7.27	1.62
Seeps	28.70	23.92	3.53	2.94	64.24	10.50	147.60	17.08
CVB	0.00	0.00	0.00	0.00	7.62	0.86	54.00	6.10
Total	**29.49**	**24.58**	**10.63**	**8.86**	**111.57**	**15.94**	**208.87**	**24.80**

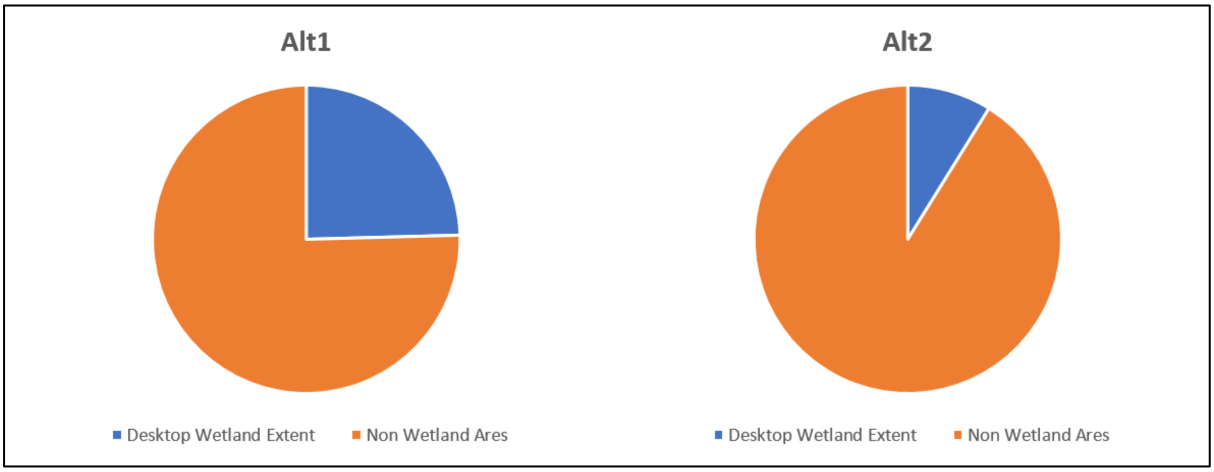

Figure 6-1: Desktop wetland extent within the primary study area (120 ha)

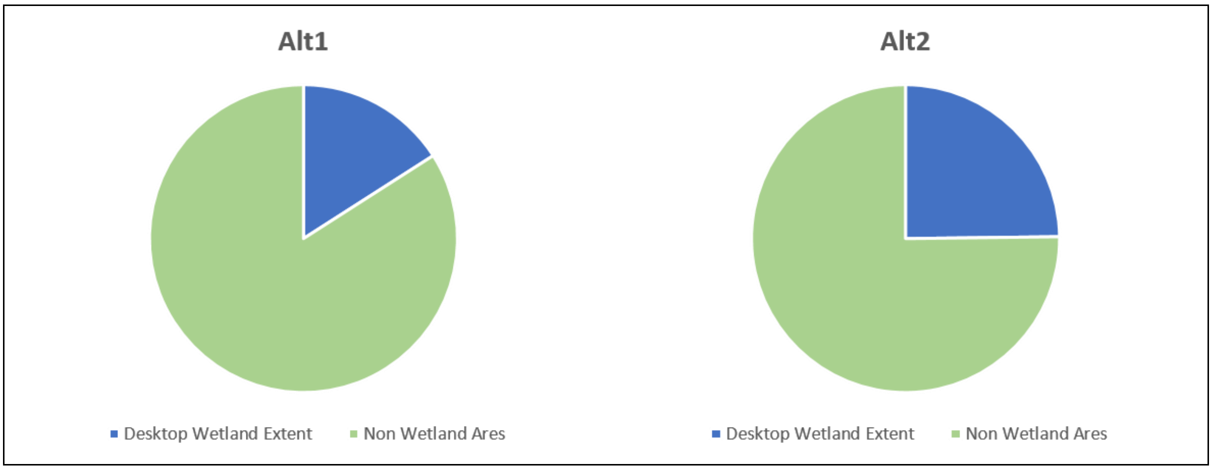

Figure 6-2: Desktop wetland extent within the secondary study area (1 km radius)

In addition to the desktop delineation a WI was also modelled for the study area. The WI reflects the propensity of an area to express wetness based on topographical variation and augmented the sensitivity analyses. The WI provides a suitable proxy for likely wetland areas within the study area. Based on the WI, Alt2, indicted a lower proportion of temporary/seasonal and permanent wetlands (**Table 6-2**; **Figure 6-5**).

Table 6-2: Wetness Index Ha equivalence unit values

Alternative Area (Inc.1km radius)	Unit value (Ha equivalence)	
	Alt1	**Alt2**
Terrestrial - Rocky/wilting point	219.73	194.22
Terrestrial - Wilting point/ field capacity	423.32	443.37
Transitional - Field capacity/ temporary (seep) wetlands	170.63	224.28
Wetland - Temporary/ seasonal wetlands	69.38	18.6
Aquatic - Seasonal/ permanent wetlands	2.62	3.44

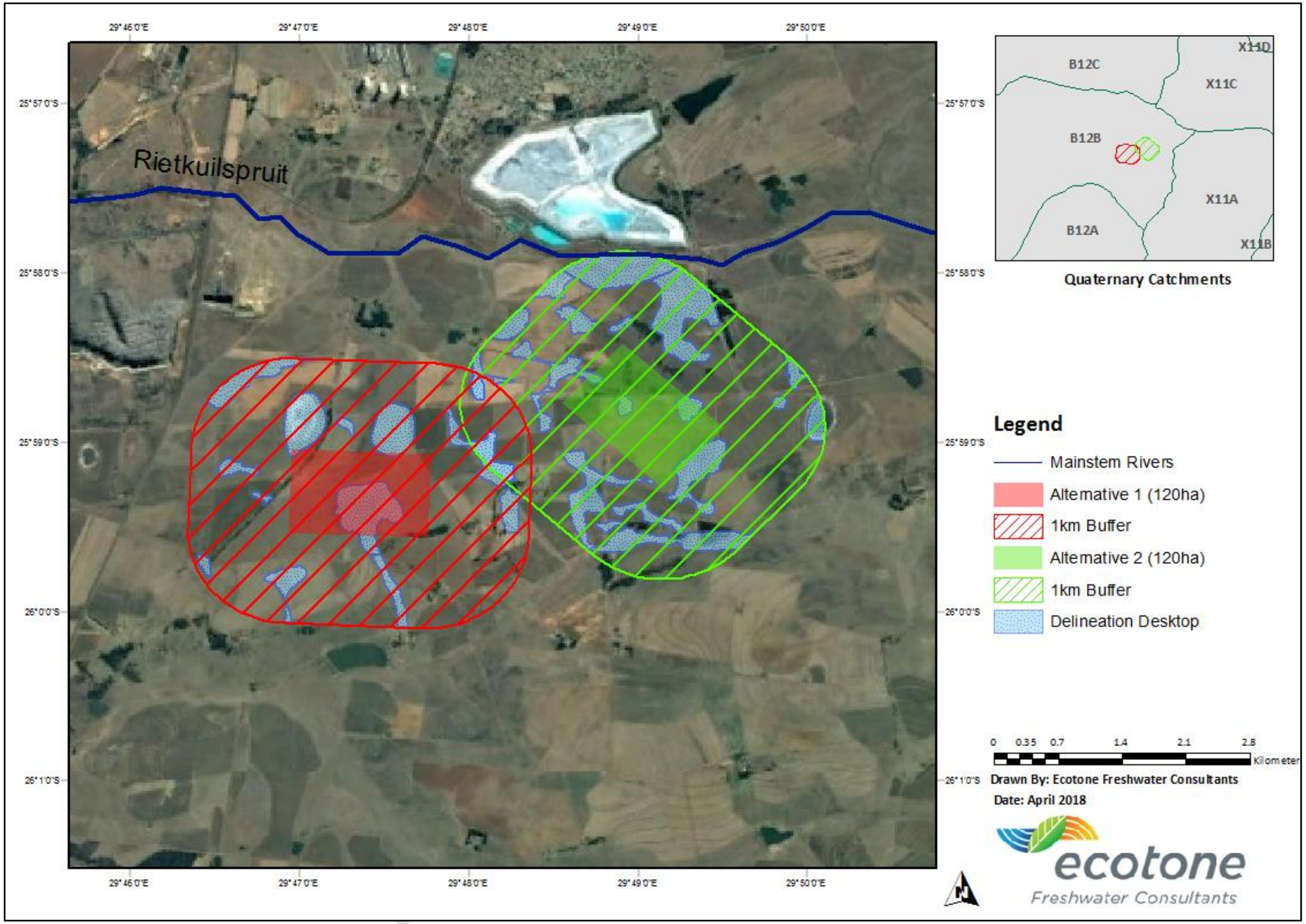

Figure 6-3: Desktop delineation of the 2 alternatives associated with the proposed ARNOT Ash Disposal Facility expansion. Data Source: DWAF, 1995; Nel *et al.,* 2004.

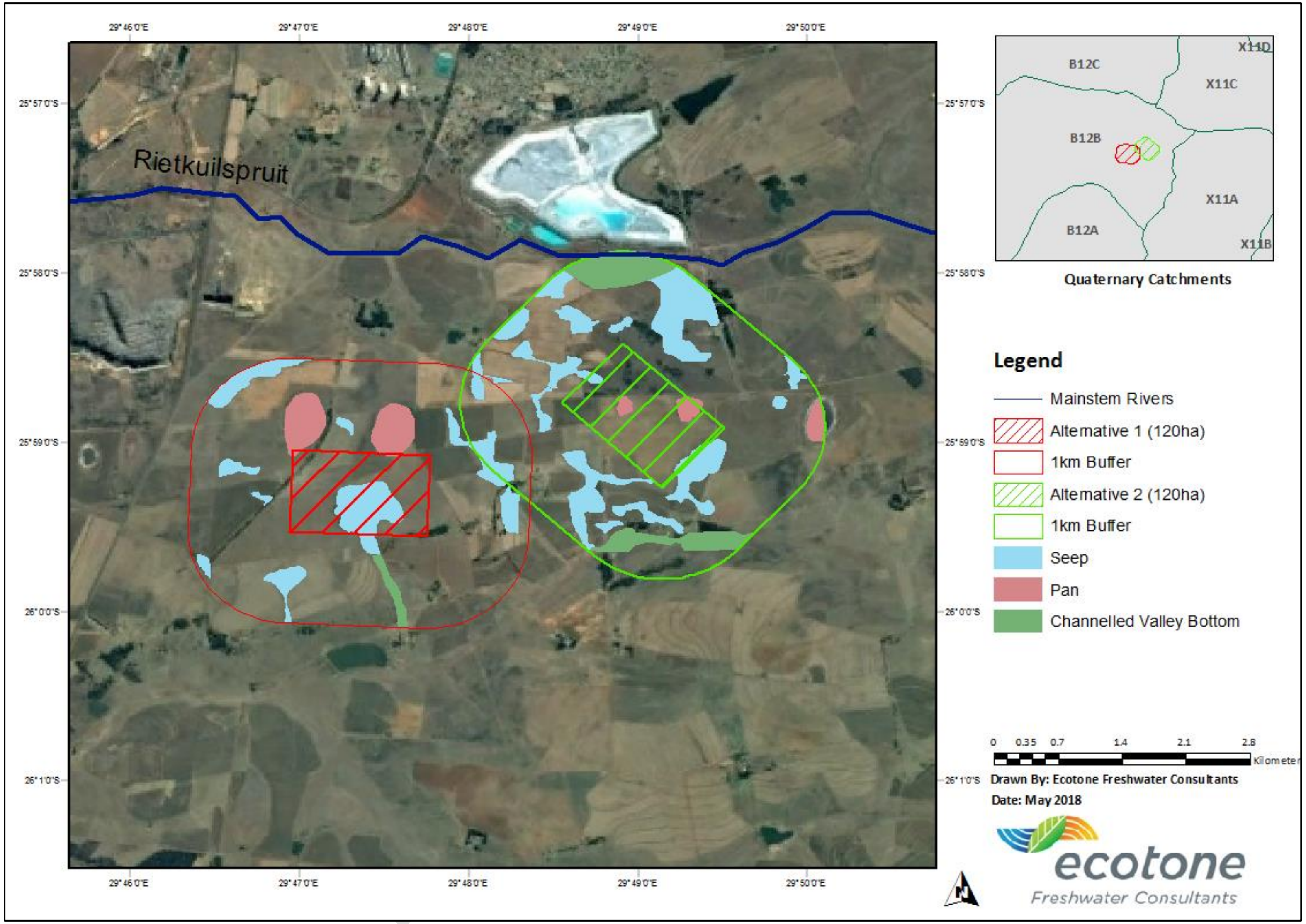

Figure 6-4: HGM units associated with the two alternatives, ARNOT Ash Disposal Facility expansion. Data Source: DWAF, 1995; Nel *et al.,* 2004.

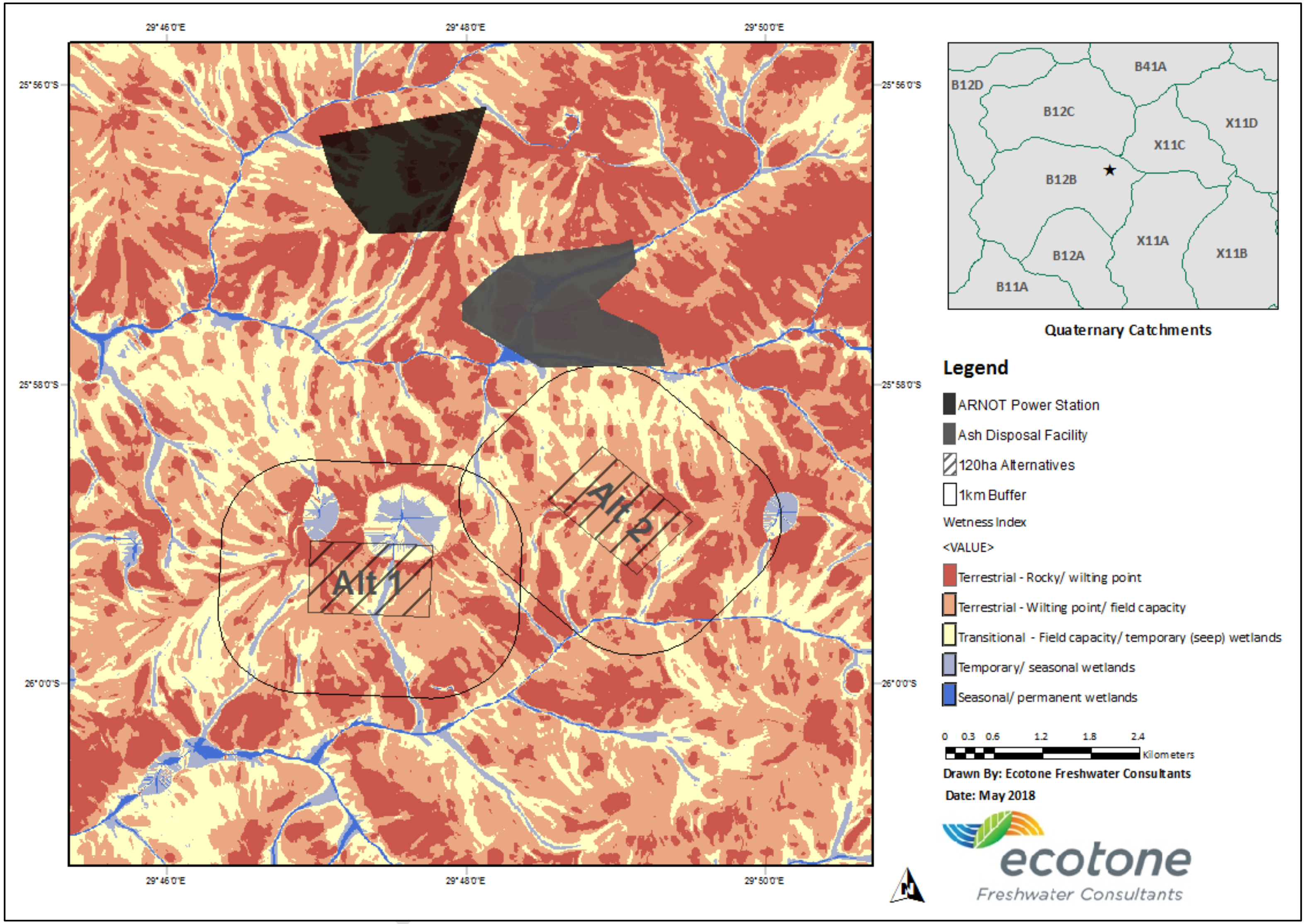

Figure 6-5: Map indicating the two alternative areas in relation to the Wetness Index. Data Source: DWAF, 1995; Nel *et al.,* 2004.

6.2. Site Sensitivity

The rationale applied with the aquatic/wetland sensitivity assessment is based on the premise that all watercourses or potential watercourse areas are sensitive. The catchment size, slope and position in the landscape determine the potential for water accumulation. Once accumulated, other factors such as underlying geology and soil permeability also contribute towards the nature of wetness expressed.

Desktop information gathered during the scoping assessment and a visual field assessment carried out in May 2018 indicated the probability of occurrence of wetland features within the three alternative areas (**Figure 6-3**; **Figure 6-4**). Based on the above and considering the extent of wetland features the two alternatives were provided a sensitivity ranking (**Table 3-2**). However, the PES of wetlands were not considered during the scoping assessment. Based on the desktop delineation, Alt2 was determined to be the preferred alternative. Alt1 was considered the least preferred due to a higher extent of wetland features within the primary study area (**Figure 6-6**) and the close proximity to two depression wetlands situated to the south (**Figure 6-4**). The proposed activities may potentially have a significant negative influence on the status of the receiving instream environment if not adequately managed.

Table 6-3: Sensitivity ratings and weighting for the two alternatives assessed

Alt	Sensitivity Rating	Description	Weighting	Preference
1	High	The proposed development will negatively influence the current status of the feature.	+1	Restricted
2	Low / Poor	The proposed development will not have a significant effect on the inherent feature status and sensitivity.	0	Preferable

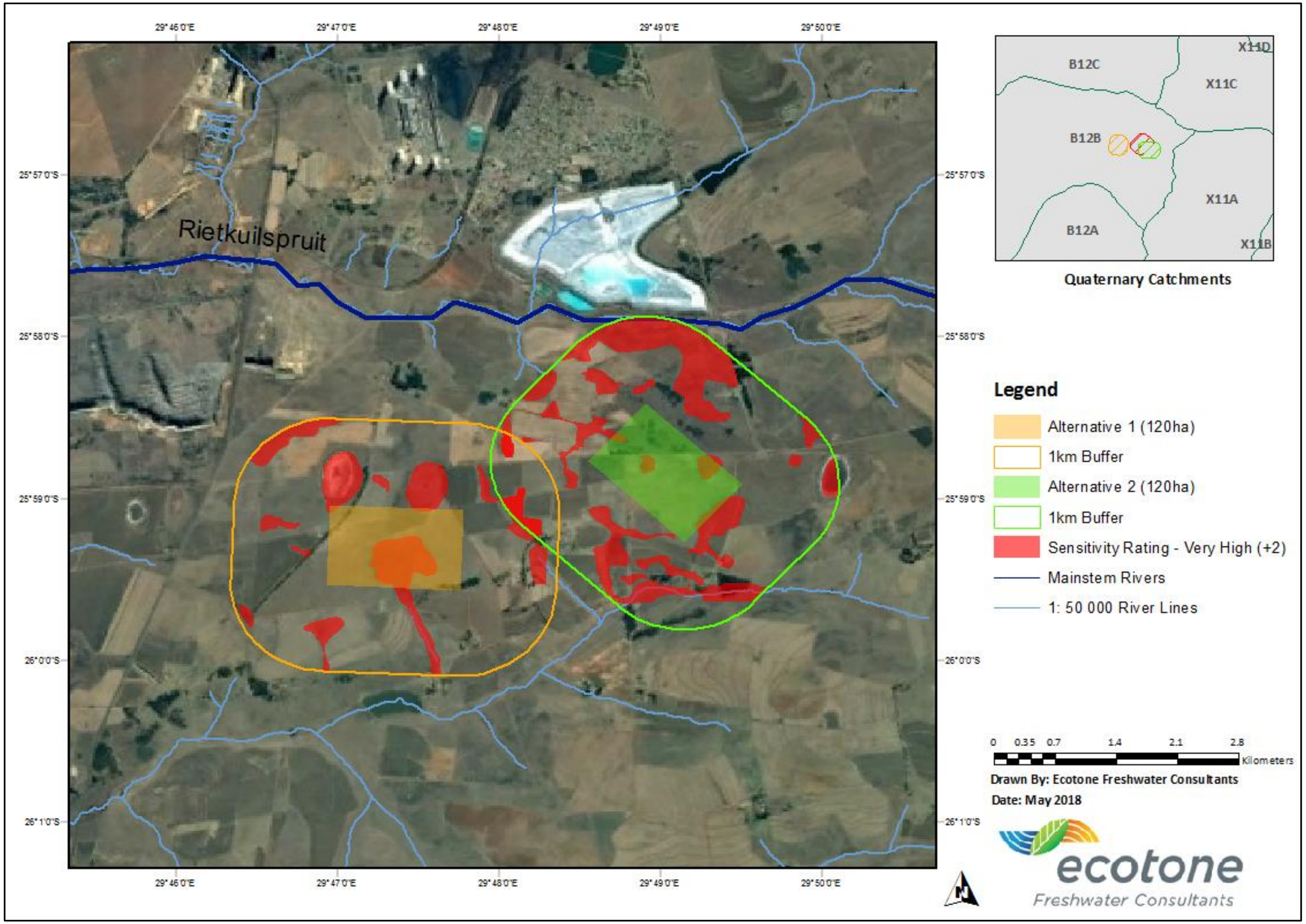

Figure 6-6: Sensitivity map of the watercourses associated with the study area. Data Source: DWAF, 1995; Nel *et al.,* 2004.

7. Preliminary Impact Assessment

7.1. Identification and Description of Potential Impacts

Impacts on the aquatic ecology may be summarised under four main points: (1) alteration to surface water quality, (2) alteration to surface water hydrology, (3) alteration in geomorphology, and (4) Aquatic habitat destruction and fragmentation. Changes to any of the abiotic drivers, due to activities related to the construction and operation of the proposed ash disposal facility, will elicit biological responses in the receiving aquatic communities. The impact assessment will focus on the loss of wetland / aquatic habitat within the primary study areas (120 ha) and impacts to the downslope environment. The potential impacts identified consider four main impacts which are listed and discussed below:

- Impacts related to a decrease in surface water quality on wetlands and aquatic biota;
- Impacts related to altered surface water hydrology on wetlands and aquatic biota;
- Impacts related to erosion and sedimentation on wetlands and aquatic biota; and
- Loss of Wetland Habitat.

7.1.1. Impacts Related to a Decrease in Surface Water Quality on Wetland Function

The points below briefly discuss the perceived impacts related to a decrease in surface water quality on aquatic biota during the different phases and activities. The main perceived impacts are briefly discussed below:

- The main perceived impact related to surface water quality during construction pertain mainly to potential hydrocarbon spills from construction equipment and machinery. 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.
- Contamination via hydrocarbons is of great concern as petroleum hydrocarbons can have a direct toxic effect on aquatic environments (Freeger *et al.,* 2003). Hydrocarbons are toxic to wetland biota and can be lethal depending upon several factors which include: the nature of the fraction, the exposure pathway, and exposure time (Abha & Singh, 2012).

- 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 ash disposal facilities and the leaching rate may be affected by several 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).

- Trace metal concentrations are expected to be very low in most freshwater systems, and any increased exposure may have an adverse impact on the resident aquatic communities. Therefore, contamination of watercourses with trace metals should be adequate monitored (Dallas & Day, 2004).

7.1.2. Impacts Related to Alteration in Surface Water Hydrology on Wetlands and Aquatic Biota

This section of the impact assessment focuses on how alterations to surface water hydrology will impact on the resident and downstream aquatic communities. The main perceived impacts are briefly discussed below:

- The complete loss of the hydrological function of the wetlands directly affected by the proposed footprint (120 ha).
- The proposed ash disposal facility will result in the localised reduction in catchment yield and potentially result in the subsequent loss in hydrological contribution to the downslope watercourses.
- 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 at the proposed ash disposal facility may possibly result in lowered base flows in the receiving aquatic systems due to the loss of the catchment area. Base flow is important as it defines habitat availability.

7.1.3. Impacts Related to Erosion and Sedimentation on Wetlands and Aquatic Biota

The points below briefly discuss the perceived impacts related to erosion and sedimentation on wetland and aquatic biota during the different phases and activities. The main perceived impacts are briefly discussed below:

- Vegetation removal and the compaction of soil during construction and operation will result in increased surface runoff and subsequently increase the erosion potential of the construction site. Furthermore, this may also have an impact on the water quality via increased turbidity.
- Typical sources of sediment during the construction phase include 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 because of the deposited sediment.

7.1.4. Loss of Wetland Habitat

The points below briefly discuss the perceived impacts related to aquatic habitat destruction and fragmentation during the different phases and activities. The main perceived impacts are briefly discussed below:

- The direct loss of wetland areas through clearing of riparian and wetland habitat will result in a complete, but localised, loss of aquatic / wetland 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 surface water quality (**Section 7.1.1**), surface water hydrology (**Section 7.1.2**) and erosion and sediment (**Section 7.1.3**) might result or contribute to habitat fragmentation.

7.2. Assessment & Evaluation of Potential Project Impacts

7.2.1. Impacts Related to a Decrease in Surface Water Quality on Wetland Function

The significance ratings for the potential impact related to a decrease in surface water quality on aquatic biota are provided in **Table 7-1** to **Table 7-4** and **Figure 7-1** to **Figure 7-4**. During the construction phase the main impact will be related to spill/leaks associated with construction equipment and machinery. Through the implementation of adequate mitigation measures the final significance rating for both alternatives 1 and 2 is considered *Low* during the construction phase, with overall significances of -3.33 and -2.92 respectively (**Table 7-1**; **Table 7-3**).

The ER scores during the operation phase are higher since the probability of water quality related impacts on aquatic ecology will be more pronounced, as seepage/leakage and areal deposition from the ash disposal facility may potentially occur. Through the implementation of adequate mitigation measures the final significance rating for all both alternatives are considered *Low* during the operational phase. (**Table 7-2**; **Table 7-4**) Alternatives 1 and 2 obtained similar overall significance scores with Alt1 obtaining a score of - 5.33, whereas Alt2 obtained a slightly lower score of -4.67.

Table 7-1: Significance rating associated with surface water quality during construction – Alt1

Impact Name	**Surface Water Quality**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	4	1
Extent	3	1	Reversibility	3	2
Duration	2	1	Probability	4	2
Environmental Risk (Pre-mitigation)					-12.00
Mitigation Measures					
Refer to Section 7.3.1					
Environmental Risk (Post-mitigation)					-2.50
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Medium: Issue has received a meaningful and justifiable public response					
Cumulative Impacts					2
Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.33
Final Significance					-3.33

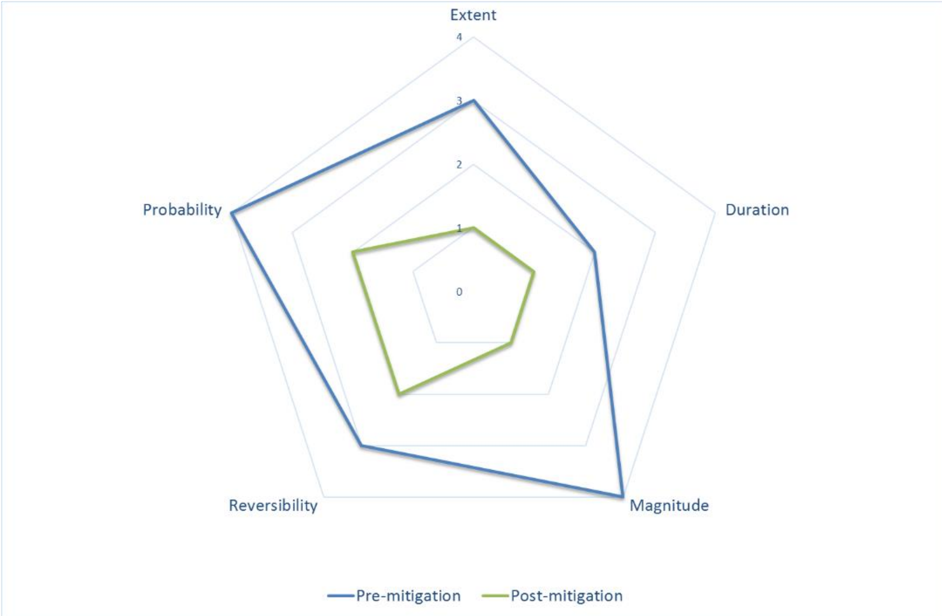

Figure 7-1: Radar plot indicating the pre – and post mitigation impacts associated with surface water quality during construction – Alternative 1.

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Table 7-2: Significance rating associated with surface water quality during operation – Alt1

Impact Name	Surface Water Quality				
Alternative	Alternative 1				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	4	2
Extent	4	2	Reversibility	3	2
Duration	4	2	Probability	4	2
Environmental Risk (Pre-mitigation)					-15.00
Mitigation Measures					
Refer to Section 7.3.1					
Environmental Risk (Post-mitigation)					-4.00
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Medium: Issue has received a meaningful and justifiable public response					
Cumulative Impacts					2
Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.33
Final Significance					-5.33

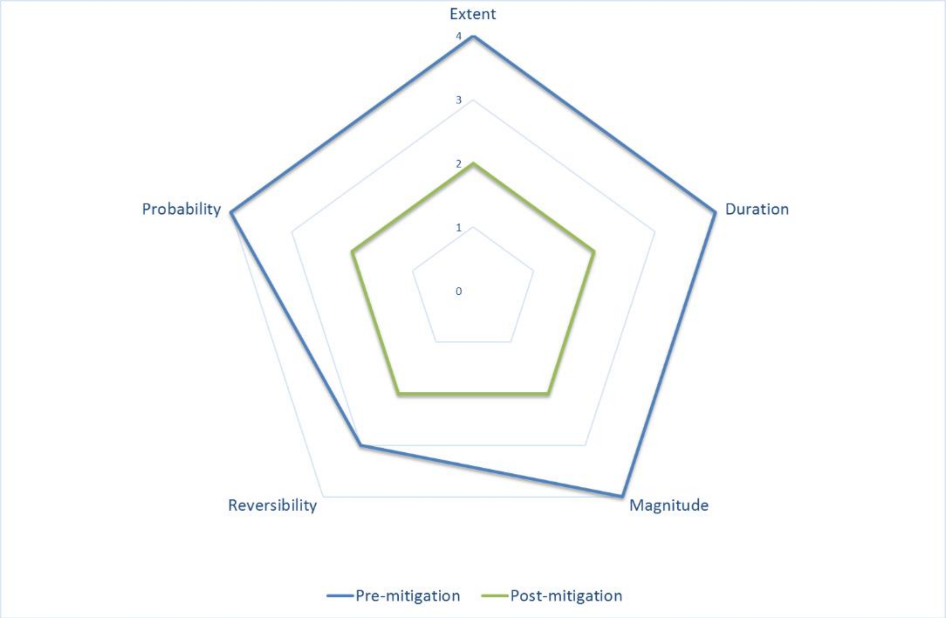

Figure 7-2: Radar plot indicating the pre – and post mitigation impacts associated with surface water quality during operation – Alternative 1.

Table 7-3: Significance rating associated with surface water quality during construction – Alt2

Impact Name	Surface Water Quality				
Alternative	Alternative 2				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	3	1
Extent	3	1	Reversibility	3	2
Duration	2	1	Probability	4	2
Environmental Risk (Pre-mitigation)					-11.00
Mitigation Measures					
Refer to Section 7.3.1					
Environmental Risk (Post-mitigation)					-2.50
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Medium: Issue has received a meaningful and justifiable public response					
Cumulative Impacts					1
Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.17
Final Significance					-2.92

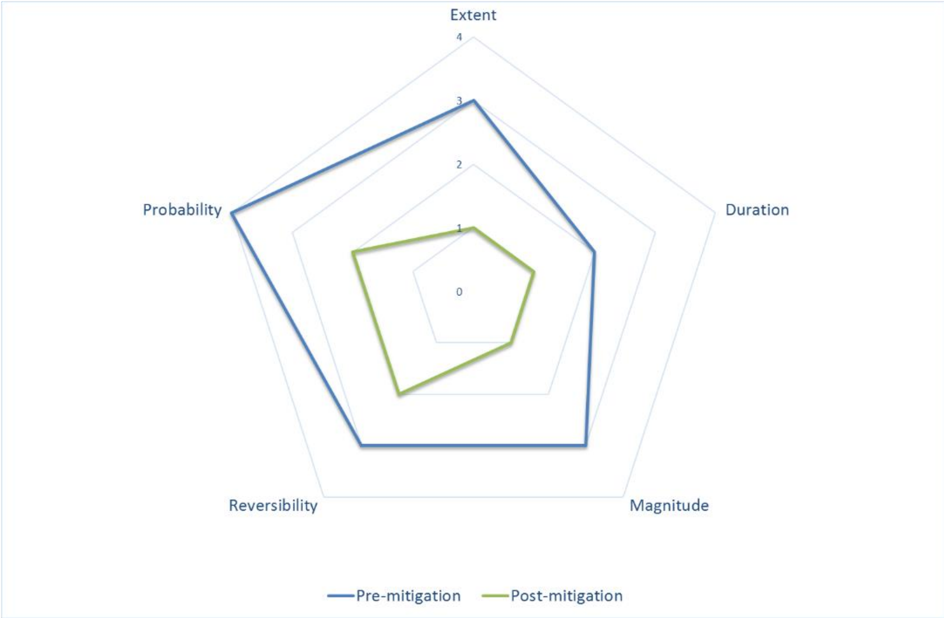

Figure 7-3: Radar plot indicating the pre – and post mitigation impacts associated with surface water quality during construction – Alternative 2.

Table 7-4: Significance rating associated with surface water quality during operation – Alt2

Impact Name	Surface Water Quality				
Alternative	Alternative 2				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	3	2
Extent	4	2	Reversibility	3	2
Duration	4	2	Probability	4	2
Environmental Risk (Pre-mitigation)					-14.00
Mitigation Measures					
Refer to Section 7.3.1					
Environmental Risk (Post-mitigation)					-4.00
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Medium: Issue has received a meaningful and justifiable public response					
Cumulative Impacts					1
Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.17
Final Significance					-4.67

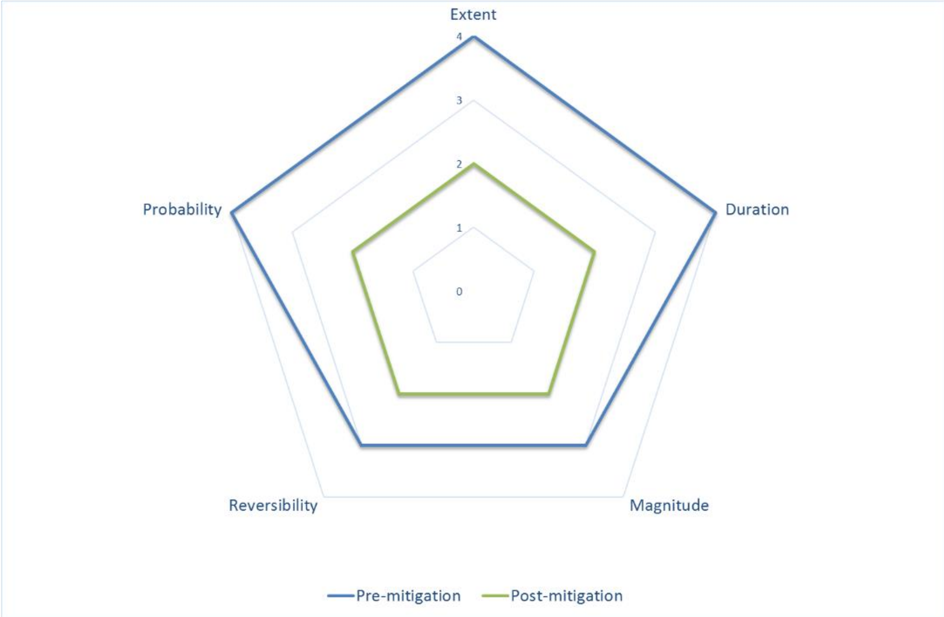

Figure 7-4: Radar plot indicating the pre – and post mitigation impacts associated with surface water quality during operation – Alternative 2.

7.2.2. Impacts Related to Altered Hydrology on Wetlands and Aquatic Biota

The significance ratings for the potential impact related to a decrease in surface water hydrology on aquatic biota are provided in **Table 7-5** to **Table 7-8** and **Figure 7-5** to **Figure 7-8.** This section focuses on the reduction in catchment yield and the subsequent loss in hydrological contribution to the downslope watercourses. The construction of the proposed ash disposal facility will result in the sterilization of wetland habitat, which will subsequently result in the loss of hydrological contribution to downslope wetlands. Alt1 obtained a higher ER score (**Table 7-5; Table 7-7**) as this alternative had a higher wetland extent within the PSA when compared to Alt 2 (**Table 6-1**; **Figure 6-1**).

The ER scores during the operation phase are higher since the duration and magnitude of hydrological related impacts on aquatic ecology will be more pronounced. Through the implementation of adequate mitigation measures the final significance rating for all three alternatives is considered *Low* during the operation phase. Alt1 obtained a higher overall significance score of – 8.2, whereas Alt2 obtained a score of – 6.67. (**Table 7-6**; **Table 7-8**). The higher score recorded at Alt1 is mainly due to the higher magnitude and reversibility scores, as Alt1 had a higher wetland extent within the PSA (**Table 6-1**; **Figure 6-1**).

Table 7-5: Significance rating associated with surface water hydrology during construction – Alt1

Impact Name	Hydrology				
Alternative	Alternative 1				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	4	2
Extent	3	2	Reversibility	3	2
Duration	4	2	Probability	4	2
Environmental Risk (Pre-mitigation)					-14.00
Mitigation Measures					
Refer to Section 7.3.2					
Environmental Risk (Post-mitigation)					-4.00
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Medium: Issue has received a meaningful and justifiable public response					
Cumulative Impacts					2
Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					2
Medium: Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.					
Prioritisation Factor					1.50
Final Significance					-6.00

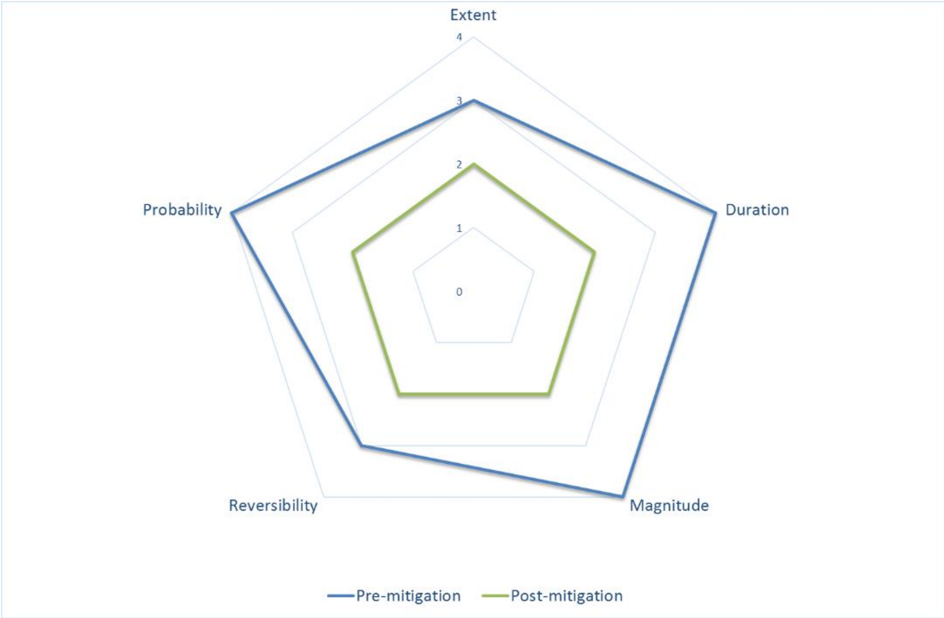

Figure 7-5: Radar plot indicating the pre – and post mitigation impacts associated with surface water hydrology during construction – Alternative 1.

Table 7-6: Significance rating associated with surface water hydrology during operation – Alt1

Impact Name	**Hydrology**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	4	3
Extent	3	2	Reversibility	4	2
Duration	5	4	Probability	4	2
Environmental Risk (Pre-mitigation)					-16.00
Mitigation Measures					
Refer to Section 7.3.2					
Environmental Risk (Post-mitigation)					-5.50
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Medium: Issue has received a meaningful and justifiable public response					
Cumulative Impacts					2
Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					2
Medium: Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.					
Prioritisation Factor					1.50
Final Significance					-8.25

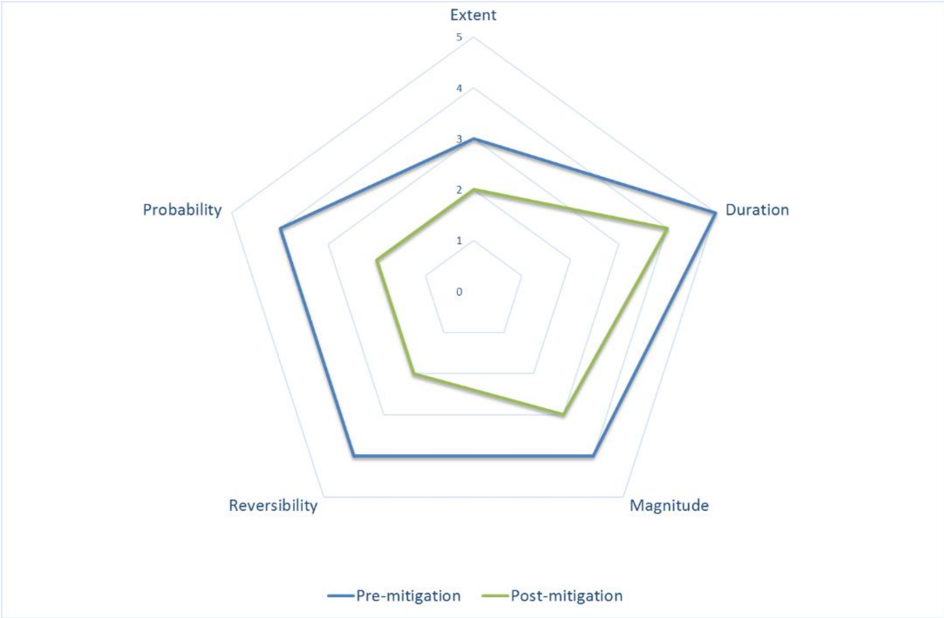

Figure 7-6: Radar plot indicating the pre – and post mitigation impacts associated with surface water hydrology during operation – Alternative 1.

Table 7-7: Significance rating associated with surface water hydrology during construction – Alt2

Impact Name	Hydrology				
Alternative	**Alternative 2**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	3	2
Extent	3	2	Reversibility	3	2
Duration	4	4	Probability	4	2
Environmental Risk (Pre-mitigation)					-13.00
Mitigation Measures					
Refer to Section 7.3.2					
Environmental Risk (Post-mitigation)					-5.00
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Medium: Issue has received a meaningful and justifiable public response					
Cumulative Impacts					1
Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					2
Medium: Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.					
Prioritisation Factor					1.33
Final Significance					-6.67

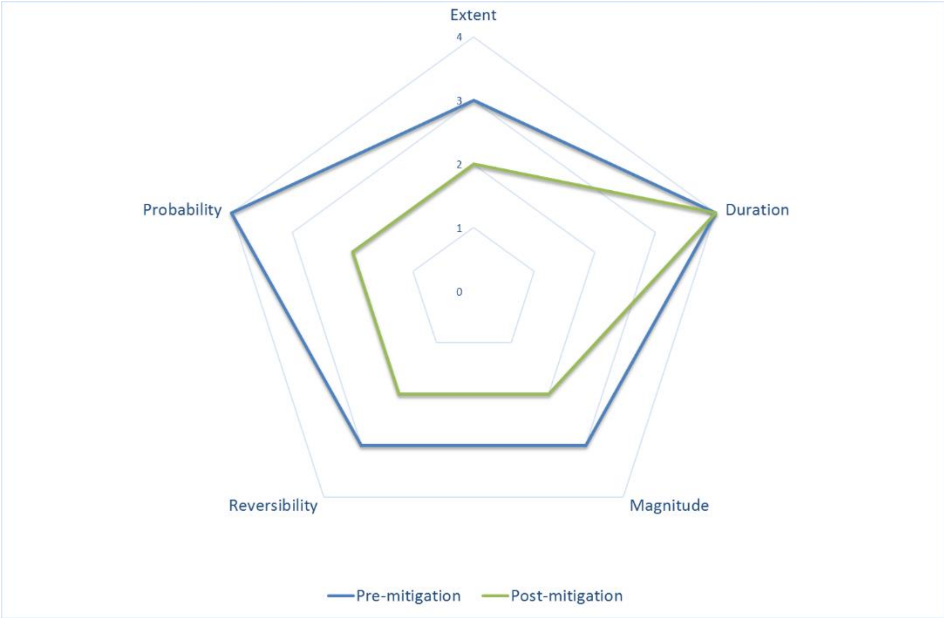

Figure 7-7: Radar plot indicating the pre – and post mitigation impacts associated with surface water hydrology during construction – Alternative 2.

Table 7-8: Significance rating associated with surface water hydrology during operation – Alt2

Impact Name	Hydrology				
Alternative	**Alternative 2**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	3	3
Extent	3	2	Reversibility	4	2
Duration	5	4	Probability	4	2
Environmental Risk (Pre-mitigation)					-15.00
Mitigation Measures					
Refer to Section 7.3.2					
Environmental Risk (Post-mitigation)					-5.50
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Medium: Issue has received a meaningful and justifiable public response					
Cumulative Impacts					1
Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					2
Medium: Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.					
Prioritisation Factor					1.33
Final Significance					-7.33

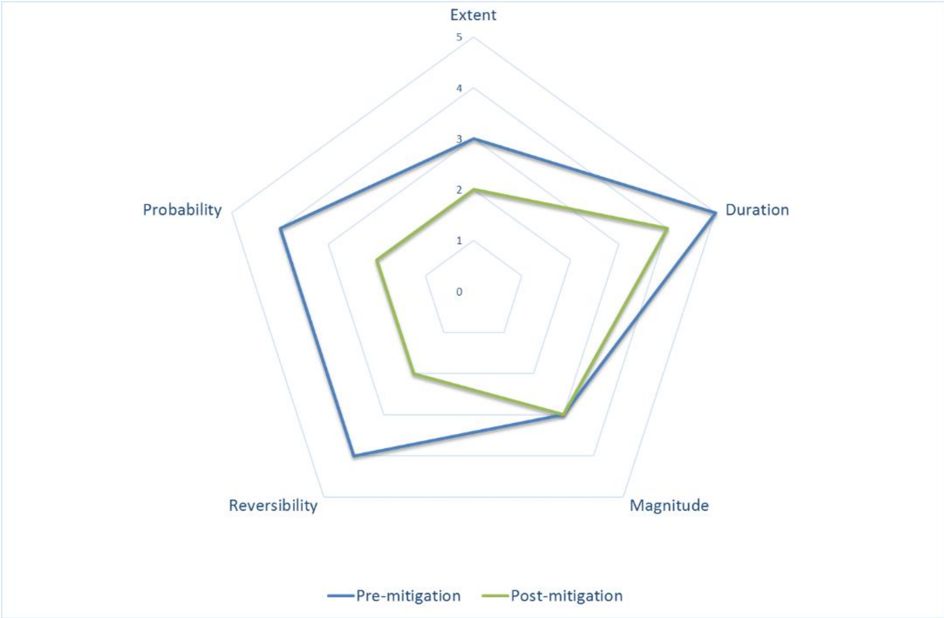

Figure 7-8: Radar plot indicating the pre – and post mitigation impacts associated with surface water hydrology during operation – Alternative 2.

7.2.3. Impacts Related to Erosion and Sedimentation on Wetlands and Aquatic Biota

The significance ratings for the potential impact related to erosion and sedimentation on aquatic biota are provided in **Table 7-9** to **Table 7-12** and **Figure 7-9** to **Figure 7-12**. The ER scores were slightly higher for Alt1 pre-mitigation, since the higher overall slope of the area resulted in a higher magnitude score (**Table 7-9**). However, through the implementation of the proposed mitigation measures, similar post mitigation scores were obtained for both alternatives (**Table 7-9; Table 7-11**) with scores of -4.67, and - 4.08 respectively. The significance is slightly higher during the operational phase due to the higher duration score. If the mitigation measures are put in place prior to the onset of construction and throughout the operational phase, the extent, duration, magnitude and probability can be mitigated. If the mitigation measures are strictly implemented the final significance of the impact can be reduced to *Low* for both alternatives (**Figure 7-10**; **Figure 7-12**).

Table 7-9: Significance rating associated with erosion and sedimentation during construction – Alt1

Impact Name	**Erosion and Sedimentation**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	3	2
Extent	3	1	Reversibility	3	2
Duration	2	2	Probability	4	2
Environmental Risk (Pre-mitigation)					-11.00
Mitigation Measures					
Refer to Section 7.3.3					
Environmental Risk (Post-mitigation)					-3.50
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Medium: Issue has received a meaningful and justifiable public response					
Cumulative Impacts					2
Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.33
Final Significance					-4.67

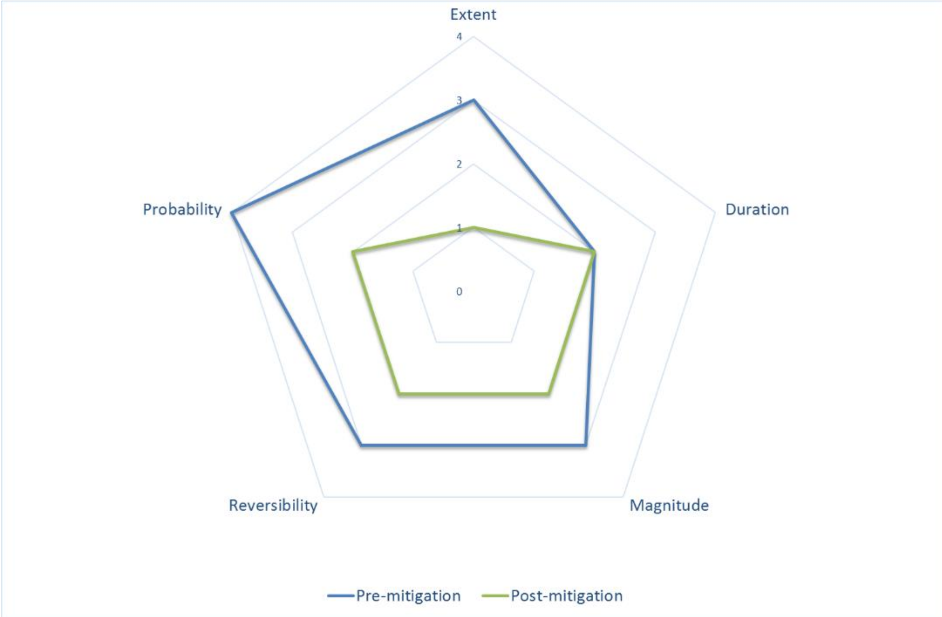

Figure 7-9: Radar plot indicating the pre – and post mitigation impacts associated with erosion and sedimentation during construction – Alternative 1.

Table 7-10: Significance rating associated with erosion and sedimentation during operation – Alt1

Impact Name	**Erosion and Sedimentation**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	3	2
Extent	3	1	Reversibility	3	2
Duration	4	2	Probability	4	2
Environmental Risk (Pre-mitigation)					-13.00
Mitigation Measures					
Refer to Section 7.3.3					
Environmental Risk (Post-mitigation)					-3.50
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Medium: Issue has received a meaningful and justifiable public response					
Cumulative Impacts					2
Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.33
Final Significance					-4.67

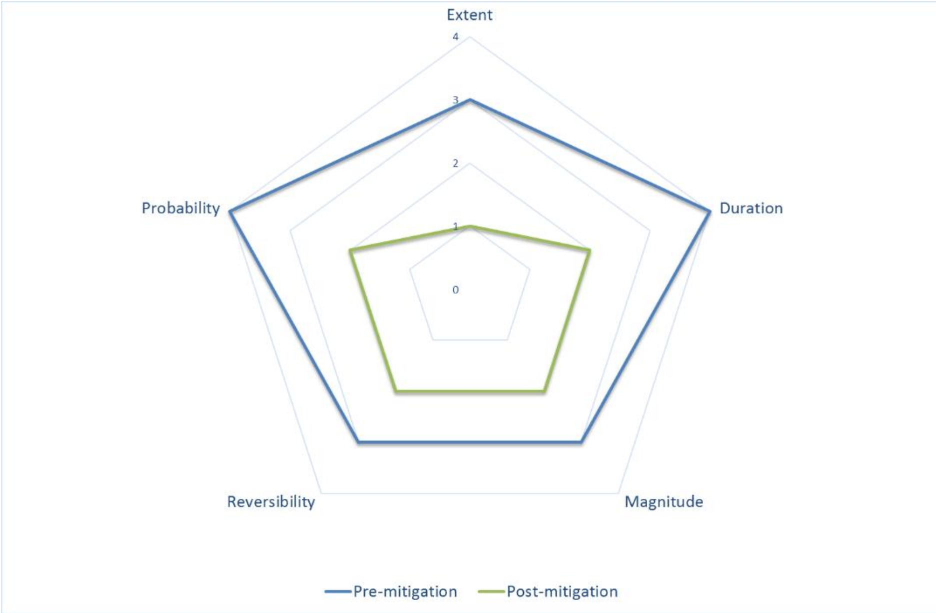

Figure 7-10: Radar plot indicating the pre – and post mitigation impacts associated with erosion and sedimentation during operation – Alternative 1.

Table 7-11: Significance rating associated with erosion and sedimentation during construction – Alt2

Impact Name	Erosion and Sedimentation				
Alternative	Alternative 2				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	4	2
Extent	3	1	Reversibility	3	2
Duration	2	2	Probability	4	2
Environmental Risk (Pre-mitigation)					-12.00
Mitigation Measures					
Refer to Section 7.3.3					
Environmental Risk (Post-mitigation)					-3.50
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Medium: Issue has received a meaningful and justifiable public response					
Cumulative Impacts					1
Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.17
Final Significance					-4.08

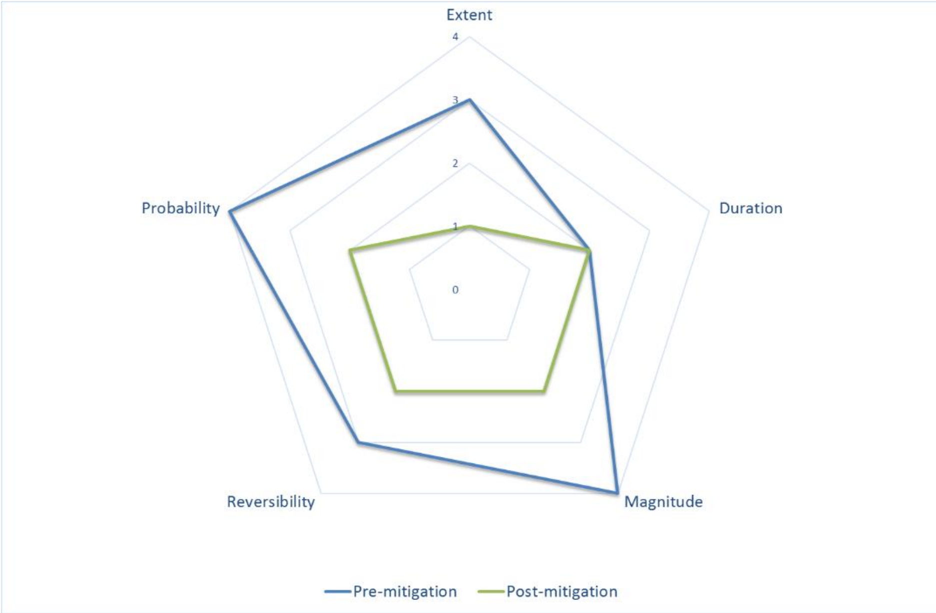

Figure 7-11: Radar plot indicating the pre – and post mitigation impacts associated with erosion and sedimentation during construction – Alternative 2.

Table 7-12: Significance rating associated with erosion and sedimentation during operation – Alt2

Impact Name	**Erosion and Sedimentation**				
Alternative	**Alternative 2**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	4	2
Extent	3	1	Reversibility	3	2
Duration	4	2	Probability	4	2
Environmental Risk (Pre-mitigation)					-14.00
Mitigation Measures					
Refer to Section 7.3.3					
Environmental Risk (Post-mitigation)					-3.50
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Medium: Issue has received a meaningful and justifiable public response					
Cumulative Impacts					1
Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.17
Final Significance					-4.08

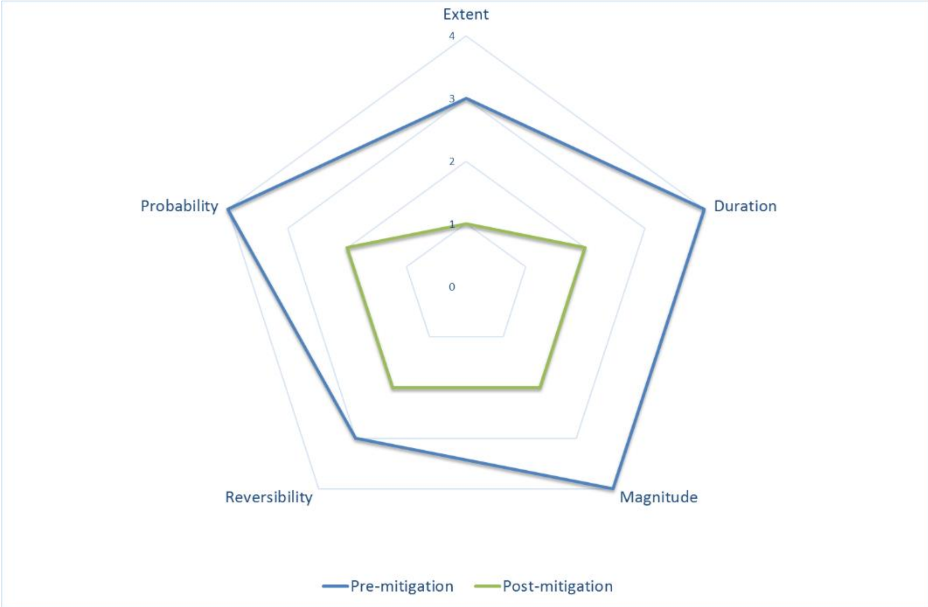

Figure 7-12: Radar plot indicating the pre – and post mitigation impacts associated with erosion and sedimentation during operation – Alternative 2.

7.2.4. Loss of Wetland Habitat

The significance ratings for the potential impact related to aquatic habitat destruction and fragmentation are provided in **Table 7-13** to **Table 7-14** and **Figure 7-13** to **Figure 7-14**. A combined assessment was carried out for the loss of wetland habitat as the construction and operation phase for the proposed ash disposal facility go hand in hand. The ER associated with the loss of wetland habitat during the construction of the ash disposal facility is considered *High* at all three alternatives due to high duration, reversibility and probability scores (**Table 7-13**; **Table 7-14**). However, Alternative 2 obtained a lower final significance rating as this alternative obtained lower magnitude and probability scores, due to the lower extent of wetland present within the primary and secondary study areas (**Table 6-1**; **Figure 6-1**).

Table 7-13: Significance rating associated with the loss of wetland habitat during construction / operation – Alt1

Impact Name	Aquatic Habitat Destruction and Fragmentation				
Alternative	Alternative 1				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	4	3
Extent	3	2	Reversibility	4	4
Duration	5	5	Probability	5	5
Environmental Risk (Pre-mitigation)					-20.00
Mitigation Measures					
Refer to Section 7.3.4					
Environmental Risk (Post-mitigation)					-17.50
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Medium: Issue has received a meaningful and justifiable public response					
Cumulative Impacts					2
Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					3
High: Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).					
Prioritisation Factor					1.67
Final Significance					-29.17

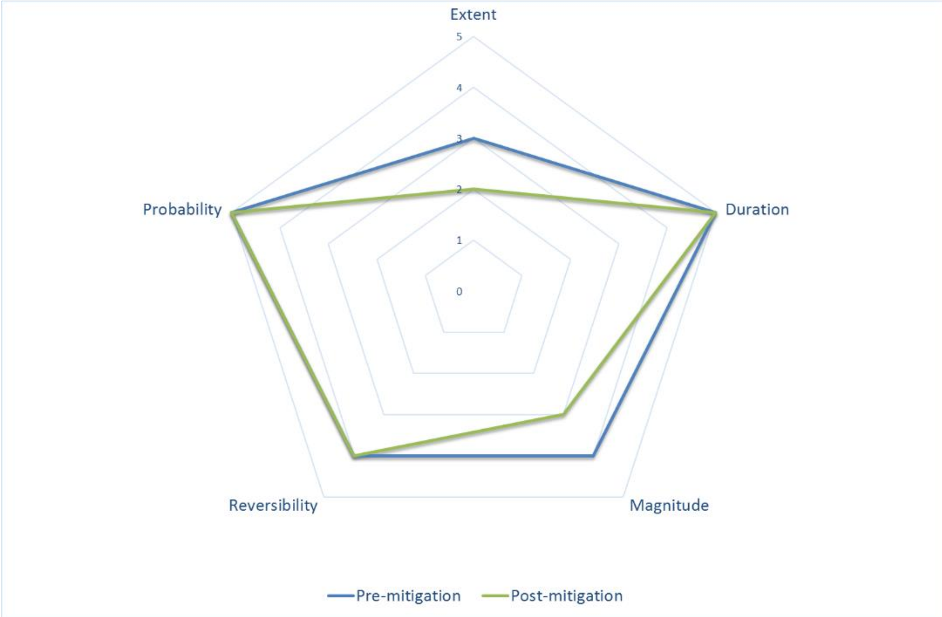

Figure 7-13: Radar plot indicating the pre – and post mitigation impacts associated with the loss of wetland habitat during construction / operation – Alternative 1.

Table 7-14: Significance rating associated with the loss of wetland habitat during construction / operation – Alt2

Impact Name	**Aquatic Habitat Destruction and Fragmentation**				
Alternative	**Alternative 2**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	3	3
Extent	3	2	Reversibility	4	4
Duration	5	5	Probability	5	4
Environmental Risk (Pre-mitigation)					-18.75
Mitigation Measures					
Refer to Section 7.3.4					
Environmental Risk (Post-mitigation)					-14.00
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Medium: Issue has received a meaningful and justifiable public response					
Cumulative Impacts					1
Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					3
High: Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).					
Prioritisation Factor					1.50
Final Significance					-21.00

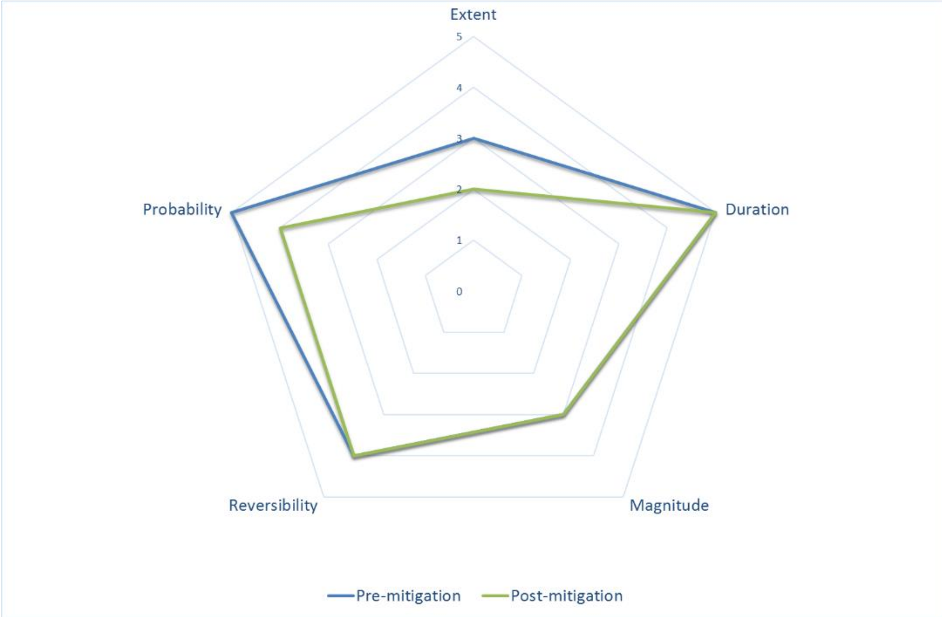

Figure 7-14: Radar plot indicating the pre – and post mitigation impacts associated with the loss of wetland habitat during construction / operation – Alternative 2.

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7.3. Potential Mitigation Measures

The following section provides a brief overview of recommendations and mitigation measures for avoiding, reducing/preventing impacts on aquatic ecology:

7.3.1. Impacts Related to a Decrease in Surface Water Quality on Wetland Function

- Avoid, as far as reasonably possible, the placement of infrastructure within regulated areas of watercourses. In instances where this is not feasible suitable mitigation measures should be in place for the protection of surface 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 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.
- Construction equipment should not be serviced or refuelled near watercourses.
- 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.

7.3.2. Impacts Related to Altered Hydrology on Wetlands and Aquatic Biota

- The stormwater design should consider the natural flood retention capacity provided by the soil (including wetlands) within the footprint. The stormwater design should compensate for any loss in natural flood retention, though carful placement of stormwater infrastructure, maximising onsite (uncontaminated) infiltration and through the strategic placement of environmental infrastructure (i.e. bioswales, berms, retention structures). The surface roughness of impermeable surfaces should also be increases as much as possible to assist runoff energy dissipation.

- The extent of wetlands should be 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 feasibly possible. This will require rehabilitation of disturbed downslope areas where attention is paid to increase surface roughness and energy dissipation.

7.3.3. Impacts Related to Erosion and Sedimentation on Wetlands and Aquatic Biota

- Limit any disturbances to the smallest possible footprint.
- 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 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. This will further reduce the risk associated with erosion/siltation;
- 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.
- Place access roads and infrastructure on natural topography and avoid side hill cuts and grades. Roads should be designed with natural reclamation in mind.
- 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.

7.3.4. Loss of Wetland Habitat

- The footprint of the proposed facility should avoid as far as feasibly possible the placement of infrastructure within watercourses. This will reduce the significance of the perceived impacts substantially.
- Limit any disturbances to the smallest possible footprint.

8. Management Plan

This section provides mitigation measures and management options and provides information regarding the roles and responsibilities for implementation with targets and performance indicators. This information is summarised in **Table 8-1**.

Table 8-1: Recommended mitigation measures including timeframes, roles and responsible parties

No.	Mitigation Measures	Phase	Timeframe	Responsible party for implementation	Monitoring Party (Frequency)	Target	Performance Indicators (Frequency)
	Impacts related to a decrease in surface water quality on wetland function						
A	The footprint of the proposed ash disposal facility should avoid, as far as feasibly possible, the placement of infrastructure within the wetland area. This will reduce the significance of the perceived impacts substantially.	Construction	Prior to construction	Applicant Contractor	ECO (weekly basis during construction)	Remain within the construction limits and avoid watercourses. Authorise any activity within the regulated area of watercourses	ECO (monthly report / checklist)
B	No dumping of any building rubble, soil, litter and debris, organic matter or chemical substances should occur within watercourses. Dumping and temporary storage of the above mentioned material/substances should only occur at predetermined locations located outside of the wetland boundaries and riparian zones.	Construction	During construction	Applicant Contractor	ECO (weekly basis during construction)	Avoid sediment laden runoff from entering the receiving aquatic environment.	ECO (monthly report / checklist)
C	Construction equipment should not be serviced or refuelled near the watercourse. Oil storage and workshop areas should be surrounded by a bund wall in order to contain spillages. In the case where soil becomes contaminated with oil, it must be removed for proper disposal or treatment (Bioremediation). In the case where soil becomes contaminated with oil, it must be removed for proper disposal or treatment (e.g. Bioremediation).	Construction Operation Decommission	During construction and throughout the lifespan of the project	Applicant Contractor	ECO (weekly basis during construction)	Comply with the waste management plan	ECO (monthly report / checklist)
D	It is important that clean and dirty water be isolated from one another in order to avoid the contamination of clean water.	Construction Operation Decommission	During construction and throughout the lifespan of the ash disposal facility	Applicant Contractor	ECO (weekly basis during construction and monthly thereafter)	Comply with the stormwater management plan	ECO (monthly report / checklist)
E	The ash disposal facility and associated pollution control facilities (Pollution control dams etc.) should be adequacy lined in order to prevent contamination via leakage / seepage.	Construction	Prior to construction	Applicant Contractor	ECO (weekly basis during construction and monthly thereafter)	Comply with the waste management plan	ECO (monthly report / checklist)

No.	Mitigation Measures	Phase	Timeframe	Responsible party for implementation	Monitoring Party (Frequency)	Target	Performance Indicators (Frequency)
	Impacts related to altered hydrology on wetlands and aquatic biota						
A	The footprint of the proposed ash disposal facility should avoid as far as feasibly possible the placement of infrastructure within the watercourses.	Planning Construction	Prior to construction	Applicant Contractor	ECO (weekly basis during construction)	Avoid as far as feasibly possible the placement of infrastructure within the watercourse.	ECO (monthly report / checklist)
B	Compacted surfaces associated with the ash disposal facility should be kept to an absolute minimum. And the surface roughness should be increased where possible.	Construction Operation	During construction and ongoing during operation	Applicant Contractor	ECO (weekly basis during construction and monthly thereafter)	Maintain the natural surface flows.	ECO (monthly report / checklist)
C	The construction activities should focus on limiting alterations to the natural hydrological boundary conditions on the downslope environment.	Construction Operation Decommission	During construction and ongoing during operation	Applicant Contractor	ECO (weekly basis during construction and monthly thereafter)	Maintain the natural surface flows.	ECO (monthly report / checklist)
D	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.	Construction Operation	During construction and ongoing during operation	Applicant Contractor	ECO (weekly basis during construction and monthly thereafter)	Maintain the natural surface flows.	ECO (monthly report / checklist)
	Impacts related to erosion and sedimentation on wetlands and aquatic biota						
A	Erosion and silt control mechanisms must be in place prior to the onset of construction. This includes the elimination of surface flow through any construction sites. Repairs need to be carried out if any damage has occurred.	Planning	Prior to construction	Applicant Contractor	ECO (weekly basis during construction and monthly thereafter)	No signs of soil erosion should be visible on site nor signs of sediment deposition.	ECO (monthly report / checklist)
B	Silt fences or hay bales need to be placed near the base of exposed slopes in order to limit the amount of sediments entering the watercourse.	Construction Operation Decommission	During construction and ongoing during operation	Applicant Contractor	ECO (weekly basis during construction and monthly thereafter)	No signs of increased sedimentation in the receiving aquatic environment.	ECO (monthly report / checklist)

No.	Mitigation Measures	Phase	Timeframe	Responsible party for implementation	Monitoring Party (Frequency)	Target	Performance Indicators (Frequency)
C	The construction of silt barriers along the drainage lines must be undertaken to curb any sediment and silt run-off in preparation of any construction activities. Ideally, the amount of land that will be disturbed should be kept to an absolute minimum.	Construction Operation Decommission	Prior to construction and ongoing during operation	Applicant Contractor	ECO (weekly basis during construction and monthly thereafter)	No signs of increased sedimentation in the receiving aquatic environment.	ECO (monthly report / checklist)
D	Non-erodible materials should be used for the construction of any berms or other isolation structures.	Planning	Prior to construction	Applicant Contractor	ECO (weekly basis during construction and monthly thereafter)	Erosion control measures should be inspected regularly and necessary repairs need to be carried out if any damage has occurred.	ECO (monthly report / checklist)
E	Clearing of vegetation needs to be limited in order to limit erosion and should only take place immediately before construction commences.	Planning	Prior to construction and ongoing during operation	Applicant Contractor	ECO (weekly basis during construction and monthly thereafter)	Ideally, the amount of land that will be disturbed should be kept to an absolute minimum.	ECO (monthly report / checklist)
F	Spoil piles should be placed outside the wetland areas 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.	Planning Construction	Prior to construction and ongoing during operation	Applicant Contractor	ECO (weekly basis during construction and monthly thereafter)	No signs of increased sedimentation in the receiving aquatic environment.	ECO (monthly report / checklist)
G	The banks of the ash disposal facility needs to be re-vegetated during operation as the upper areas reach their capacity. Suitable Indigenous vegetation need to be used after consultation with a vegetation specialist.	Operation Decommission	Construction Operation Decommission	Applicant Contractor Vegetation specialist	ECO (weekly basis during construction and monthly thereafter) Vegetation specialist (after the raining season until the specialist deems the rehabilitation adequate)	The established of indigenous vegetation with no signs of increased sedimentation in the receiving aquatic environment.	ECO (monthly report / checklist)

No.	Mitigation Measures	Phase	Timeframe	Responsible party for implementation	Monitoring Party (Frequency)	Target	Performance Indicators (Frequency)
H	The movement of vehicles and machine should be restricted to pre-determined areas and paths. Vehicles should be restricted from moving over areas that have been stabilised and re-vegetated.	Operation Decommission	During operation and ongoing through to the decommissioning phase.	Contractor ECO	ECO (weekly basis during construction and monthly thereafter)	Monitor and prevent the formation of erosion features. Any damage to stabilised areas should be repaired as soon as feasibly possible and monitored by the ECO.	ECO (monthly report / checklist)
			Aquatic Habitat Destruction and Fragmentation				
A	Construction and operation activities should remain strictly within the direct footprint of the proposed ash disposal facility in order to limit as far as feasibly possible the destruction of the instream and wetland habitat It is recommended that the proposed footprint be demarcated in order to minimise the unnecessary destruction of habitat.	Construction Operation	Construction Operation	Applicant Contractor ECO	ECO (on a monthly basis)	Prevent unnecessary destruction of instream habitat. Remain within the construction limits.	ECO (monthly report / checklist)

9. Action Plan

Provided in this section is an action plan for the implementation of the recommended mitigation measures. It focuses on management actions required for implementation by identifying responsible parties, monitoring and reviewing plans and timeframes for implementation (**Table 9-1**). It is important that this action plan be viewed in unison with the mitigation/management plan.

Table 9-1: Proposed Action Plan

Phase	Management action	Timeframe for implementation	Responsible Party for implementation	Responsible party for Monitoring/ audit/Review (frequency)
Planning	The footprint of the proposed expansion of the Arnot waste disposal facility should be kept to an absolute minimum and avoid as far as feasibly possible the placement of infrastructure within the watercourse. This will drastically reduce the significance of the perceived impacts.	Prior to commencing the construction phase	Applicant Contractor	ECO
Construction	*In situ* water quality	Throughout the construction phase	ECO	ECO (Weekly)
	Aquatic and wetland Biomonitoring regime	Throughout the construction phase	ECO	Qualified aquatic /wetland specialist - *Pr. Sci. Nat.* registered (Biannually)
Operation	*In situ*	Throughout the operation phase	ECO	ECO (Monthly)
	laboratory water quality	Throughout the operation phase	ECO	Qualified aquatic /wetland specialist - *Pr. Sci. Nat.* registered (Biannually)
	Aquatic and wetland Biomonitoring regime	Throughout the operation phase	ECO	Qualified aquatic /wetland specialist - *Pr. Sci. Nat.* registered (Biannually)

10. Monitoring Plan

10.1. Monitoring Parameters

- Water Quality *in situ* measurements (pH, electrical conductivity, total dissolved solids, turbidity and temperature).
- Major ions (calcium, chloride, magnesium, potassium, sodium, sulphate and alkalinity).
- Trace elements.
- Diatoms (Specific Pollution Index- SPI, Biological Diatom Index-BDI and % Pollution Tolerant Valves- %PTV).
- Aquatic macroinvertebrates (ASPT, MIRAI scores and ecological categories where and if applicable).

10.2. Monitoring Frequency

- *In situ* water quality measurements: weekly during construction and monthly during operation.
- Laboratory analysis: Bi-annually during the operation phase.
- Biomonitoring: Bi-annually biomonitoring of response metrics listed under the monitoring parameters during the construction and operational phases.

10.3. Monitoring Locations

- Biomonitoring locations will be selected during the EIA phase for the preferred alternative.
- The river/stream biomonitoring point should provide suitable habitat and flow requirements for invertebrate colonisation. Emphasis should be places on a consistent sampling effort between monitoring sites at comparable habitat units.

11. Plan of study for the EIA phase

An aquatic ecology survey will be undertaken to ascertain the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the rivers and wetlands located within the preferred alternative. The Scope of Work that will be encompassed to reach the objective is summarised and outlined below and the following information will be generated in the form of a detailed freshwater ecology report.

11.1. Rivers

Sites will be strategically chosen, and biomonitoring methodology will be applied to ascertain the PES of the associated systems. This assessment will involve the characterisation of the aquatic environment and related biota, as well as the generation of PES data with the use of the following response and driver metrics where applicable:

Response metrics:

- Aquatic macroinvertebrate assessment - using the South African Scoring System version 5 or SASS 5 (Dickens & Graham, 2002). In addition, the percentage of Ephemeroptera-Plecoptera-Trichoptera taxa (%EPT) will be determined.
- Fish community assessment – using the Fish Response Assessment Index (FRAI - Kleynhans, 2007).
- Diatom community assessment - collection according to Taylor *et al.* (2005) and analysis according to Lecointe *et al.* (1993).

Drivers:

- Habitat assessment – Invertebrate Habitat Assessment System (IHAS - McMillan, 1998) and Index of Habitat Integrity (IHI - Kleynhans, 1996).
- Water quality analysis - selected *in situ* variables (at all biomonitoring sites). These variables will include pH, conductivity, and Total Dissolved Solids (TDS).

11.2. Wetlands

- Wetland delineation and mapping (1:10 000) of wetlands associated with the preferred alternative for the proposed expansion of the Arnot Ash Disposal Facility, using DWAF (2005) methodology.
- Generation of PES and EIS data for the wetlands using Wet-EcoServices (Kotze *et al*., 2009) and Wet-Health (MacFarlane *et al*., 2009).
- Identification of current impacts, including point and non-point source impacts.

11.3. Deliverables

- An analysis of habitat biotopes, diatom-, macroinvertebrate- and fish community structures and *in situ* water quality where applicable.
- An analysis of the PES and EIS of relevant wetlands.
- A wetland delineation and application of relevant buffer zones to delineated wetlands.
- A detailed report on the status of the surface water ecology and wetlands.
- Identification of current impacts on rivers and wetland systems, including point and non-point source impacts.
- An impact assessment with regards to impacts of the proposed Arnot Ash Disposal Facility on the surrounding aquatic ecosystems.

11.4. Limitations/Assumptions

The following limitations and assumptions apply to the aquatic component of the study:

- The aquatic survey can only be carried out if sufficient rainfall has triggered a sufficient flow. Flow is essential for the river biomonitoring to be carried out.
- The study does not include quantitative data related to population dynamics of the aquatic biota.
- The wetland study will be carried out on a 1:10 000 scale.

12. Assumptions and Limitations

- A total assessment of all probable scenarios or circumstances that may exist for the study area was not undertaken. No assumptions should be made, unless opinions are specifically indicated and provided. Data presented in this document may not explain all possible conditions that may exist given the nature of the enquiry.
- The information presented in this document only has reference to the investigated study area(s) and cannot be applied to any other area without prior investigation.
- The risk assessment was limited to the spatial extent of wetlands on each alternative and within a 1km radius thereof. An assessment of residual wetland functionality may influence the extent of functional wetlands associated with each alternative and may thus influence the preference rating.
- The risk assessment focussed in the placement of the ash disposal facility footprint and a 1km radius thereof. The alternative alignments of associated linear infrastructure was not considered within this scoping assessment. The potential risk of linear infrastructure may outweigh the benefit of placing the facility on a smaller wetland footprint.
- The impact assessment was based on the desktop delineation of the study areas with a brief site inspection, carried out in May 2018. The scoping phase field assessment focussed on landscape features, the presence of surface water and obligate and facultative wetland plant species. ***The soil profile was not assessed during the scoping phase***.

13. Conclusion

Based on the available desktop information, WI and desktop delineation, it is recommended based on the presence and absence of wetland features that Alt2 should be assessed during the upcoming EIA Phase assessment. Alt2 indicated a lower extent of wetland areas within the primary (120 ha) study area (**Table 6-1**) and was therefore considered the preferred alternative in terms of wetland /aquatic ecology (**Table 13-1**). Furthermore, Alt2 is closer to the existing infrastructure. It follows that it will require linear infrastructure over a shorter distance and will decrease the number of possible contamination pathways compared to Alt1. Risks pertaining to linear infrastructure have not been considered within this scoping assessment.

Table 13-1: Summary of the Ranking for the two proposed alternatives

	Alternative 1	**Alternative 2**
Rank	Restricted	Preferable

14. References

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