APPENDIX D

SPECIALIST REPORTS

Appendix D1: Ecological Survey Report

Appendix D2: Heritage Survey Report

Appendix D3: Aquatic Specialists Reports

APPENDIX D1

ECOLOGICAL SURVEY REPORT

TERMS OF REFERENCE (Ecological)

- Undertake baseline survey (reconnaissance) and describe affected environment within the project footprint from a biodiversity perspective.
- Approach to include desktop study and site visits, as deemed necessary, to understand the affected environment and to adequately investigate and evaluate salient issues. Indigenous knowledge (i.e. targeted consultation) should also be regarded as a potential information resource.
- Take into consideration the provincial conservation goals and targets.
- Assess the current ecological status and the conservation priority within the project footprint and adjacent area (as deemed necessary). Provide a concise description of the importance of the affected area to biodiversity in terms of pattern and process, ecosystem goods and services, as appropriate.
- Undertake sensitivity study to identify protected and conservation-worthy species.
- Assess impacts to fauna and flora, associated with the project.
- Identify alternatives from a biodiversity perspective.
- Comply with specific requirements and guidelines of MTPA.
- Assess the impacts (direct, indirect and cumulative) in terms of their significance (using suitable evaluation criteria) and suggest suitable mitigation measures. In accordance with the mitigation hierarchy, negative impacts should be avoided, minimised, rehabilitated (or reinstated) or compensated for (i.e. offsets), whereas positive impacts should be enhanced. A risk-averse and cautious approach should be adopted under conditions of uncertainty.

PROPOSED KRIEL-MATLA ASH TRANSFER LINK

Ecological Assessment Report

NOVEMBER 2015

Prepared for: Eskom Holdings SOC Ltd

NEMAI CONSULTING

Environmental, Social and OHS Consultants

P.O. Box 1673
Sunninghill
2157

147 Bram Fisher Drive
Ferndale
2194

Tel: 011 781 1730
Fax: 011 781 1731
Email: info@nemai.co.za

Title and Approval Page

Project Name:	**Proposed Kriel-Matla Ash Transfer Link.**		
Report Title:	Ecological Assessment Report		
Authority Reference:	N/A		
Report Status:	Draft		
Client:	Eskom Holdings SOC Ltd		
Client Representative:	Deidre Herbst		
Prepared By:	Nemai Consulting C.C.		
NEMAI CONSULTING	011 781 1730 011 781 1731 ronaldp@nemai.co.za	147 Bram Fischer Drive 2194, Ferndale P.O. Box 1673 2157, Sunninghill	
Report Reference:	**10472**	R-PRO-REP|20151022	
Authorisation	Name	Signature	Date
Author:	Mr. Ronald Phamphe	[signature]	05/11/2015
Approved By:	Vanessa Stippel		
Author's Affiliations	**Professional Natural Scientist**: South African Council for Natural Scientific Professions	Ecological Science (400349/2)	
	Professional Member of South African Institute of Ecologists and Environmental Scientists		
	Professional Member: South African Association of Botanists.		

.

Executive Summary

Eskom Holdings SOC Ltd: Kriel Power Station has appointed Nemai Consulting as an Independent Environmental Consultant to undertake Environmental Impact Assessment process for the proposed Kriel-Matla ash transfer link. Kriel Power Station is a coal fired power station consisting of six units which produce a combined base load of 3 000 MW. The power station has a remaining operating life of 26 years and is scheduled to be decommissioned in 2039. To generate 3 000 MW of electricity coal is burnt by the boilers which produces ash as a waste product. The ash is then disposed of at the ash disposal facility.

Kriel Power Station Ash Dam will reach its maximum capacity in approximately June 2017 and Eskom is currently in the process of undertaking the environmental impact assessment process for a new Ash Dam. However, according to the latest schedule a new ash dam will only be commissioned in September 2020 and thus Kriel will not have sufficient capacity to deal with the ash generated between 2017 and 2020.

As an intermediate solution, Eskom has proposed the Kriel-Matla Ash Transfer Link which will involve the transferring of 100% of Kriel Power Station Ash to Matla Power Station Ash Dam as well as the return of all Kriel Ash Water from the Matla Power Station Ash Dam to Kriel Power Station for a period of approximately 3.5 - 4 years until the new Kriel Ash Dam is developed.

The proposed project involved the installation of four new ash pipelines from Kriel Distribution Box Pump House to Matla's Ash Dam. In addition, a new Booster Pump house will be constructed at Matla adjacent to the existing booster pump house to accommodate the three extra booster pumps and three Ash Water Return pipelines

A new barge at the Matla ash water return dam (final cut) accommodating three pumps and pipelines to this new booster pump house will also be required. The existing slurry pump house and substations at the Kriel Ash Dam may also require upgrades to effectively pump the ash slurry to the Matla ash dam.

An Ecological Assessment was undertaken as part of the Environmental Impact Assessment (EIA) process in order to assess the impacts that the proposed pipeline will have on the receiving environment.

The objective of this study was to identify sensitive species and their habitats along the corridor of proposed pipeline routes and this will be refered to in this entire report as the Study area. The current ecological status and conservation priority of vegetation on the site were assessed. Potential faunal habitats were investigated in the study area and all mammals, birds, reptiles and amphibians. Red data species (both fauna and flora) that are known to occur on site were investigated.

The study area falls within the grassland biome. The Grassland biome has a high biodiversity, ranked only below the Fynbos biome in terms of biodiversity in South Africa. It is found mainly on the high central plateau of South Africa, and the inland areas of KwaZulu-Natal and the Eastern Cape. Grasslands are dominated by a single layer of grasses. Trees are absent, except in a few localised habitats and geophytes are often abundant. Mucina and Rutherford (2006) classified the proposed pipeline as falling within the Eastern Highveld Grassland vegetation unit and this vegetation type is listed as endangered. According to the data from South African National Biodiversity Institute (SANBI), Eastern Highveld Grassland Threatened Terrestrial Ecosystem was recorded on the proposed pipeline route and this ecosystem type has a vulnerable status. Even though the vegetation type and threatened ecosystem is listed as endangered and vulnerable respectively, the study area has been highly transformed and disturbed due to ash dumps. According to the Mpumalanga Biodiversity Conservation Plan (2013), the study area falls within the "*Heavily Modified", "Moderately modified- Old lands"* and "*Other Natural Areas*" categories.

The infrastructure construction on or near the site have completely transformed the study area. Due to the displacement of indigenous vegetation, this area is totally transformed and do not resemble the species composition of natural vegetation. As to be expected is the species richness relatively low and consist of a high proportion of weedy and invasive species. This vegetation type also has no conservation value. The extent of this habitat unit was also identified using topographical maps of the area as well as *Google Earth* ® imagery.

During the field survey, no threatened species were observed on site but only one plant species of conservation concern was noted, namely *Hypoxis hemerocallidea* (Star flower/African potato)) and this species is listed as *Declining.* Even though most areas fall within the heavily modified and moderately modified with old lands, this species was recorded in areas designated as 'other natural areas'. It is recommended that prior to construction, this species must be rescued and relocated to a safer place with suitable survival and growth-enabling conditions and then following construction they can be re-established at the site.

Mammals are sensitive to disturbances and as such few were expected to occur on site. Only three mammal species were recorded on site during the field assessment, namely House rat, Cape Porcupine and Scrub Hare. This could be attributed to anthropogenic disturbances observed on site such as habitat transformation. The species recorded have a wide distribution range. No Red Data mammal species were recorded. Rats, such as alien House rats (*Rattus rattus*) are common within inhabited areas and transformed areas. The proposed pipeline replacement will have an insignificant impact on mammal conservation.

Conservation and planning tools were reviewed for relevancy in terms of the project area, and it was found that the study area did not contain or form part of any Important Bird & Biodiversity areas but two unprotected closest ones are situated approximately 32km away, namely Devon Grasslands IBA in the west and Amersfoort-Bethal-Carolina IBA in the east of the study area. An avifaunal study indicated that the drainage lines, stands of *Eucalyptus* trees and patches of grasslands should provide natural habitats for bird species, however no Red Data bird species were observed on the study site.

A numbers of bird species in South Africa have declined mainly due to massive habitat transformation and degradation as well as increased levels of human disturbances, extensive habitat transformation due to mining, industrial and commercial and agricultural activities. Human activity has transformed grasslands in South Africa to a point where few pristine examples exist. Factors such as increased pasture management (overgrazing), decrease in grassland management due to frequent fires and land-use alteration (urbanisation) also contribute in the decline of species. More intensive surveys conducted over longer periods over several seasons are required in order to ascertain the current status of the above-mentioned threatened bird species on and surrounding the site. Many avifaunal species are adaptable as they are habitat generalists and can therefore accommodate a certain degree of habitat degradation and transformation. Other species are extremely habitat specific and have to rely on certain habitat units for breeding, hunting or foraging and roosting. Habitat-specific species are sensitive to environmental change, with destruction of habitat being the leading cause of species decline worldwide. Due to high levels of habitat transformation, the site offers limited suitable habitat for any larger terrestrial birds as well as certain smaller raptor species.

An avifaunal study indicated that the drainage lines, stands of *Eucalyptus* trees and patches of grasslands should provide natural habitats for bird species, however no Red Data bird species were observed on the study site. *Eucalyptus* species were recorded along the route and although they are invader species, they have become important refuges for certain species of raptors. Large *Eucalyptus* trees are used by the migratory Lesser Kestrels for roosting purposes, although no known roost sites exist in the study area. One of the significant sensitive faunal habitats such as wetlands and or drainage lines, is believed to be suitable habitats for birds. Wetlands/rivers are of particular importance for birds in the study area and also essential breeding grounds for many threatened cranes and other waterbirds. The marshland vegetation of the pans and surrounding dense *Themeda triandra* grasslands offers favourable roosting and possible nesting habitat for African Grass Owls but the habitat fragmentation could be a deterrent. Areas with reeds, sedges or grassy tangles are suitable for Common Waxbills (*Estrilda astrilda*) and various warblers (Marais and Peacock, 2008). Plant species such as the Common Reed provides nesting and roosting sites for bird species. The patches of open grassland areas on site represent a significant feeding area for many bird species in the area. Several typical Red Data grassland species were recorded in the square grid by SABAP1. It is therefore highly unlikely that these species could occur in the grassland remaining on the site due to mining activities taking place. The Blue Crane (*Anthropoides paradisea*) and African Grass-Owl (*Tyto capensis*) are amongst the RDL species recorded from the area that readily utilize this habitat unit. Factors such as habitat loss and fragmentation are responsible for the decline in Grass owl population. Frequent burning of habitat can cause major impacts due to reduced or affected foraging, roosting, and nesting sites. Non-threatened species that may from time to time frequent the grassland habitat in the study area are Swainson's Spurfowl (*Pternistis swainsonii*), African Pipit (*Anthus cinnamomeus*), Cape Longclaw (*Macronyx capensis*), several cisticola species, Long-tailed Widowbird (*Euplectes progne*), Rufous-naped Lark (*Mirafra africana*), and Black-shouldered Kite (*Elanus caeruleus*). Open grasslands not associated with wetland habitat also form an important habitat unit to support diversity that also include various RDL species. Bird species recorded (19) during the field survey were common and widespread and no Red Data bird species were observed on the study site.

Large areas surrounding the two Power Stations have resulted in increased habitat modification and transformation as well as increased human presence and associated disturbances (illegal reptile collecting, indiscriminate killing of all snake species, frequent fires) surrounding the site coupled with increased habitat destruction and disturbances on the neighbouring properties are all causal factors in the alteration and disappearance of reptile diversity in the area. Only one reptile species was noted on site, this being the Montane Speckled Skink (*Trachylepis punctatissima*). This species is found in a variety of habitats, wet and dry, from grassland and savanna to shrubland, including rock outcrops. It is not considered to be of significant importance from a conservation perspective.

Termite mounds were present on the study area. Some large mounds had been damaged by previous foraging by Antbears. This resulted in the exposing of tunnels into the interior of the termite mound. Old termite mounds offer important refuges especially during veld fires as well as cold winter months for numerous frog, lizard, snake and smaller mammal species. Large number of species of mammal, birds, reptiles and amphibians feed on the emerging alates (winged termites). No termite mounds were destroyed during the brief field survey.

The wetlands and canals on or near the route are probably important breeding habitat for most of the frog species which could occur at the site. During the field assessment, one frog species was noted on site, namely Queckett's River Frog (*Amietia queckettí*). It is a common species found on the banks of slow-flowing streams or other permanent bodies of water in a wide range of wetland habitats in grassland, savannah and forest fringe. It frequently inhabits garden ponds and water features.

From a broad and preliminary evaluation of the study area, it is evident that the proposed Ash transfer link will have minimal impacts on the receviing environment. Two alternative pipeline crossings were considered, and there is no ecological preference between the alternatives as they cross the similar habitats. From an ecological perspective, the proposed route 2 is not preferred due to its close proximity to a wetland. The proposed development should proceed subject to the above, and mitigation measures must be employed to minimise potential impacts from the project.

Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1 BACKGROUND AND INTRODUCTION

Eskom SOC Holdings: Kriel Power Station has appointed Nemai Consulting as an Independent Environmental Consultant to undertake Environmental process for the proposed Kriel-Matla ash transfer link. Kriel Power Station is a coal fired power station consisting of six units which produce a combined base load of 3 000 MW. The power station has a remaining operating life of 26 years and is scheduled to be decommissioned in 2039. To generate 3 000 MW of electricity coal is burnt by the boilers which produces ash as a waste product. The ash is then disposed of at the ash disposal facility.

Kriel Power Station Ash Dam will reach its maximum capacity in approximately June 2017 and Eskom is currently in the process of undertaking the environmental impact assessment process for a new Ash Dam. However, according to the latest schedule a new ash dam will only be commissioned in September 2020 and thus Kriel will not have sufficient capacity to deal with the ash generated between 2017 and 2020.

As an intermediate solution, Eskom has proposed the Kriel-Matla Ash Transfer Link which will involve the transferring of 100% of Kriel Power Station Ash to Matla Power Station Ash Dam as well as the return of all Kriel Ash Water from the Matla Power Station Ash Dam to Kriel Power Station for a period of approximately 3.5 - 4 years until the new Kriel Ash Dam is developed.

The proposed project involved the installation of four new ash pipelines from Kriel Distribution Box Pump House to Matla's Ash Dam. In addition, a new Booster Pump house will be constructed at Matla adjacent to the existing booster pump house to accommodate the three extra booster pumps and three Ash Water Return pipelines

A new barge at the Matla ash water return dam (final cut) accommodating three pumps and pipelines to this new booster pump house will also be required.

An Ecological Assessment was undertaken as part of the Environmental Impact Assessment (EIA) process in order to assess the impacts that the proposed pipelines will have on the receiving environment.

The objective of this study was to identify sensitive species and their habitats along the proposed pipeline route. The current ecological status and conservation priority of vegetation on the site were assessed. Potential faunal habitats were investigated in the study area and all mammals, birds, reptiles and amphibians known to occur on site or seen on site were recorded. Red data species (both fauna and flora) that are known to occur on site were investigated.

1.1 Objectives of the survey

In order to achieve the aim stated above, the following objectives are to be achieved:

- To apply relevant literature to determine the diversity and eco-status of the plants, mammals, birds, reptiles and amphibians along the proposed pipeline route;
- To carry out a field surveys to gain an understanding of the diversity and eco-status of taxa which inhabit the proposed study area, as well as the presence of unique habitats that might require further investigation or protection;
- To assess the current habitat and conservation status of plant and animal species on the study site;
- To comment on ecological sensitive species/areas;
- To assess the possible impact of the proposed project on these taxa and/or habitats;
- To list the species on site and to recommend necessary actions in case of occurrence of endangered, vulnerable or rare species or any species of conservation importance; and
- To provide management recommendations to mitigate negative and enhance positive impacts along the proposed pipeline route.

2 RELEVANT LEGISLATION AND GUIDELINES

The following pieces of legislation are relevant to this project:

- The Constitution, 1996 (Act 108 of 1996) – Section 24;
- Environment and Conservation Act 1989 (Act No. 73 of 1989);
- Conservation of Agricultural Resources Act 1983 (Act No. 43 of 1983);
- The white paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (1997);

- National Environmental Management Act 1998 (Act No. 107 of 1998);
- National Environmental Management Biodiversity Act 2004 (Act No. 10 of 2004);
- Mpumalanga Tourism and Parks Agency requirements for assessing and mitigating Environmental Impacts of development applications and
- Mpumalanga Biodiversity Sector Plan, 2013.

3 STUDY AREA

The two power stations, Kriel and Matla fall within the Emalahleni Local Municipality (ELM) and the Nkangala District Municipality (NDM) in Mpumalanga Province (**Figures 1 & 2**). They are situated between the towns of Bethal and Ogies on the R545 road. Kriel Power Station is situated on various portions of the farms Kriel Power Station 65 IS, Driefontein 69 IS, Vaalpan 68 IS and Onverwacht 70 IS whilst Matla Power Station is found on portions of the farms Matla Power station 141 IS, Driefontein 69 IS, Bakenlaagte 84 IS and Vlaklaagte 83 IS.

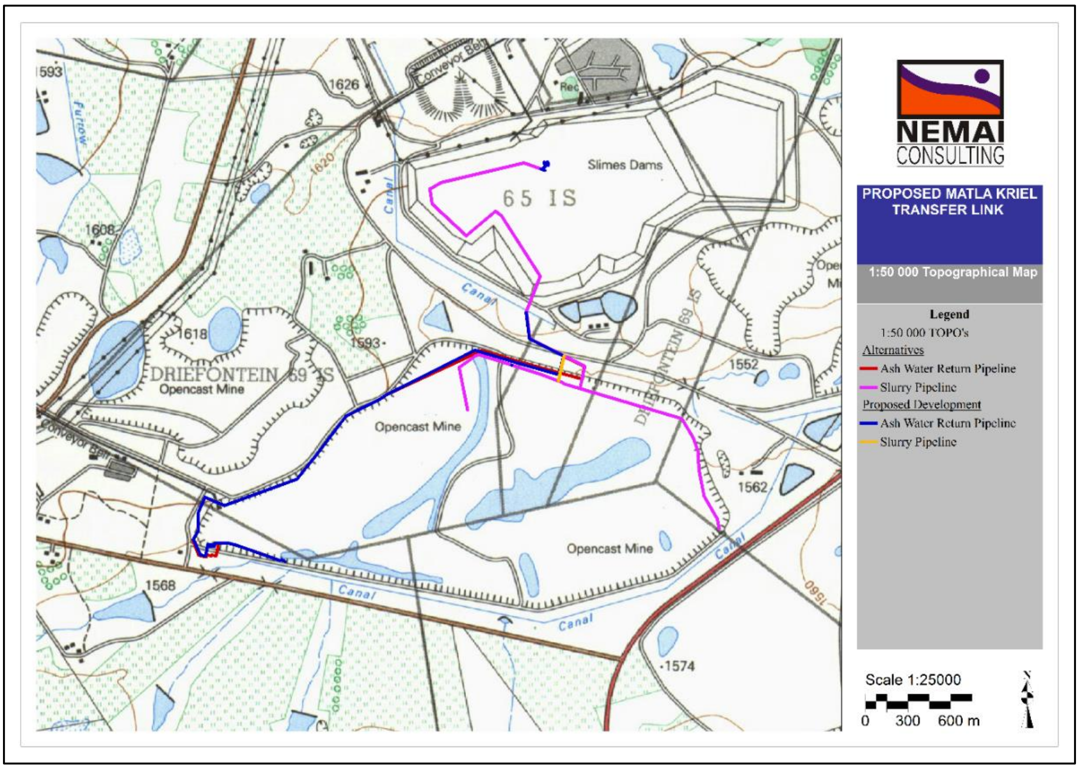


Figure 1: Locality Map

Figure 2: Google Earth Map of proposed development.

3.1 <u>Pipeline alternatives</u>

Two pipeline routes were considered for this project, namely Alternative Ash Water Return Pipeline and Alternative Slurry Pipeline.

3.1.1 Alternative Route 1 (Figure 3)

The proposed route is crossing under Mine haul road using pipe sleeves and crossing of two natural watercourses with pipe gantries. This crossing is at least 150m further from crossing alternative 2 which is deemed as too close to a wetland.

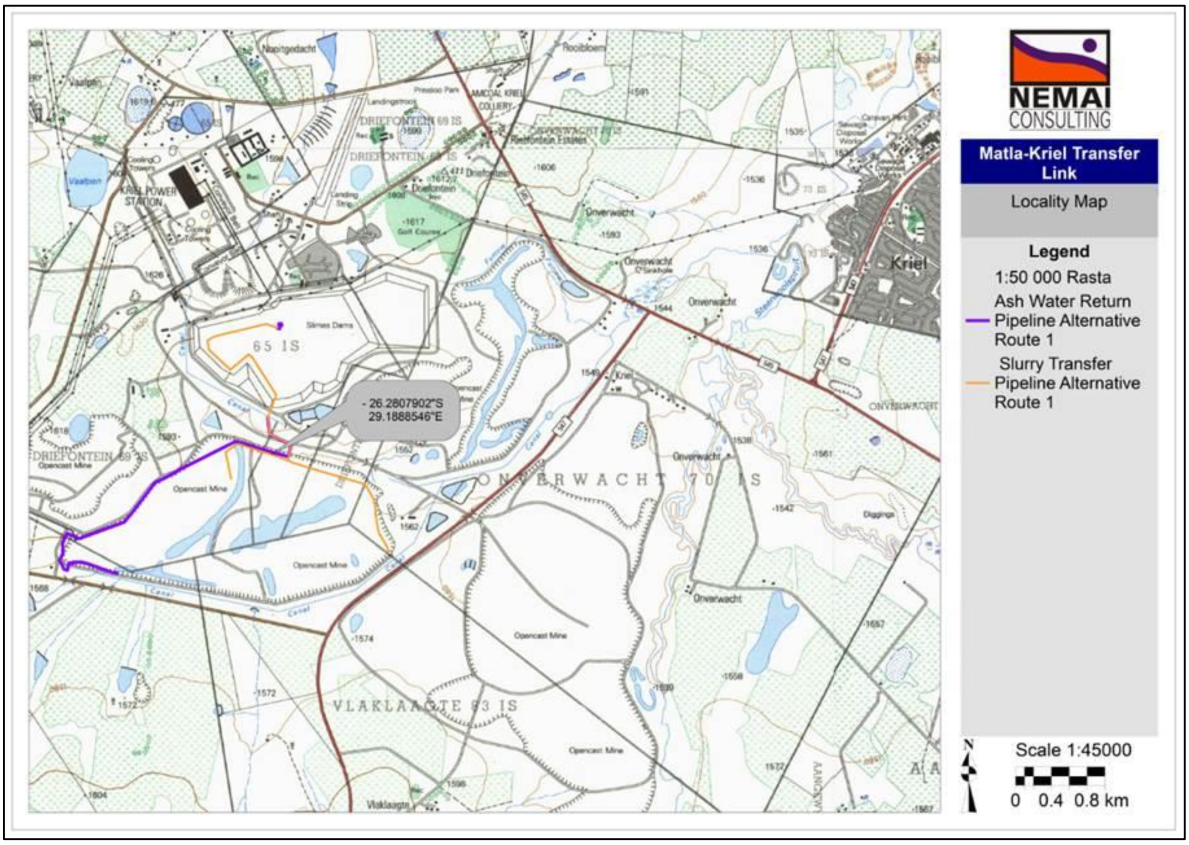


Figure 3: Alternative Route 1

3.1.2 Alternative Route 2 (Figure 4):

This alternative route is crossing under Mine haul road using pipe sleeves and crossing of two natural watercourses with pipe gantries. Same concept as alternative 1 however longer gantry structures will be required due to wider watercourses.

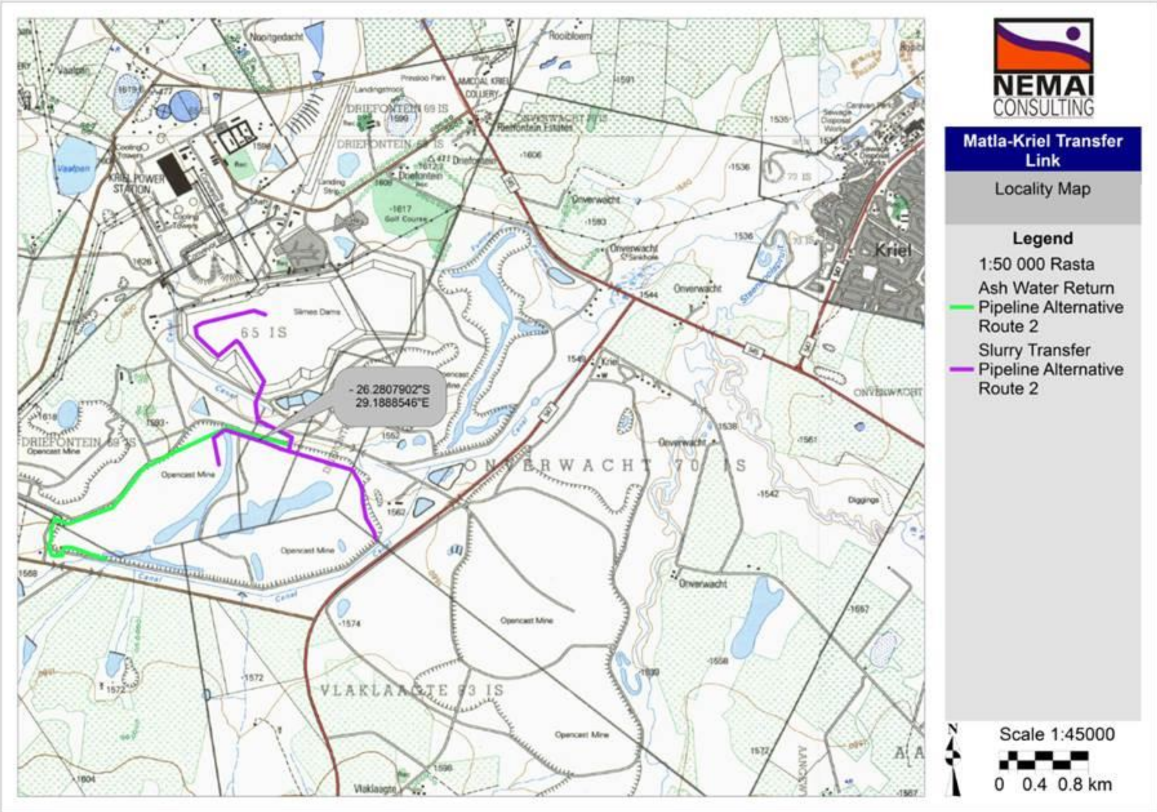


Figure 4: Alternative Route 2

4 MPUMALANGA BIODIVERSITY SECTOR PLAN-TERRESTRIAL CRITICAL BIODIVERSITY AREAS

A regional conservation plan was produced by the Mpumalanga Tourism and Parks Agency (MTPA). This plan indicated several areas requiring some level of conservation within the strategic premise to either systematically include these areas into conservation areas or to protect these areas from irresponsible development. The Mpumalanga Biodiversity Sector Plan has divided the distribution of the Province's biodiversity into the following 9 categories in the table below (**Table 1**) (MTPA, 2013). The proposed pipelines falls within the "*Heavily Modified", "Moderately modified- Old lands"* and "*Other Natural Areas*" categories (**Figure 5**).

Table 1. MBCP Categories (MTPA, 2013)

Category		Description
1	Protected areas	These are protected areas that were used to meet biodiversity targets in MBSP 2013.
2	Critical Biodiversity	This category comprises areas considered critical for meeting biodiversity targets and thresholds, and which are required to ensure the persistence

Category		Description
	Area: Irreplaceable	and of species and the functioning of ecosystems. Such biodiversity or landscape facets is usually at risk of being lost due to the remaining distribution being below target. For example, only known sites for certain threatened species, or areas of high connectivity value which have high risk of having connectivity disrupted (i.e. critical corridor linkages in the landscape).
3	Critical Biodiversity Area: Optimal	The CBA Optimal Areas, previously referred to as Important & Necessary in MBCPv1, are the best localities out of a larger selection of available PUs as they are optimally located to meet both the various biodiversity targets and the criteria defined by either the Marxan design or cost layers. These areas have a irreplaceability (or frequency selection score) of less than 80%. In Marxan, this is categorised as the “Best” solution and is essentially the most efficient and thus optimal solution to meet all biodiversity conservation targets while avoiding high cost areas as much as possible.
4	Ecological Support Area: Landscape-scale corridors	These corridors represent the ideal or best route option to support existing biodiversity and allow them to adapt to the impacts of climate change. The functionality of these corridors to support biodiversity connectivity needs to be maintained.
5	Ecological Support Area: Local-scale corridors	These are fine scale connectivity pathways that contribute to connectivity between climate change focal areas. They represent alternative pathways for movement, and thus lessen the effect of critical linkages and provide networks that are more robust to disturbance. The ecological functionality of these corridors to support biodiversity connectivity needs to be maintained.
6	Ecological Support Area: Species Specific	These are areas required for the persistence of specific species. Although these areas are frequently transformed, a change in current land use, to anything other than rehabilitated land, would most likely result in a loss of that feature from the area identified. Only one area, an important over-wintering site for Blue Crane shared with Gauteng, and which comprises a matrix of natural and cultivated lands, was identified by expert opinion.
7	Ecological Support Area: Protected Area buffers	These are areas around our Protected Areas where changes in land-use may affect the ecological functioning or tourism potential of the PAs. The purpose of buffer zones is to mediate the impacts of undesirable land-uses that have a negative effect on the environment. This zone also offers tourism opportunities. Changes in land use usually have either direct impacts, such as cultivating virgin land, or both direct and indirect impacts, such as light and noise pollution in addition to a change in land cover. The nature of the impacts needs to be assessed and appropriate land-uses supported. The buffer distances applied, include: • National Parks: National biodiversity and tourism asset. A 10 km buffer applied as indicated in Listing Notice 3. Undesirable land-uses must be avoided. • Protected Areas (Nature Reserves): Nature reserves have both biodiversity and tourism value, and any undesirable changes in land-use should be avoided. A 5 km buffer distance has been applied around nature reserves as indicated in Listing Notice 3. • Protected Environments: Usually production landscapes with biodiversity friendly management. Management plans in place for improvement of biodiversity. A 1 km buffer is applied around Protected Environments.

Category		Description
8	Other Natural Areas (ONA)	Natural areas which are not identified to meet biodiversity pattern or process targets, provided that CBAs or ESAs are not lost. ONA will most likely provide a range of ecosystem services from their ecological infrastructure in varying efficiency and effectiveness. Although these areas are not essential for ensuring the persistence of biodiversity or landscape targets, they are still important repositories of species and play an important role in society as ecological infrastructure. They are however, not prioritized for immediate conservation action.
9	Heavily Modified	Includes areas currently transformed where biodiversity and ecological function has been lost to the point that it is not worth considering for conservation at all.
10	Moderately Modified – Old Lands:	Includes areas which were modified within the last 80 years but were at some point abandoned, including old mines and old cultivated lands, collectively termed "old Lands". They are areas where biodiversity and function have been seriously compromised in the past, but may still play an important role in the provisioning of ecosystem services.

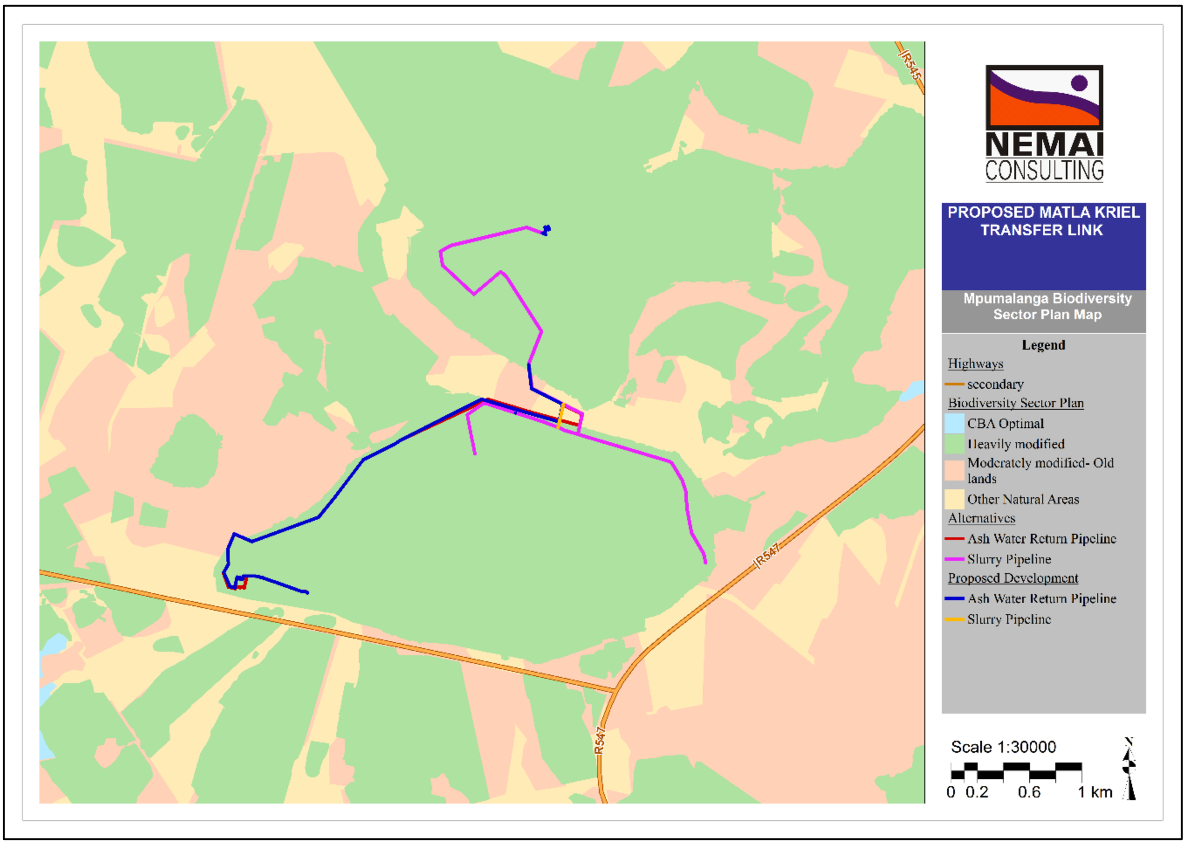


Figure 5. Mpumalanga Biodiversity Sector Plan Map in relation to the proposed development site

5 LIMITATIONS AND GAPS

The constraints or limitations to the survey included:

- Since environmental impact studies deal with dynamic natural systems additional information may come to light at a later stage and Nemai Consulting can thus not accept responsibility for conclusions and mitigation measures made in good faith based information gathered or databases consulted at the time of the investigation.

6 REGIONAL VEGETATION

The study area falls within the Grassland biome (Rutherford and Westfall, 1994) (**Figure 6**). The Grassland Biome is found mainly on the high central plateau of South Africa, and the inland areas of KwaZulu-Natal and the Eastern Cape. Grasslands are dominated by a single layer of grasses. Trees are absent, except in a few localised habitats and geophytes are often abundant (Low and Rebelo, 1996). Mucina and Rutherford (2006) classified the proposed pipeline as falling within the Eastern Highveld Grassland vegetation type unit, as indicated in **Figure 7** below.

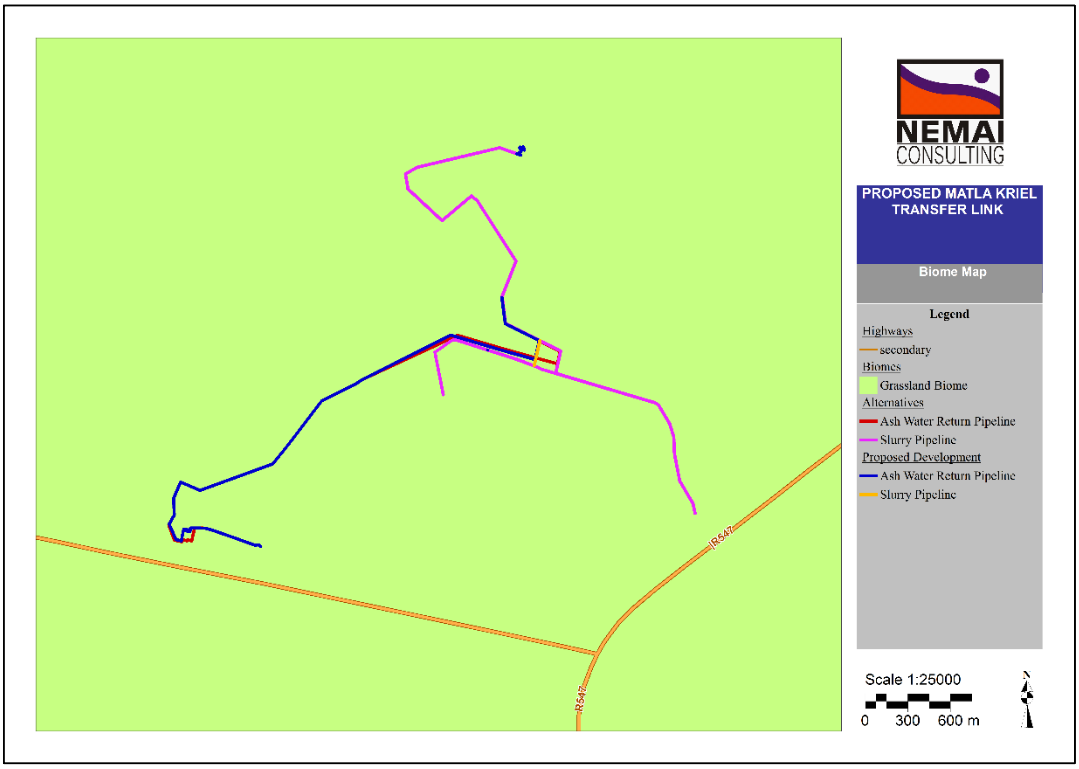


Figure 6. Biome in relation to the proposed development site

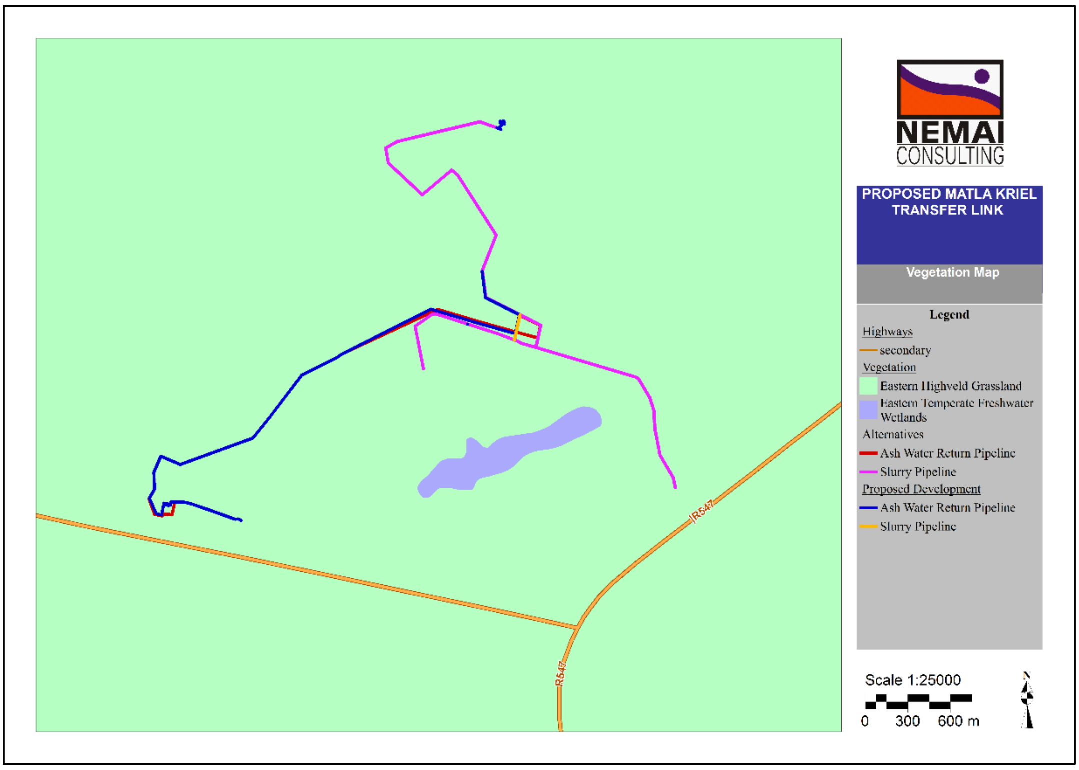


Figure 7. Vegetation type occurring in the study area

The description of the vegetation type follows below:

6.1 Eastern Highveld Grassland

The Eastern Highveld Grassland is recorded on the plains between Belfast in the east and the eastern side of Johannesburg in the west, extending southwards to Bethal, Ermelo and west of Piet Retief within the Mpumalanga and Gauteng Provinces of South Africa. This Grassland is found on slightly to moderately undulating plains, including some low hills and pan depressions and consist of short, dense grassland, dominated by the usual highveld grass composition (*Aristida, Digitaria, Eragrostis, Themeda, Tristachya etc*) with small, scattered rocky outcrops with wiry, sour grasses and some woody species. Woody species include *Acacia caffra, Celtis africana, Diospyros lycioides* subsp*. lycioides, Parinari capensis, Protea caffra* and *Rhus magalismontana* (Mucina and Rutherford, 2006).

Conservation Status

The conservation status is described as **Endangered** with a conservation target of 24%. Approximately 44% of the Eastern Highveld Grassland has been transformed, primarily by cultivation, plantations, mining, urbanization and building of dams. Erosion is very low and no serious alien infestation is reported, although species such as *Acacia mearnsii* can become dominant in disturbed places (Mucina and Rutherford, 2006).

7 TERRESTRIAL THREATENED ECOSYSTEMS

The South African National Biodiversity Institute (SANBI), in conjunction with the Department of Environmental Affairs (DEA), released a draft report in 2009 entitled “Threatened Ecosystems in South Africa: Descriptions and Maps”, to provide background information on the above List of Threatened Ecosystems (SANBI, 2009). The purpose of this report was to present a detailed description of each of South Africa’s ecosystems and to determine their status using a credible and practical set of criteria. The following criteria were used in determining the status of threatened ecosystems:

- Irreversible loss of natural habitat;
- Ecosystem degradation and loss of integrity;

- Limited extent and imminent threat;
- Threatened plant species associations;
- Threatened animal species associations; and
- Priority areas for meeting explicit biodiversity targets as defined in a systematic conservation plan.

In terms of section 52(1) (a), of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004), a national list of ecosystems that are threatened and in need of protection was gazetted on 9 December 2011 (Government Notice 1002 (Driver *et. Al*, 2004). The list classified all threatened or protected ecosystems in South Africa in terms of four categories; Critically Endangered (CR), Endangered (EN), Vulnerable (VU), or Protected. The purpose of categorising these ecosystems is to prioritise conservation areas in order to reduce the rates of ecosystem and species extinction, as well as preventing further degradation and loss of structure, function, and composition of these ecosystems. It is estimated that threatened ecosystems make up 9.5% of South Africa, with critically endangered and endangered ecosystems accounting for 2.7%, and vulnerable ecosystems 6.8% of the land area. It is therefore vital that Threatened Terrestrial Ecosystems inform proactive and reactive conservation and planning tools, such as Biodiversity Sector Plans, municipal Strategic Environmental Assessments (SEAs) and Environmental Management Frameworks (EMFs), Environmental Impact Assessments (EIAs) and other environmental applications (Mucina *et al*., 2006).

According to the data from South African National Biodiversity Institute, one Threatened Terrestrial Ecosystem is recorded on site, namely the Eastern Highveld Grassland also shown in **Figure 8**. This threatened ecosystem is listed as *Vulnerable* (Mucina *et al.,* 2006).

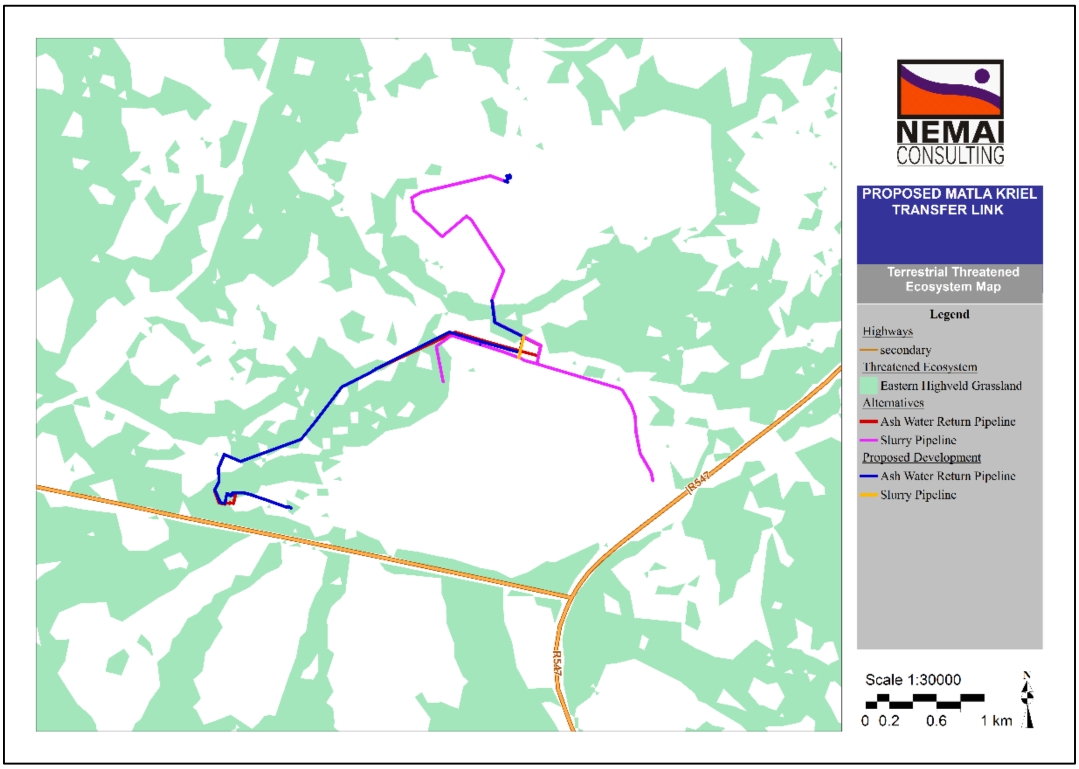


Figure 8. Terrestrial Threatened Ecosystem occurring on the proposed development site.

8 METHODOLOGY

The White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (1997) and the National Environmental Management Act 1998 (Act No 107 of 1998) specify that due care must be taken to conserve and avoid negative impacts on biodiversity, as well as the sustainable, equitable and efficient use of biological resources.

8.1 Flora

The flora assessment consisted of two complementary approaches:

- A desktop analysis, which included literature review, topographical maps, and Google Earth imagery; and
- A site visit was conducted in October 2015.

Satellite imagery of the area was obtained from Google Earth and was studied in order to acquire a three dimensional impression of the topography and land use and also to identify potential "hot-spots" or specialized habitats such as rivers on or near the proposed pipeline route.

The Pretoria Computerised Information System (PRECIS) list of Red Data plants recorded in the 2629AC quarter degree grid square was obtained from SANBI. The list was consulted to verify the record of occurrence of the plant species seen in the vicinity of the proposed pipeline route. The site sampled is also only a very small portion of the whole grid and so habitats suitable for certain species in the PRECIS list may not be present at the areas sampled. The vegetation map published in Mucina and Rutherford (2006) was consulted to identify vegetation units that are found in the study area. The desktop component of the study of the habitats of the red-data-listed plants was conducted before the site visit.

The habitats on the proposed development site were inspected in a random zigzag fashion, paying particular attention to areas that at first sight appeared to be sensitive. All general observations were noted such as grasses, herbs (forbs), shrubs and trees. The habitats suitable for Red Data listed species known to occur in the quarter degree grid square were examined intensively for the presence of such species. Attention was also paid to the occurrence of medicinal, alien and declared weed species. Field guides such as van Wyk *et al.,* (1997), Pooley (1998), van Oudshoorn (1999) and Manning (2009) were utilised during the field work.

Exotic and invasive plant species were categorised according to the framework laid out by The Conservation of Agricultural Resources Act (CARA) (Act 43 of 1983). CARA defines weeds as alien plants, with no known useful economic purpose that should be eradicated. Invader plants, also considered by the Act, can also be of alien origin but may serve useful purposes as ornamental plants, as sources of timber, or other benefits such as medicinal uses (Henderson, 2001). These plants need to be managed and prevented from spreading.

Invasive species are controlled by the National Environmental Management: Biodiversity Act, 2004 (Act no. 10 of 2004) - Alien and Invasive Species (AIS) Regulations which became law on 1 October 2014. The AIS Regulations list four (4) different categories of invasive species that must be managed, controlled or eradicated from areas where they may cause harm to the environment, or that are prohibited to be brought into South Africa.

Invasive plant species are divided into four categories:

- Category 1a: Invasive species which must be combatted and eradicated. Any form of trade or planting is strictly prohibited.

- Category 1b: Invasive species which must be controlled and wherever possible, removed and destroyed. Any form or trade or planting is strictly prohibited.

- Category 2: Invasive species, or species deemed to be potentially invasive, in which a permit is required to carry out a restricted activity. Category 2 species include commercially important species such as pine, wattle and gum trees.

- Category 3: Invasive species which may remain in prescribed areas or provinces. Further planting, propagation or trade, is however prohibited.

According to van Oudtshoorn (1999), a grass species reacts to grazing in one of two ways: it can either become more or less abundant. **Table 2** describes the classification of grasses.

Table 2. Classification of grasses (van Oudtshoorn, 1999).

Class	Description	Examples
Decreasers	Grasses that are abundant in good veld, but that decrease in number when the veld is overgrazed or undergrazed.	*Themeda trianda, Digitaria eriantha*
Increaser 1	Grasses that are abundant in underutilised veld. These grasses are usually unpalatable, robust climax species that grow without any defoliation	*Hyperthelia dissoluta, Trachypogon spicatus*
Increaser 2	Grasses that are abundant in overgrazed veld. These grasses increase due to the disturbing effect of overgrazing and include mostly pioneer and subclimax species	*Aristida adscensionis, Eragrostis rigidor*
Increaser 3	Grasses that are commonly found in overgrazed veld. These are usually unpalatable, dense climax grasses	*Sporobolus africanus, Elionurus muticus*
Invaders	All plants that are not indigenous to an area. These plants are mostly pioneer plants and are difficult to eradicate	*Arundo donax*

8.2 <u>Mammals</u>

Mammal site visit was conducted in October 2015 and during this visit, the observed and presence of mammals associated with the recognized habitat types of the study site were recorded during the day. No night surveys were undertaken. Adjoining properties were also scanned for important faunal habitats. During the site visit, mammals were identified by spoor, burrow and visual sightings through random transect walks.

8.3 <u>Avifauna</u>

Avifauna site visits were conducted in October 2015 in order to record the presence of bird species associated with the habitat systems on the studied site and to identify possible sensitive areas. The study site was surveyed on foot and any bird species seen or heard were recorded. Adjoining properties were also scanned for important bird species and/or habitats. Birds were identified visually using 10X42 Bushnell Waterproof binoculars where necessary, by call and from feathers. Where necessary, identifications were verified using Sasol Birds of Southern Africa (Sinclair *et al.,* 2002) and the Chamberlain Guide to Birding Gauteng (Marais and Peacock, 2008).

8.4 Reptiles

The reptile assessments were conducted in October 2015 and this was during the day. During the field visit, the observed and derived presence of reptiles associated with the recognised habitat types of the study site was recorded. This was done with due regard to the known distributions of Southern African reptiles. Reptiles were identified by sightings during random transect walks. Possible burrows or other reptile retreats were inspected for any inhabitants.

8.5 Amphibians

According to Carruthers (2001), amphibians are extremely sensitive to habitat transformation and degradation. The adjoining properties were scanned for important amphibian habitats. Amphibians were identified by their vocalisations. A CD with frog calls by Du Preez and Carruthers (2009) was used to identify species by their calls when applicable. Sites were walked, covering as many habitats as possible.

9 RESULTS AND DISCUSSION

9.1 Flora

9.1.1 Desktop study results

The proposed sites are located within the 2629AC quarter degree square in terms of the 1:50 000 grid of South Africa. SANBI used this grid system as a point of reference to determine any Red Data plant species or any species of conservation importance occurring in South Africa. This can be used to determine the list of species which could potentially occur within an area. **Tables 3 & 4** provide details on the Red Data plant species which have been recorded in 2629AC grid cell. The definitions of the conservation status are provided in **Table 5**. Due to the fact that threatened species have been historically noted in the region as mentioned in **Table 3**, it is imperative, during the construction phase, that detailed searches for these rare/threatened and protected species are made during the appropriate time of year when plants are likely to be more visible.

Table 3. Floral species of conservational significance recorded from the QDS of 2629AC

Family	Species	Threat status	SA Endemic	Growth forms
Amaryllidaceae	*Boophone disticha* (L.f.) Herb.	Declining	No	Geophyte, succulent
Amaryllidaceae	*Crinum bulbispermum* (Burm.f.) Milne-Redh. & Schweick.	Declining	No	Geophyte, hydrophyte
Asphodelaceae	*Kniphofia typhoides* Codd	NT	No	Herb, succulent

Table 4. Farm Names where the Red Data Plant species were recorded, which could potentially occur in the study area (MTPA data).

Farm Name	Scientific Name	Conservation RSA	Conservation MTPA
Blesbokspruit 90 IS	*Gladiolus robertsoniae*	NT	NT
Frischgewaagd 87 IS	*Kniphofia typhoides*	NT	NT
Holfontein 138 IS	*Boophane disticha*	Declining	Declining
Kwaggaslaagte 91 IS	*Gladiolus robertsoniae*	NT	NT
Zondagsfontein 124 IS	*Kniphofia typhoides*	NT	NT

Table 5. Definitions of Red Data status (Raimondo et al. 1999)

Symbol	Status	Description
NT	Near Threatened	A taxon is Near Threatened when available evidence indicates that it nearly meets any of the five IUCN criteria for Vulnerable, and is therefore likely to qualify for a threatened category in the near future.
	Declining	A taxon is Declining when it does not meet any of the five IUCN criteria and does not qualify for the categories Critically Endangered, Endangered, Vulnerable or Near Threatened, but there are threatening processes causing a continuing decline in the population.

9.1.2 Plant species recorded in the proposed construction of pipeline

The infrastructure construction on or near the two Power Stations have completely transformed the study area. Due to the displacement of indigenous vegetation, this area is totally transformed and do not resemble the species composition of natural vegetation. As to be expected is the species richness relatively low and consist of a high proportion of weedy and invasive species. This vegetation type also has no conservation value. The extent of this habitat unit was also identified using topographical maps of the area as well as *Google Earth* ® imagery. All of the species recorded along the proposed pipeline route area are listed in **Table 6** below.

Table 6. Plant species recorded in the proposed pipeline route

Scientific name	Common name	Ecological status	Form
Acacia mearnsii	Black Wattle	Category 2	Tree
Alternanthera pungens	Khakhiweed	Weed	Herb
Argemone ochroleuca subsp. *ochroleuca*	White-flowered Mexican poppy	Category 1b	Herb
Berkheya setifera	Buffalo-tongue Berkheya	Medicinal	Herb
Bidens pilosa	Common Black-jack	Weed	Herb
Campuloclinium macrocephalum	Pom pom weed	Category 1b	Herb
Canna indica	Indian shot	Category 1b	Herb
Cirsium vulgare	Scotch Thistle	Category 1b	Herb
Conyza bonariensis		Weed	Herb
Cortaderia selloana		Category 1b	Grass
Cynodon dactylon	Couch Grass	Increaser 2	Grass
Cyperus sp.			Sedge
Cyperus esculentus	Yellow Nut Sedge	Medicinal	Sedge
Cyperus longus	Waterbiesie	Medicinal	Sedge
Datura ferox	Large thorn apple	Category 1b	Shrub
Datura stramonium	Common thorn apple	Category 1b	Shrub
Digitaria eriantha	Common Finger Grass	Decreaser	Grass
Eucalyptus camaldulensis	River Red Gum	Invader 2	Tree
Eragrostis gummiflua	Gum Grass	Increaser 2	Grass
Gomphocarpus fruticosus			Herb
Gomphrena celosioides	Prostrate globe amaranth	Exotic	Herb
Hibiscus trionum	Bladder Hibiscus	Medicinal	Herb
Hyparrhenia hirta	Common Thatching Grass	Increaser 1	Grass
Hypochaeris radicata	Hairy wild lettuce/Spotted cat's ear	Weed	Herb
Hypoxis hemerocallidea	Star-Flower/African Potato	Medicinal	Herb
Imperata cylindrica	Cottonwool grass	Increaser 1	Grass
Leonotis leonurus	Wild Dagga	Medicinal	Herb
Melia azedarach	Persian Lilac/Syringa	Category 1b	Tree
Melinis repens	Natal Red Top	Increaser 2	Grass
Oxalis obliquifolia	Oblique-leaved sorrel		Herb
Panicum maximum	Guinea Grass	Decreaser	Grass
Plantago major	Broadleaved Ribwort	Weed/Medicinal	Herb
Paspalum dilatatum	Dallis grass	Exotic	Grass
Persicaria lapathifolia	Spotted knotweed	Exotic	Herb
Phragmites australis	Common reed	Thatching	Reed
Prunus persica	Peach tree	Exotic	Tree
Pseudognaphalium luteo-album	Jersey Cudweed	Medicinal	Herb
Richardia brasiliensis	Mexican richardia	Exotic	Herb
Robinia pseudoacacia	Black locust	Invader 2	Tree
Salix babylonica	Weeping Willow	Invader 2	Tree

Scientific name	Common name	Ecological status	Form
Schoenoplectus corymbosus			Sedge
Searsia lancea	Karee		Tree
Setaria sphacelata var. sphacelata	Common Bristle Grass	Decreaser	Grass
Sida cordifolia		Medicinal	Herb
Sonchus asper	Spiny sowthistle	Weed	Shrub
Solanum mauritianum	Bugweed	Category 1b	Shrub
Sporobolus africanus	Ratstail Dropseed	Increaser 3	Grass
Striga bilabiata	Small Witchweed		Heb
Stoebe vulgaris (Seriphium plumosum)	Bankruptbush		Herb
Tagetes minuta	Tall Khaki Weed	Weed	Herb
Themeda triandra	Red Grass	Decreaser	Grass
Typha capensis	Bulrush		Aquatic herb
Verbena bonariensis	Tall Verbena	Weed	Shrub
Verbena brasiliensis		Weed	Herb
Xysmalobium undulatum	Milk bush	Medicinal	Herb

9.1.3 Alien invasive species recorded in the proposed development site

Alien invader plants are species that are of exotic, non-native or of foreign origin that typically invade undeveloped or disturbed areas. Invaders are a threat to our ecosystem because by nature they grow fast, reproduce quickly and have high dispersal ability (Henderson, 2001). This means that invader plants and seeds spread rapidly and compete for the growing space of our own indigenous plants. If these invader plants out-compete indigenous plants there is a shift in the species composition of the area and the changing our plant communities causes a decline in species richness and biodiversity (Henderson, 2001). Many factors allow alien invasive plants to succeed, particularly the absence of their natural enemies. This makes it difficult to control invasive plants without bringing in natural enemies and eliminating the high competition they have over the indigenous vegetation (Bromilow, 2010). Alien invasive plant species within the study area were observed to occur in clumps, scattered distributions or as single individuals on site. Invader and weed species must be controlled to prevent further infestation and it is recommended that all individuals of invader species (Especially Category 1) must be removed and eradicated (Henderson, 2001). Species such as *Datura ferox* (**Figure 9**) *Datura stramonium* (**Figure 10**) and *Cirsium vulgare* (**Figure 11**) (Category 1b*)* were common in the study area.

Figure 9. Alien plant *Datura ferox* recorded along the proposed route

Figure 10. Alien plant *Datura stramonium* recorded along the proposed route

Figure 11. Alien plant *Cirsium vulgare* recorded along the proposed route

There are methods to eradicate alien invasive species, such as:

- Mechanical methods - felling, removing or burning invading alien plants;
- Chemical methods - using environmentally safe herbicides;
- Biological control - using species-specific insects and diseases from the alien plant's country of origin and
- Integrated control - combinations of the above three approaches. Often an integrated approach is required in order to prevent serious impacts (http://www.dwaf.gov.za/wfw/default.aspx).

It is important that the Environmental Management Programme (EMPr) takes into account suitable methods to ensure that alien invasive plant species are controlled in areas affected by the construction.

9.1.4 Threatened Species and Species of Conservation Concern and medicinal plants recorded on the proposed Kriel-Matla transfer link

According to the National Environmental Management Biodiversity Act 2004 (Act 10 of 2004 as amended), there is a dire need to conserve biodiversity in each province and as such, all natural and/or indigenous resources must be utilised sustainably. At the proposed route, there are a number of plants that are used to provide medicinal products (**Table 6**). In some cases there is merit in protecting or translocating them before the proposed development commences. While many of these plants are indigenous or exotic weeds that have medicinal value (and for which no action is necessary with respect to conservation), their economic value means that they are considered to be in need of protection.

According to the South African Red data list categories done by SANBI (**Figure 12**), **threatened species** are species that are facing a high risk of extinction. Any species classified in the IUCN categories Critically Endangered, Endangered or Vulnerable is a threatened species whereas **Species of conservation concern** are species that have a high conservation importance in terms of preserving South Africa's high floristic diversity and include not only threatened species, but also those classified in the categories Extinct in the Wild (EW), Regionally Extinct (RE), Near Threatened (NT), Critically Rare, Rare, Declining and Data Deficient - Insufficient Information (DDD).

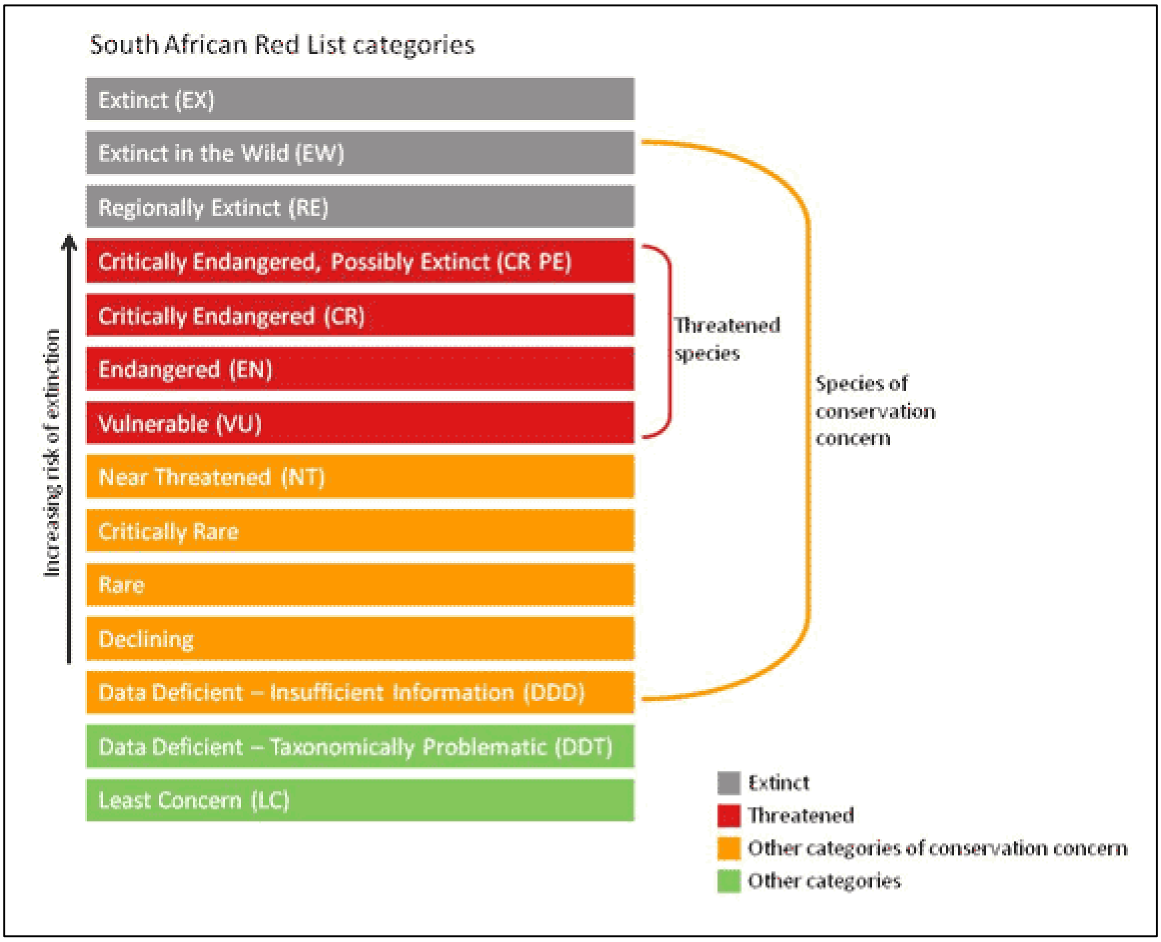


Figure 12. South African Red data list categories (SANBI website)

During the field survey, no threatened species were observed on site but only one plant species of conservation concern was noted, namely *Hypoxis hemerocallidea* (Star flower/African potato)). Raimondo *et al.,*(2009) listed this species as *Declining.*

Hypoxis hemerocallidea (Star flower/African potato) (**Figure 13**) occurs in open grassland and woodland and is widespread in South Africa in the eastern summer rainfall provinces (Eastern Cape, Free State, KwaZulu-Natal, Mpumalanga, Gauteng and Limpopo). It is used to treat headaches, dizziness, mental disorders, cancers, inflammation and HIV (Pooley, 1998).

Figure 13. Star flower/African potato recorded in the study area

Table 7 indicate the GPS co-ordinates of the *Hypoxis hemerocallidea* on the proposed development site. The distribution of *Hypoxis hemerocallidea* plant species in the proposed site is shown in **Figures 14.**

Table 7. GPS co-ordinates of the *Hypoxis hemerocallidea* recorded on the proposed development site.

Species	Common name	Latitude	Longitude
Hypoxis hemerocallidea	Star flower/African potato	26°16'42.92"S	29°11'15.96"E
		26°16'43.40"S	29°11'16.59"E
		26°16'44.14"S	29°11'16.12"E

Species	Common name	Latitude	Longitude
		26°16'44.51"S	29°11'16.87"E
		26°16'44.46"S	29°11'17.53"E

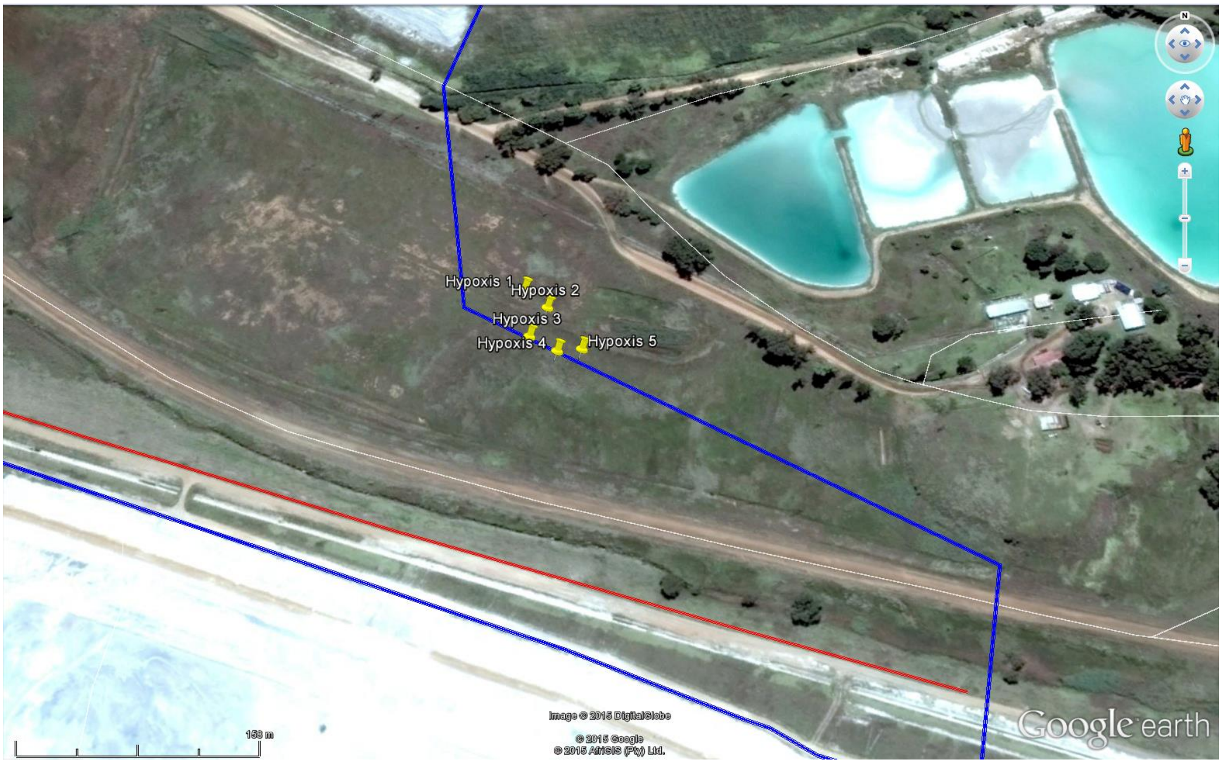


Figure 14. The distribution of *Hypoxis hemerocallidea* recorded in the proposed development site

9.1.5 Habitat available for species of conservation importance

Data sourced from SANBI and MTPA indicated plant species on the Red Data List that are known to occur in or surrounding the two proposed sites; as well as their probability of occurrence (indicated in **Table 8)**. The probability of occurrence is based on the suitable habit where the species is likely to occur.

Table 8. Red Data Listed plant species which could potentially occur in the proposed route.

Species	Status	Flowering season	Suitable habitat	Probability of Occurrence
Boophone disticha	Declining	Flowering usually begins in July, ending in November	Occurs along watercourses or where underground water is present	Likely
Crinum bulbispermum	Declining	It is in flower from June to August	Needs a damp but sunny environment during spring and	Likely

Species	Status	Flowering season	Suitable habitat	Probability of Occurrence
			summer and is a greedy feeder	
Gladiolus robertsoniae	Near Threatened	It flowers in October	The plants inhabit areas of short high altitude grassland growing in heavy black clay soil derived from dolerite	Unlikely
Kniphofia typhoides	Near Threatened	Generally flowers in the first three weeks of February, often at the rainiest time of the year	This species is endemic to heavy, black clay soil regions and is generally found in climax *Themeda triandra* grassland	Unlikely

9.2 Fauna

The evaluation of faunal presence is based on the presence / absence of mammals, birds, and reptiles at the proposed pipeline route. The survey determined the current status of threatened animal species occurring, or likely to occur within the proposed pipeline route, describing the available and sensitive habitats. Faunal data was obtained during a field survey assessments of the proposed pipeline route, which was carried out on foot. The data was supplemented by previous surveys conducted in similar habitats, literature investigations, and historic data. Different habitats were explored to identify any sensitive or endangered species. Mammal nomenclature is referred to using Stuart & Stuart, (1998), Skinner & Chimimba (2005), Friedman & Daly (2004); bird names by Hockey *et al.* (2005); reptile names by Branch (1988), Branch (2001) and Amphibian names by Minter *et al.* 2004.

9.2.1 Mammals

9.2.1.1 Desktop survey results

The potential mammal species that could be found along the proposed pipeline routes are those which have been recorded in the grid cell 2629AC (ADU, 2015) and are listed in **Table 9** below. According to this list, no mammal species of conservation importance is known to occur in the region. Due to the habitat disturbance, the list is likely to overestimate the occurrence of mammal species in the area and thus should be viewed with a degree of caution.

Table 9: Mammal species recorded in the grid cell 2629AC (ADU, 2015), which could potentially occur on the proposed pipeline route

Family	Genus	Species	Common name	Red list category	Atlas region endemic
Bovidae	*Raphicerus*	*campestris*	Steenbok	Least Concern	Yes
Muridae	*Gerbilliscus*	*brantsii*	Highveld Gerbil	Least Concern	
Muridae	*Mastomys*	*natalensis*	Natal Mastomys	Least Concern	
Muridae	*Otomys*	*auratus*	Southern African Vlei Rat	Not listed	Yes
Muridae	*Rhabdomys*	*pumilio*	Xeric Four-striped Grass Rat	Least Concern	Yes
Nesomyidae	*Dendromus*	*mesomelas*	Brants's African Climbing Mouse	Least Concern	Yes
Soricidae	*Myosorex*	*varius*	Forest Shrew	Data Deficient	Yes

9.2.1.2 Mammals recorded along the proposed pipelines route

Mammals are sensitive to disturbances and as such few were expected to occur on site. Only three mammal species were recorded on site during the field assessment (**Table 10)**. This could be attributed to anthropogenic disturbances observed on site such as habitat transformation. The species recorded have a wide distribution range. No Red Data mammal species were recorded. Rats, such as alien House rats (*Rattus rattus*) are common within inhabited areas and transformed areas. The proposed pipeline replacement will have an insignificant impact on mammal conservation.

Table 10. Mammals recorded in the proposed pipeline route

Order:	Scientific name	English name	Status
Rodentia	*Rattus rattus*	House rat	Least concern
Hystricidae	*Hystrix africaeaustralis*	Cape Porcupine	Least Concern
Leporidae	*Lepus saxatilis*	Scrub Hare	Least Concern

9.2.2 Avifauna

As previously mentioned, the study area falls within the Grassland biome and this biome is considered as a home to 52 of the 122 Important Bird Area (IBA) in South Africa (O' Connor & Bredenkamp, 1997). Of South Africa's 841 bird species, 350 occur in the Grassland Biome. This includes 29 species of conservation concern, 10 endemics, and as many as 40 specialist species that are exclusively dependent on grassland habitat. Threatened grassland bird species range from LBJs (such as Yellow-breasted Pipit, Rudd's Lark and Botha's Lark) to the larger charismatic species (such as Secretarybird, Denham's Bustard, African Grass-Owl and Southern Bald Ibis) (Barnes, 1998). This is why the grasslands hold priority Important Bird & Biodiversity Areas (IBAs).

9.2.2.1 Desktop survey results

The IBA Programme identifies and works to conserve a network of sites critical for the long-term survival of bird species that are globally threatened, have a restricted range and are restricted to specific biomes/vegetation types. Several Conservation and planning tools were consulted for relevancy for the project. These included IBAs. No IBA occurs in the study area, but the two unprotected closest ones are situated approximately 32km away, namely Devon Grasslands IBA (**Figure 15**) in the west and Amersfoort-Bethal-Carolina IBA (**Figure 16**) in the east of the study area.

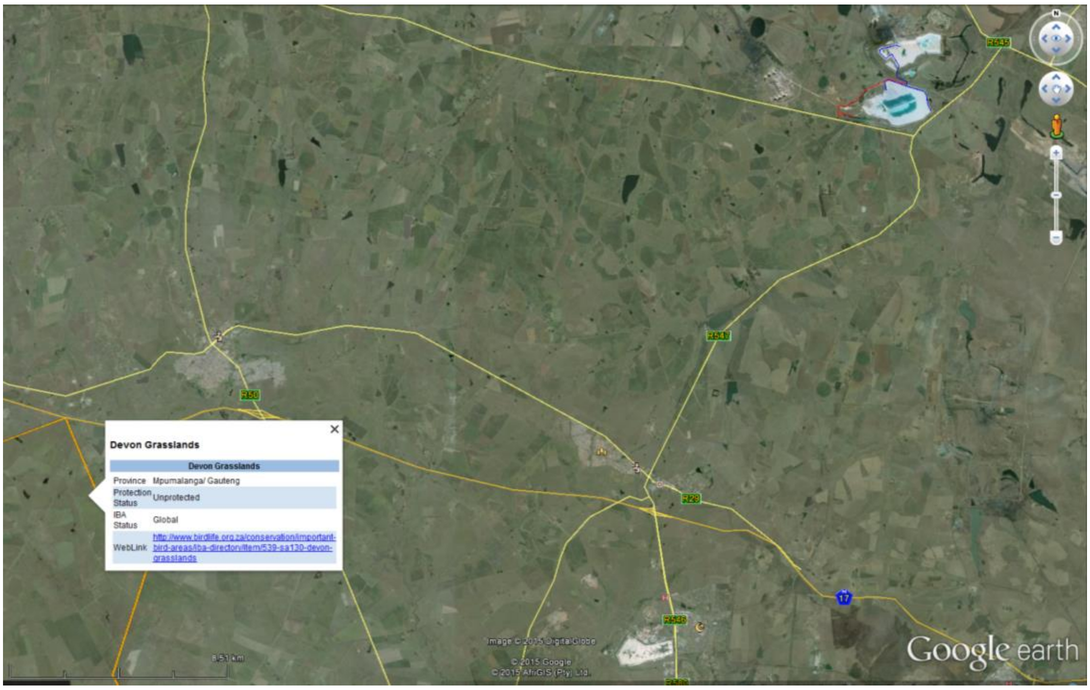


Figure 15. Devon Grasslands IBA recorded west of the study area

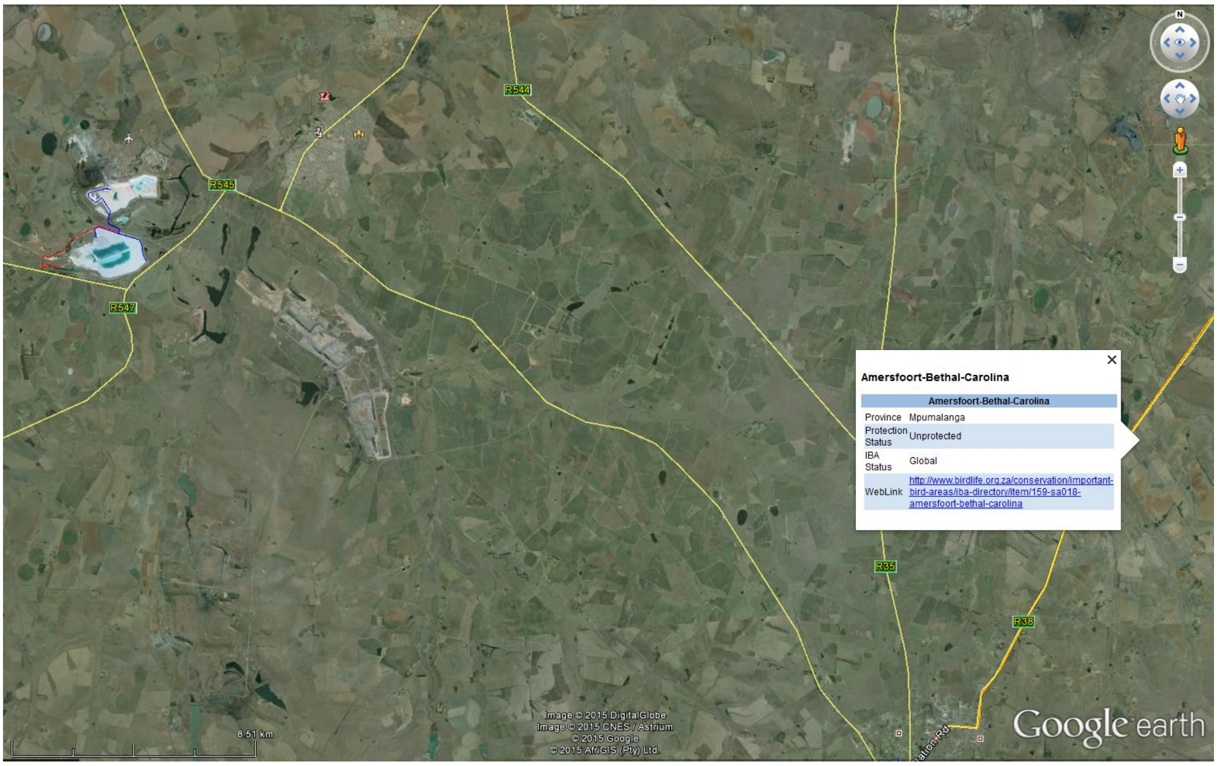


Figure 16. Amersfoort-Bethal-Carolina IBA recorded west of the study area

Observations regarding the number and diversity of birds will provide valuable input to sound management practices. According to the report by Scherman Colloty & Associates cc (SC&A) assisted by Pachnoda Consulting (2011), pairs of the Southern Bald Ibis (*Geronticus calvus*) (listed by Barnes, 2000 as "*vulnerable*") and Lanner Falcon (*Falco biarmicus*) (listed as "Near-threatened") were observed in Kriel Power Station along the furrow. **Table 11** indicates the Red Data bird species that were previously recorded in 2629AC by MTPA while **Appendix A** indicates Southern African Bird Atlas Project (SABAP) 2.

Table 11. Red Listed bird species which could potentially occur in the two proposed sites (MTPA).

Farm Name/Area	Common Name	Scientific Name	Conservation RSA	Conservation MTPA
Kinross	White-headed Vulture	*Aegypius occipitalis*	Vulnerable	Vulnerable
Grootpan 86 IS	African Grass-Owl	*Tyto capensis*	Vulnerable	Vulnerable
Onverwacht 70 IS	African Grass-Owl	*Tyto capensis*	Vulnerable	Vulnerable
Schaapkraal 93 IS	Blue Crane	*Anthropoides paradiseus*	Vulnerable	Vulnerable
Uitmalkaar 126 IS	African Grass-Owl	*Tyto capensis*	Vulnerable	Vulnerable
Vlaklaagte 92 IS	Blue Crane	*Anthropoides paradiseus*	Vulnerable	Vulnerable

9.2.2.2 Field work results

A numbers of bird species in South Africa have declined mainly due to massive habitat transformation and degradation as well as increased levels of human disturbances, extensive habitat transformation due to mining, industrial and commercial and agricultural activities. Human activity has transformed grasslands in South Africa to a point where few pristine examples exist (Low & Rebelo 1996). Factors such as increased pasture management (overgrazing), decrease in grassland management due to frequent fires and land-use alteration (urbanisation) also contribute in the decline of species. More intensive surveys conducted over longer periods over several seasons are required in order to ascertain the current status of the above-mentioned threatened bird species on and surrounding the site. Many avifaunal species are adaptable as they are habitat generalists and can therefore accommodate a certain degree of habitat degradation and transformation (Harrison *et al*., 1997). Other species are extremely habitat specific and have to rely on certain habitat units for breeding, hunting or foraging and roosting. Habitat-specific species are sensitive to environmental change, with destruction of habitat being the leading cause of species decline worldwide (Barnes, 2000). Due to high levels of habitat transformation, the site offers limited suitable habitat for any larger terrestrial birds as well as certain smaller raptor species.

An avifaunal study indicated that the drainage lines, stands of *Eucalyptus* trees and patches of grasslands should provide natural habitats for bird species, however no Red Data bird species were observed on the study site. *Eucalyptus* species were recorded along the route and although they are invader species, they have become important refuges for certain species of raptors. Large *Eucalyptus* trees are used by the migratory Lesser Kestrels for roosting purposes (Harrison et al., 1997), although no known roost sites exist in the study area. One of the significant sensitive faunal habitats such as wetlands and or drainage lines, is believed to be suitable habitats for birds. Wetlands/rivers are of particular importance for birds in the study area and also essential breeding grounds for many threatened cranes and other waterbirds. The marshland vegetation of the pans and surrounding dense *Themeda triandra* grasslands offers favourable roosting and possible nesting habitat for African Grass Owls but the habitat fragmentation could be a deterent. Areas with reeds, sedges or grassy tangles are suitable for Common Waxbills (*Estrilda astrilda*) and various warblers (Marais and Peacock, 2008). Plant species such as the Common Reed provides nesting and roosting sites for bird species. The patches of open grassland areas on site represent a significant feeding area for many bird species in the area. Several typical Red Data grassland species were recorded in the square grid by SABAP1, as indicated in **Table 11**. It is therefore highly unlikely that these species could occur in the grassland remaining on the site due to mining activities taking place. The Blue Crane (*Anthropoides paradisea*) and African Grass-Owl (*Tyto capensis*) are amongst the RDL species recorded from the area that readily utilize this habitat unit. Factors such as habitat loss and fragmentation are responsible for the decline in Grass owl population (Barnes, 2000). Frequent burning of habitat can cause major impacts due to reduced or affected foraging, roosting, and nesting sites. Non-threatened species that may from time to time frequent the grassland habitat in the study area are Swainson's Spurfowl (*Pternistis swainsonii*), African Pipit (*Anthus cinnamomeus*), Cape Longclaw (*Macronyx capensis*), several cisticola species, Long-tailed Widowbird (*Euplectes progne*), Rufous-naped Lark (*Mirafra africana*), and Black-shouldered Kite (*Elanus caeruleus*) (Harrison *et al*., 1997). Open grasslands not associated with wetland habitat also form an important habitat unit to support diversity that also include various RDL species.

Nineteen (19) bird species (**Table 12)** were recorded during the field survey. Species recorded were common and widespread and typical of grassland environment.

Table 12. Bird species recorded along the proposed pipeline route

Species number	Common name	Scientific name
63	Black-headed Heron	*Ardea cinerea*
71	Cattle Egret	*Bubulus ibis*
91	African Sacred Ibis	*Threskiornis aethiopicus*
94	Hadeda Ibis	*Bostrychia hagedash*
127	Black-shouldered kite (**Figure 17**)	*Elanus caerulus*
255	Crowned Lapwing (Plover) (**Figure 18**)	*Vanellus coronatus*
258	Blacksmith Lapwing (Plover) (**Figure 19**)	*Vanellus armatus*
349	Rock Pigeon	*Columba guinea*
352	Red-eyed Dove	*Streptopelia semitorquata*
355	Laughing Dove	*Streptopelia senegalensis*
548	Pied Crow	*Corvus albus*
568	Red-eyed Bulbul	*Pycnonotus nigricans*
596	African (Common) Stonechat	*Saxicola torquatus*
732	Common Fiscal (Fiscal Shrike)	*Lanius collaris*
758	Common (Indian) Myna	*Acridotheres zeylonus*
801	House Sparrow	*Passer domesticus*
814	Southern Masked-Weaver	*Ploceus velatus*
824	Southern Red Bishop	*Euplectes orix*
826	Yellow-crowned Bishop	*Euplectes afer*

Figure 17. Black-shouldered kite on site

Figure 18. Crowned Lapwing (Plover) on site

Figure 19. Blacksmith Lapwing (Plover) on site

9.2.2.3 Habitat requirements for Red Data bird species

Table 13 below provides an important guideline of what could potentially be encountered anywhere in the study area in suitable habitat, and should not be used as a guideline for actual densities on the ground. In addition it must be pointed out that the species below could have been recorded anywhere within the square of 2629AC, and not necessarily within the exact proposed study area for this project.

Table 13. Red Data Bird species recorded in grid cell 2629AC which could potentially occur in the study area (SABAP 1) (Harrison *et al*., (1997), Barnes (2000), SABAP2, Ansara, (2004) and Tarboton *et. al*. 1987).

Common Name	Conservation Status	Suitable Habitat	Probability of occurrence
White-headed Vulture	*Aegypius occipitalis*	It is found in open savannahs and thorn bush.	Unlikely
African Grass-Owl	*Tyto capensis*	Likely to be found in rank grass adjacent to wetlands.	Maybe/Likely
Blue Crane	*Anthropoides paradiseus*	Can be present in the pockets of remaining grassland and wetlands.	Maybe/Likely

9.2.3 Reptiles

Canals and patches of grasslands on site provide suitable habitats for reptile species recorded on site. Reptiles are extremely secretive and difficult to observe during field surveys. Riverine habitats are traditionally rich in reptile diversity and densities due to the habitat supporting a high abundance of prey species, such as frogs, birds and small mammals. Species are also very often "ousted" into wetland and riparian zones due to transformation of lands for urban and agricultural purposes (Branch, 2001). Vegetative cover is also greater within this habitat type. The majority of reptile species are sensitive to severe habitat alteration and fragmentation.

9.2.3.1 Desktop survey results

According to O' Connor & Bredenkamp (1997), the grassland biome houses 22% of South Africa's endemic reptiles. The Field Guide to the Snakes and other Reptiles of Southern Africa (Branch, 2001) and South African Red Data Book Reptiles (Branch, 1988) were books used during the field surveys. **Table 14** lists reptile species which are recorded in the grid cell 2629AC based on the South African Reptile Conservation Assessment (ADU, 2015). According to the list, no species of conservation importance is known to occur in the vicinity of the proposed development area.

Table 14. Reptile species recorded in grid cell 2629AC which could occur in the study area (ADU, 2015)

Family	Genus	Species	Subspecies	Common name	Red list category	Atlas region endemic
Atractaspididae	*Aparallactus*	*capensis*		Black-headed Centipede-eater	Least Concern (SARCA 2014)	
Cordylidae	*Pseudocordylus*	*melanotus*	*melanotus*	Common Crag Lizard	Least Concern (SARCA 2014)	Yes
Leptotyphlopidae	*Leptotyphlops*	*scutifrons*	*conjunctus*	Eastern Thread Snake	Not listed	
Scincidae	*Trachylepis*	*capensis*		Cape Skink	Least Concern (SARCA 2014)	
Scincidae	*Trachylepis*	*punctatissima*		Speckled Rock Skink	Least Concern (SARCA 2014)	

9.2.3.2 Reptiles recorded along the proposed Ash transfer link

Large areas surrounding the site have resulted in increased habitat modification and transformation as well as increased human presence and associated disturbances (illegal reptile collecting, indiscriminate killing of all snake species, frequent fires) surrounding the site coupled with increased habitat destruction and disturbances on the neighbouring properties are all causal factors in the alteration and disappearance of reptile diversity in the area (Jacobsen, 2005).

Termite mounds were present on the study area (**Figure 20**). Some large mounds had been damaged by previous foraging by Antbears. This resulted in the exposing of tunnels into the interior of the termite mound. Old termite mounds offer important refuges especially during veld fires as well as cold winter months for numerous frog, lizard, snake and smaller mammal species (Jacobsen, 2005). Large number of species of mammal, birds, reptiles and amphibians feed on the emerging alates (winged termites). No termite mounds were destroyed during the brief field survey.

Figure 20. Termite mound recorded on site

Only one reptile species was noted along the proposed Ash transfer link, this being the Montane Speckled Skink (*Trachylepis punctatissima*) (**Figure 21**). This species is found in a variety of habitats, wet and dry, from grassland and savanna to shrubland, including rock outcrops (Branch, 1998). It is not considered to be of significant importance from a conservation perspective.

Figure 21. Montane Speckled Skink recorded on site

From the field results, it is evident that transformation of land was responsible for the low number of observations.

9.2.4 Amphibians

Amphibians are an important component of South Africa's exceptional biodiversity and are such worthy of both research and conservation effort. This is made additionally relevant by international concern over globally declining amphibian populations, a phenomenon currently undergoing intensive investigation but is still poorly understood (Wyman, 1990 & Wake, 1991). This decline seems to have worsened over the past 25 years and amphibians are now more threatened than either mammals or birds, though comparisons with other taxa are confounded by a shortage of reliable data. Amphibians are an important component of South Africa's exceptional biodiversity (Siegfried, 1989) and are worthy of both research and conservation effort.

9.2.4.1 Desktop survey results

Most frogs have a biphasic life cycle, where eggs laid in water develop into tadpoles and these live in the water until they metamorphose into juvenile frogs living on the land. This fact, coupled with being covered by a semi-permeable skin makes frogs particularly vulnerable to pollutants and other environmental stresses. Consequently frogs are useful environmental bio-monitors (bio-indicators) and may acts as an early warning system for the quality of the environment. Frogs and tadpoles are good species indicator on water quality, because they have permeable, exposed skins that readily absorb toxic substances. Tadpoles are aquatic and greatly exposed to aquatic pollutants (Blaustein, 2003). The presence of amphibians is also generally regarded as an indication of intact ecological functionality and therefore construction activities within these habitat units should be undertaken in an ecologically-sensitive manner.

According to Frog Atlas of Southern African (ADU, 2015), no frog species of conservation importance has been recorded in grid cell 2629AC. **Table 15** indicates frogs that were recorded in grid cell 2629AC.

Table 15: Amphibian species recorded in the grid cell 2629AC (ADU, 2015), which could potentially occur along the proposed pipeline route

Family	Genus	Species	Common name	Red list category	Atlas region endemic
Bufonidae	*Amietophrynus*	*gutturalis*	Guttural Toad	Least Concern	
Bufonidae	*Amietophrynus*	*rangeri*	Raucous Toad	Least Concern	
Bufonidae	*Schismaderma*	*carens*	Red Toad	Least Concern	
Hyperoliidae	*Kassina*	*senegalensis*	Bubbling Kassina	Least Concern	
Hyperoliidae	*Semnodactylus*	*wealii*	Rattling Frog	Least Concern	
Phrynobatrachidae	*Phrynobatrachus*	*natalensis*	Snoring Puddle Frog	Least Concern	
Pipidae	*Xenopus*	*laevis*	Common Platanna	Least Concern	
Pyxicephalidae	*Amietia*	*fuscigula*	Cape River Frog	Least Concern	
Pyxicephalidae	*Amietia*	*quecketti*	Queckett's River Frog	Least Concern	Yes
Pyxicephalidae	*Cacosternum*	*boettgeri*	Common Caco	Least Concern	
Pyxicephalidae	*Strongylopus*	*fasciatus*	Striped Stream Frog	Least Concern	
Pyxicephalidae	*Tomopterna*	*natalensis*	Natal Sand Frog	Least Concern	

9.2.4.2 Field work results

The wetlands and canals on or near the proposed Ash transfer link are probably important breeding habitat for most of the frog species which could occur at the site. During the field assessment, one frog species was noted along the proposed Ash transfer link, namely Queckett's River Frog (*Amietia quecketti*) (**Figure 22**). It is a common species found on the banks of slow-flowing streams or other permanent bodies of water in a wide range of wetland habitats in grassland, savannah and forest fringe. It frequently inhabits garden ponds and water features (du Preez and Carruthers (2009).

Figure 22. River Frog recorded on site

10 ENVIRONMENTAL IMPACT ASSESSMENT

10.1 Methodology

All impacts are analysed in the section to follow (**Table 16**) with regard to their nature, extent, magnitude, duration, probability and significance. The following definitions apply:

Nature (/Status) The project could have a positive, negative or neutral impact on the environment.

Extent

- Local – extend to the site and its immediate surroundings.
- Regional – impact on the region but within the province.
- National – impact on an interprovincial scale.
- International – impact outside of South Africa.

Magnitude

Degree to which impact may cause irreplaceable loss of resources.

- Low – natural and social functions and processes are not affected or minimally affected.
- Medium – affected environment is notably altered; natural and social functions and processes continue albeit in a modified way.
- High – natural or social functions or processes could be substantially affected or altered to the extent that they could temporarily or permanently cease.

Duration

- Short term – 0-5 years.
- Medium term – 5-11 years.
- Long term – impact ceases after the operational life cycle of the activity either because of natural processes or by human intervention.
- Permanent – mitigation either by natural process or by human intervention will not occur in such a way or in such a time span that the impact can be considered transient.

Probability

- Almost certain – the event is expected to occur in most circumstances.
- Likely – the event will probably occur in most circumstances.
- Moderate – the event should occur at some time.
- Unlikely – the event could occur at some time.
- Rare/Remote – the event may occur only in exceptional circumstances.

Significance

Provides an overall impression of an impact's importance, and the degree to which it can be mitigated. The range for significance ratings is as follows-

- 0 – Impact will not affect the environment. No mitigation necessary.
- 1 – No impact after mitigation.
- 2 – Residual impact after mitigation.
- 3 – Impact cannot be mitigated.

10.2 Assessment of Environmental Impacts and Suggested Mitigation Measures

Only the environmental issues identified during the appraisal of the receiving environment and potential impacts are assessed below (**Table 16**). Mitigation measures are provided to prevent (first priority), reduce or remediate adverse environmental impacts.

Table 16. Recommended mitigation measures with significance rating before and after mitigation for the proposed Kriel-Matla transfer link.

FLORA PRE – CONSTRUCTION PHASE					
Impact	Nature	Description		Mitigation	
Direct	Positive	Search and Rescue of plant species of conservation concern		One plant species of conservation concern was noted on site, namely *Hypoxis hemerocallidea*. It is recommended that prior to construction, this species must be rescued and relocated to a safer place with suitable survival and growth-enabling conditions and then following construction they can be re-established at the site.	
Without Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Medium	Medium-term	Almost certain	2
With Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Low	Short-term	Likely	1

FLORA PRE – CONSTRUCTION PHASE					
Impact	Nature	Description		Mitigation	
Direct	Negative	Site clearing		During site preparation, topsoil and subsoil are to be stripped separately from each other and must be stored separately from spoil material for use in the rehabilitation phase. It should be protected from wind and rain, as well as contamination from diesel, concrete or wastewater. Records of all environmental incidents must be maintained and a copy of these records must be made available to authorities on request throughout the project execution	
Without Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	High	Medium-term	Likely	2
With Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Medium	Short-term	Likely	1

FAUNA PRE – CONSTRUCTION PHASE					
Impact	Nature	Description		Mitigation	
Direct	Negative	Clearing of site		During site preparation special care must be taken during the clearing of the works area to minimise damage or disturbance of roosting and nesting sites. During site clearance, special care must be taken where organic material will be stored separately from the topsoil and spoil material to ensure for the protection thereof. This topsoil must be re-used during the rehabilitation phase.	
Without Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	High	Medium-term	Likely	2
With Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Medium	Medium-term	Likely	1

FLORA CONSTRUCTION PHASE					
Impact	Nature	Description		Mitigation	
Direct	Negative	Soil contamination, vegetation loss and vegetation disturbance due to fuel and chemical spills to the canals and wetlands.		Appropriate measures should be implemented in order to prevent potential soil pollution through fuel and oil leaks and spills and then compliance monitored by an appropriate person. Make sure construction vehicles are maintained and serviced to prevent oil and fuel leaks. Emergency on-site maintenance should be done over appropriate drip trays and all oil or fuel must be disposed of according to waste regulations. Drip-trays must be placed under vehicles and equipment when not in use. Implement suitable erosion control measures	
Without Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	High	Medium-term	Likely	2
With Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Medium	Medium-term	Likely	1

FLORA CONSTRUCTION PHASE					
Impact	Nature	Description		Mitigation	
Direct	Negative	Vegetation and habitat disturbance due to the accidental introduction of alien species.		Promote awareness of all personnel. The establishment of pioneer species should be considered with the natural cycle of rehabilitation of disturbed areas, which assists with erosion control, dust and establishment of more permanent species. This can be controlled during construction phase and thereafter more stringent measures should be implemented during the rehabilitation and post rehabilitation. Larger exotic species that are not included in the Category 1b list of invasive species could also be allowed to remain for aesthetic purposes	
Without Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	High	Medium-term	Likely	2
With Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Medium	Medium-term	Likely	1

FLORA CONSTRUCTION PHASE					
Impact	Nature	Description		Mitigation	
Direct	Negative	Vegetation and habitat disturbance due to pollution and littering during construction phase.		The Contractor should employ personnel on site responsible for preventing and controlling of litter. Promote good housekeeping with daily clean-ups on site. During construction, refresher training can be conducted to construction workers with regards to littering, *ad hoc* veld fires, and dumping. No fires are allowed on site.	
Without Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Medium	Medium-term	Likely	2
With Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Low	Medium-term	Likely	1

FLORA CONSTRUCTION PHASE					
Impact	Nature	Description		Mitigation	
Direct	Negative	Damage to plant life outside of the proposed pipeline route.		Construction activities should be restricted to the development footprint area and then the compliance in terms of footprint can be monitored by ECO. Areas which could be deemed as no go should be clearly marked.	
Without Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Medium	Medium-term	Likely	2
With Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Low	Medium-term	Likely	1

FAUNA CONSTRUCTION PHASE					
Impact	Nature	Description		Mitigation	
Direct	Negative	Disturbance to animals		Animals residing within the designated area shall not be unnecessarily disturbed. During construction, refresher training can be conducted to construction workers with regards to littering and poaching. The Contractor and his/her employees shall not bring any domestic animals onto site. Toolbox talks should be provided to contractors regarding disturbance to animals. Particular emphasis should be placed on talks regarding snakes.	
Without Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Medium	Medium-term	Unlikely	2
With Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Low	Medium-term	Unlikely	1

FAUNA CONSTRUCTION PHASE					
Impact	Nature	Description		Mitigation	
Direct	Negative	Allow for safe animal passage through and specifically out of the construction site.		With regards to other areas which may need to be fenced temporarily during construction, *ie* aloe area where moles were found, a normal stock fence can be utilised, either diamond or rectangular fencing.	
Without Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Medium	Medium-term	Unlikely	2
With Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Medium	Medium-term	Unlikely	1

FLORA OPERATIONAL PHASE					
Impact	Nature	Description		Mitigation	
Direct	Negative	The proposed construction activities may affect biodiversity through the encroachment of exotic vegetation following soil disturbance, in addition the maintenance of the area would disturb naturalised species within the area.		Newly cleared soils will have to be re-vegetated and stabilised as soon as construction has been completed and there should be an on-going monitoring program to control and/or eradicate newly emerging invasives.	
Without Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Medium	Medium-term	Likely	2
With Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Low	Medium-term	Unlikely	1

FLORA OPERATIONAL PHASE					
Impact	Nature	Description		Mitigation	
Direct	Negative	Rehabilitation of the site		All areas to be affected by the proposed project will be rehabilitated after construction and all waste generated by the construction activities will be stored in a temporary demarcated storage area, prior to disposal thereof at a licensed registered landfill site. As much vegetation growth as possible should be promoted within the proposed development site in order to protect soils and to reduce the percentage of the surface area which is left as bare ground. In this regard special mention is made of the need to use indigenous vegetation species as the first choice during landscaping. The plant material to be used for rehabilitation should be similar to what is found in the surrounding area.	
Without Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Medium	Medium-term	Likely	2
With Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Low	Medium-term	Unlikely	1

FAUNA OPERATIONAL PHASE					
Impact	Nature	Description		Mitigation	
Direct	Negative	Disturbance of faunal species		The disturbance of fauna should be minimized. Animals residing within the designated area shall not be unnecessarily disturbed.	
Without Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Medium	Medium-term	Likely	2
With Mitigation	Extent	Magnitude	Duration	Probability	Significance
	Local	Low	Medium-term	Unlikely	1

11 CONCLUSION AND RECOMMENDATIONS

The proposed Ash transfer link falls within the grassland biome. The Grassland biome has a high biodiversity, ranked only below the Fynbos biome in terms of biodiversity in South Africa. It is found mainly on the high central plateau of South Africa, and the inland areas of KwaZulu-Natal and the Eastern Cape. Grasslands are dominated by a single layer of grasses. Trees are absent, except in a few localised habitats and geophytes are often abundant. Mucina and Rutherford (2006) classified the proposed pipeline as falling within the Eastern Highveld Grassland vegetation unit and this vegetation type is listed as endangered. According to the data from South African National Biodiversity Institute (SANBI), Eastern Highveld Grassland Threatened Terrestrial Ecosystem was recorded on the proposed pipeline route and this ecosystem type has a vulnerable status. Even though the vegetation type and threatened ecosystem is listed as endangered and vulnerable respectively, the study area has been highly transformed and disturbed due to ash dumps. According to the Mpumalanga Biodiversity Conservation Plan (2013), the study area falls within the "*Heavily Modified", "Moderately modified- Old lands"* and "*Other Natural Areas*" categories.

The infrastructure construction on or near the proposed Ash transfer link have completely transformed the biodiversity around the two Power Stations. Due to the displacement of indigenous vegetation, this area is totally transformed and do not resemble the species composition of natural vegetation. As to be expected is the species richness relatively low and consist of a high proportion of weedy and invasive species. This vegetation type also has no conservation value. The extent of this habitat unit was also identified using topographical maps of the area as well as *Google Earth* ® imagery.

During the field survey, no threatened species were observed along the proposed Ash transfer link but only one plant species of conservation concern was noted, namely *Hypoxis hemerocallidea* (Star flower/African potato)) and this species is listed as *Declining.* Even though most areas fall within the heavily modified and moderately modified with old lands, this species was recorded in areas designated as 'other natural areas'. It is recommended that prior to construction, this species must be rescued and relocated to a safer place with suitable survival and growth-enabling conditions and then following construction they can be re-established at the site.

No fauna of conservation importance were recorded along the proposed Ash transfer link. The habitat transformation, mining activities and associated disturbances taking place usually have a detrimental impact on fauna species (especially mammals and snakes) in the area.

From a broad and preliminary evaluation of the study area, it is evident that the proposed Ash transfer link will have minimal impacts on the receviing environment. Two alternative pipeline crossings were considered, and there is no ecological preference between the alternatives as they cross the similar habitats. From an ecological perspective, the proposed route 2 is not preferred due to its close proximity to a wetland. The proposed development should proceed subject to the above, and mitigation measures must be employed to minimise potential impacts from the project.

12 REFERENCES

ANIMAL DEMOGRAPHY UNIT (2015). FrogMAP Virtual Museum. Accessed at http://vmus.adu.org.za/?vm=FrogMAP on 2015-10-07.

ANIMAL DEMOGRAPHY UNIT (2015). MammalMAP Virtual Museum. Accessed at http://vmus.adu.org.za/?vm=MammalMAP on 2015-10-07.

ANIMAL DEMOGRAPHY UNIT (2015). ReptileMAP Virtual Museum. Accessed at http://vmus.adu.org.za/?vm=ReptileMAP on 2015-10-07.

ANSARA, T. M. (2004) Determining the ecological status and possible anthropogenic impacts on the grass owl (*Tyto capensis*) populations in the East Rand Highveld, Gauteng. MSc. Dissertation, Rand Afrikaans University, Johannesburg.

BARNES, K.N. (ed.) (1998). The Important Bird Areas of Southern Africa. BirdLife South Africa: Johannesburg.

BARNES, K.N. (ed.) (2000). The Eskom Red Data Book of Birds of South Africa, Lesotho & Swaziland. Birdlife South Africa, Johannesburg.

BLAUSTEIN, ANDREW R. (2003). Amphibian Population Declines. Encyclopedia.com. [Online] 2003. [Cited: 11 March 2011.] http://www.encyclopedia.com/doc/1G2-3409400018.html.

BRANCH, W.R. (1988). South African Red Data Book - Reptiles and Amphibians. South African National Scientific Programmes Report No. 151. CSIR, Pretoria.

BRANCH, B. (2001). Snakes and Other Reptiles of Southern Africa. Struik Publishers, South Africa.

BROMILOW, C. (1995). Problem Plants of South Africa. Briza Publications, Pretoria.

BROMILOW, C. (2010). Problem plants of South Africa. Briza, Pretoria.

CARRUTHERS, V. (2001). Frogs and frogging in southern Africa. Struik Publishers, Cape Town.

DU PREEZ, L.H. & CARRUTHERS, V.C. (2009). Complete Guide to the Frogs of Southern Africa. Random House Struik. 488pp.

DRIVER, A., MAZE, K., LOMBARD A.T., NEL, J., ROUGET, M., TURPIE, J.K., COWLING, R.M., DESMET, P., GOODMAN, P., HARRIS, J., JONAS, Z., REYERS, B., SINK, K. & STRAUSS, T. (2004). South African National Spatial Biodiversity Assessment 2004: Summary Report. South African National Biodiversity Institute, Pretoria.

FRIEDMANN, Y. AND DALY, B, (EDITORS) (2004). Red Data Book of the mammals of South Africa: a conservation assessment: CBSG southern Africa, Conservation Breeding Specialist Group (SSC/IUCN). Endangered Wildlife Trust, South Africa.

HARRISON, J.A., ALLAN, D.G., UNDERHILL, L.G., HERREMANS, M., TREE, A.J., PARKER, V. & BROWN, C.J. (EDS) (1997). The atlas of Southern African birds. Vols. 1&2. BirdLife South Africa, Johannesburg.

HENDERSON, L. 2001. Alien weeds and invasive plants. ARC, Pretoria.

HOCKEY, P.A.R., DEAN, W.R.J. & RYAN, P.G. (eds.) (2005). Roberts – Birds of Southern Africa. VIIth ed. John Voelcker Bird Book Fund. Cape Town.

JACOBSEN, N. (2005). Remarkable Reptiles of South Africa. Briza Publications. Pretoria. South Africa.

LOW, A.B & REBELO, A.G. (1996). Vegetation of South Africa, Lesotho and Swaziland. Department of Environmental Affairs and Tourism, Pretoria.

MANNING, J. (2009). Field guide to the wild flowers of South Africa. Struik, Cape Town.

MARAIS, E. & PEACOCK, F. (2008). The chamberlain guide to birding Gauteng. Miranda Publishing. Cape Town.

MINTER, L.R., BURGER, M., HARRISON, J.A., BRAACK, H.H., BISHOP, P.J. AND KNOEPFER, D. (2004). Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland. SI/MAB Series No. 9, Washington, D.C.

MUCINA, L. & RUTHERFORD, M.C. (eds). (2006). The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African Biodiversity Institute, Pretoria.

O'CONNOR, T.G. and G.J. BREDENKAMP. (1997). Grassland. In Cowling, R.M., D.M. Richardson, and S.M. Pierce, editors. (eds). Vegetation of Southern Africa. pp. 215–257.Cambridge University Press. London.

POOLEY, E.S. (1998). A Field Guide to Wildflowers Kwazulu-Natal and the eastern region. Natal Flora Publishers Trust: Durban, South Africa.

RAIMONDO, D., VON STADEN, L., FODEN, W., VICTOR, J.E., HELME, N.A., TURNER, R.C., KAMUNDI, D.A. & MANYAMA, P.A. (eds) In press. Red List of South African plants. Strelitzia 25. South African National Biodiversity Institute, Pretoria.

RUTHERFORD, M.C. & WESTFALL, R.H. (1994). Biomes of southern Africa: an objective characterisation. Mem. Bot. *Surv*. S. Afr. No. 63.

SANBI. (2009). Draft Threatened Ecosystems in South Africa: Descriptions and Maps. Department of Environmental Affairs and Tourism. Pretoria.

SCHERMAN COLLOTY & ASSOCIATES CC (SC&A) ASSISTED BY PACHNODA CONSULTING (2011). AQUATIC AND TERRESTRIAL ECOLOGICAL ASSESSMENT Environmental Impact Assessment. DRAFT REPORT V1.

SINCLAIR, I., HOCKEY, P. & TARBOTON, W. (2002). Sasol Birds of Southern Africa. Struik Publishers, Cape Town.

SKINNER, J.D. & CHIMIMBA, C. T. (2005). The Mammals of the Southern African Subregion. Cambridge University Press, Cambridge.

STUART, C. & STUART, T. (1988). Field Guide to the Mammals of Southern Africa. Struik Publishers, Cape Town.

TARBOTON, W.R., KEMP.M.I. & KEMP. A. C., (1987): Birds of the Transvaal. Transvaal Museum: Pretoria.

VAN OUDSHOORN, F. (1999). Guide to grasses of southern Africa. Briza Publications, Pretoria.

VAN WYK, B., VAN OUDTSHOORN, B. AND GERICKE, N. (1997). Medicinal plants of South Africa. Briza Publications, Pretoria.

WAKE, D.B. (1991). Declining amphibian populations. Science 253:860.

WYMAN, R.I. (1990). What's happening to the amphibians? Conservation Biology 4:350-352.

Appendix A. Bird species recorded in grid cell 2629AC

Ref	Species name	Afrikaans	Taxonomic name	Full protocol			Adhoc protocol			Incidentals		SABAP1
				Rep Rate (%)	n	Latest	Rep Rate (%)	n	Latest	Reports	Latest	
269	Avocet, Pied	Bontelsie	*Recurvirostra avosetta*									✓ 4.76
432	Barbet, Acacia Pied	Bonthoutkapper	*Tricholaema leucomelas*									✓ 40.14
431	Barbet, Black-collared	Rooikophoutkapper	*Lybius torquatus*									✓ 21.09
439	Barbet, Crested	Kuifkophoutkapper	*Trachyphonus vaillantii*									✓ 36.73
808	Bishop, Southern Red	Rooivink	*Euplectes orix*	75	3	10/02/2014						✓ 75.51
812	Bishop, Yellow-crowned	Goudgeelvink	*Euplectes afer*	25	1	10/02/2014						✓ 42.18
722	Bokmakierie, Bokmakierie	Bokmakierie	*Telophorus zeylonus*									✓ 36.73
545	Bulbul, Dark-capped	Swartoogtiptol	*Pycnonotus tricolor*									✓ 8.84
152	Buzzard, Jackal	Rooiborsjakkalsvoel	*Buteo rufofuscus*									✓ 3.40
154	Buzzard, Steppe	Bruinjakkalsvoel	*Buteo vulpinus*									✓ 10.20
860	Canary, Black-throated	Bergkanarie	*Crithagra atrogularis*	50	2	01/04/2014						✓ 47.62
857	Canary, Cape	Kaapse Kanarie	*Serinus canicollis*									✓ 0.68
866	Canary, Yellow	Geelkanarie	*Crithagra flaviventris*	25	1	10/02/2014						✓ 6.80
859	Canary, Yellow-fronted	Geeloogkanarie	*Crithagra mozambicus*									✓ 29.25
575	Chat, Anteating	Swartpiek	*Myrmecocichla formicivora*	100	4	01/04/2014						✓ 32.65
570	Chat, Familiar	Gewone Spekvreter	*Cercomela familiaris*									✓ 1.36
631	Cisticola, Cloud	Gevlekte Klopkloppie	*Cisticola textrix*									✓ 14.97
630	Cisticola, Desert	Woestynklopkloppie	*Cisticola aridulus*									✓ 1.36
646	Cisticola, Levaillant's	Vleitinktinkie	*Cisticola tinniens*	100	4	01/04/2014						✓ 70.75
634	Cisticola, Wing-snapping	Kleinste Klopkloppie	*Cisticola ayresii*	25	1	10/02/2014						✓ 5.44
629	Cisticola, Zitting	Landeryklopkloppie	*Cisticola juncidis*	50	2	01/04/2014						✓ 41.50
504	Cliff-swallow, South African	Familieswael	*Hirundo spilodera*	50	2	01/04/2014						✓ 18.37
212	Coot, Red-knobbed	Bleshoender	*Fulica cristata*	25	1	10/02/2014						✓ 81.63
50	Cormorant, Reed	Rietduiker	*Phalacrocorax africanus*									✓ 80.95
47	Cormorant, White-breasted	Witborsduiker	*Phalacrocorax carbo*	25	1	01/04/2014						✓ 59.86
203	Crake, Black	Swartriethaan	*Amaurornis flavirostris*									✓ 4.08
523	Crow, Cape	Swartkraai	*Corvus capensis*									✓ 12.93
522	Crow, Pied	Witborskraai	*Corvus albus*									✓ 2.04
352	Cuckoo, Diderick	Diederikkie	*Chrysococcyx caprius*	25	1	10/02/2014						✓ 27.89
343	Cuckoo, Red-chested	Piet-my-vrou	*Cuculus solitarius*									✓ 4.76
52	Darter, African	Slanghalsvoel	*Anhinga rufa*									✓ 41.50
317	Dove, Laughing	Rooiborsduifie	*Streptopelia senegalensis*	100	4	01/04/2014						✓ 93.88
318	Dove, Namaqua	Namakwaduifie	*Oena capensis*									✓ 4.76
314	Dove, Red-eyed	Grootringduif	*Streptopelia semitorquata*	75	3	10/02/2014						✓ 36.05
940	Dove, Rock	Tuinduif	*Columba livia*	75	3	01/04/2014						✓ 29.25
95	Duck, African Black	Swarteend	*Anas sparsa*									✓ 8.84
101	Duck, Fulvous	Fluiteend	*Dendrocygna bicolor*									✓ 0.68
103	Duck, Maccoa	Bloubekeend	*Oxyura maccoa*									✓ 4.76
104	Duck, White-backed	Witrugeend	*Thalassornis leuconotus*									✓ 3.40
100	Duck, White-faced	Nonnetjie-eend	*Dendrocygna viduata*									✓ 23.81

Ref	Species name	Afrikaans	Taxonomic name	Full protocol			Adhoc protocol			Incidentals		SABAP1
				Rep Rate (%)	n	Latest	Rep Rate (%)	n	Latest	Reports	Latest	
96	Duck, Yellow-billed	Geelbekeend	*Anas undulata*	50	2	01/04/2014						✓ 63.95
368	Eagle-owl, Spotted	Gevlekte Ooruil	*Bubo africanus*									✓ 8.16
61	Egret, Cattle	Veereier	*Bubulcus ibis*	25	1	10/02/2014						✓ 81.63
58	Egret, Great	Grootwitreier	*Egretta alba*									✓ 5.44
59	Egret, Little	Kleinwitreier	*Egretta garzetta*									✓ 31.97
60	Egret, Yellow-billed	Geelbekwitreier	*Egretta intermedia*									✓ 24.49
119	Falcon, Amur	Oostelike Rooipootvalk	*Falco amurensis*	25	1	10/02/2014						✓ 23.13
114	Falcon, Lanner	Edelvalk	*Falco biarmicus*									✓ 1.36
120	Falcon, Red-footed	Westelike Rooipootvalk	*Falco vespertinus*									✓ 0.68
820	Finch, Red-headed	Rooikopvink	*Amadina erythrocephala*									✓ 59.18
707	Fiscal, Common (Southern)	Fiskaallaksman	*Lanius collaris*	75	3	10/02/2014						✓ 92.52
149	Fish-eagle, African	Visarend	*Haliaeetus vocifer*	25	1	01/04/2014						✗ 0.00
86	Flamingo, Greater	Grootflamink	*Phoenicopterus ruber*									✓ 5.44
87	Flamingo, Lesser	Kleinflamink	*Phoenicopterus minor*									✓ 0.68
205	Flufftail, Red-chested	Rooiborsvleikuiken	*Sarothrura rufa*									✓ 0.68
678	Flycatcher, Fairy	Feevlieievanger	*Stenostira scita*									✓ 9.52
665	Flycatcher, Fiscal	Fiskaalvlieievanger	*Sigelus silens*									✓ 3.40
654	Flycatcher, Spotted	Europese Vlieievanger	*Muscicapa striata*									✓ 0.68
179	Francolin, Orange River	Kalaharipatrys	*Scleroptila levaillantoides*									✓ 10.88
178	Francolin, Red-winged	Rooivlerkpatrys	*Scleroptila levaillantii*									✓ 1.36
339	Go-away-bird, Grey	Kwêvoel	*Corythaixoides concolor*									✓ 0.68
89	Goose, Egyptian	Kolgans	*Alopochen aegyptiacus*	50	2	30/08/2009						✓ 67.35
88	Goose, Spur-winged	Wildemakou	*Plectropterus gambensis*									✓ 21.09
5	Grebe, Black-necked	Swartnekdobbertjie	*Podiceps nigricollis*									✓ 0.68
4	Grebe, Great Crested	Kuifkopdobbertjie	*Podiceps cristatus*									✓ 12.24
6	Grebe, Little	Kleindobbertjie	*Tachybaptus ruficollis*	25	1	10/02/2014						✓ 57.82
263	Greenshank, Common	Groenpootruiter	*Tringa nebularia*									✓ 6.80
192	Guineafowl, Helmeted	Gewone Tarentaal	*Numida meleagris*	75	3	01/04/2014						✓ 76.19
288	Gull, Grey-headed	Gryskopmeeu	*Larus cirrocephalus*	25	1	30/08/2009						✓ 59.86
72	Hamerkop, Hamerkop	Hamerkop	*Scopus umbretta*									✓ 26.53
169	Harrier, Black	Witkruisvleivalk	*Circus maurus*									✓ 4.08
168	Harrier, Pallid	Witborsvleivalk	*Circus macrourus*									✓ 0.68
64	Heron, Black	Swartreier	*Egretta ardesiaca*									✓ 1.36
55	Heron, Black-headed	Swartkopreier	*Ardea melanocephala*	50	2	01/04/2014						✓ 75.51
56	Heron, Goliath	Reusereier	*Ardea goliath*									✓ 3.40
54	Heron, Grey	Bloureier	*Ardea cinerea*									✓ 61.90
57	Heron, Purple	Rooireier	*Ardea purpurea*									✓ 18.37
62	Heron, Squacco	Ralreier	*Ardeola ralloides*	25	1	10/02/2014						✓ 0.68
115	Hobby, Eurasian	Europese Boomvalk	*Falco subbuteo*									✓ 0.68
418	Hoopoe, African	Hoephoep	*Upupa africana*									✓ 38.10
81	Ibis, African Sacred	Skoorsteenveer	*Threskiornis aethiopicus*	50	2	01/04/2014						✓ 74.15
83	Ibis, Glossy	Glansibis	*Plegadis falcinellus*									✓ 24.49

Ref	Species name	Afrikaans	Taxonomic name	Full protocol			Adhoc protocol			Incidentals		SABAP1
				Rep Rate (%)	n	Latest	Rep Rate (%)	n	Latest	Reports	Latest	
84	Ibis, Hadeda	Hadeda	*Bostrychia hagedash*	100	4	01/04/2014						✓ 73.47
82	Ibis, Southern Bald	Kalkoenibis	*Geronticus calvus*									✓ 2.04
122	Kestrel, Greater	Grootrooivalk	*Falco rupicoloides*									✓ 21.77
125	Kestrel, Lesser	Kleinrooivalk	*Falco naumanni*									✓ 10.20
123	Kestrel, Rock	Kransvalk	*Falco rupicolus*									✓ 29.25
395	Kingfisher, Giant	Reusevisvanger	*Megaceryle maximus*									✓ 3.40
397	Kingfisher, Malachite	Kuifkopvisvanger	*Alcedo cristata*									✓ 2.04
394	Kingfisher, Pied	Bontvisvanger	*Ceryle rudis*									✓ 20.41
130	Kite, Black-shouldered	Blouvalk	*Elanus caeruleus*	75	3	10/02/2014						✓ 89.80
129	Kite, Yellow-billed	Geelbekwou	*Milvus aegyptius*									✓ 2.72
247	Lapwing, African Wattled	Lelkiewiet	*Vanellus senegallus*	50	2	30/08/2009						✓ 29.93
245	Lapwing, Blacksmith	Bontkiewiet	*Vanellus armatus*	100	4	01/04/2014						✓ 93.88
242	Lapwing, Crowned	Kroonkiewiet	*Vanellus coronatus*									✓ 68.71
3550	Lark, Agulhas Clapper	Overbergklappertjie	*Mirafra marjoriae*									✓ 2.04
4123	Lark, Agulhas Long-billed	Overberglangbeklewerik	*Certhilauda brevirostris*									✓ 0.68
4124	Lark, Benguela Long-billed	Kaokolangbeklewerik	*Certhilauda benguelensis*									✓ 0.68
472	Lark, Botha's	Vaalrivierlewerik	*Spizocorys fringillaris*									✓ 2.04
4140	Lark, Cape Clapper	Kaapse Klappertjie	*Mirafra apiata*									✓ 2.04
4125	Lark, Cape Long-billed	Weskuslangbeklewerik	*Certhilauda curvirostris*									✓ 0.68
1183	Lark, Eastern Clapper	Hoeveldklappertjie	*Mirafra fasciolata*									✓ 2.04
4126	Lark, Eastern Long-billed	Grasveldlangbeklewerik	*Certhilauda semitorquata*									✓ 0.68
4127	Lark, Karoo Long-billed	Karoolangbeklewerik	*Certhilauda subcoronata*									✓ 0.68
490	Lark, Pink-billed	Pienkbeklewerik	*Spizocorys conirostris*									✓ 2.72
488	Lark, Red-capped	Rooikoplewerik	*Calandrella cinerea*	50	2	30/08/2009						✓ 46.26
458	Lark, Rufous-naped	Rooineklewerik	*Mirafra africana*									✓ 6.12
474	Lark, Spike-heeled	Vlaktelewerik	*Chersomanes albofasciata*									✓ 4.76
703	Longclaw, Cape	Oranjekeelkalkoentjie	*Macronyx capensis*	100	4	01/04/2014						✓ 76.19
167	Marsh-harrier, African	Afrikaanse Vleivalk	*Circus ranivorus*	50	2	30/08/2009						✓ 2.72
510	Martin, Banded	Gebande Oewerswael	*Riparia cincta*	50	2	01/04/2014						✓ 0.68
509	Martin, Brown-throated	Afrikaanse Oewerswael	*Riparia paludicola*	75	3	01/04/2014						✓ 21.77
506	Martin, Rock	Kransswael	*Hirundo fuligula*									✓ 30.61
803	Masked-weaver, Southern	Swartkeelgeelvink	*Ploceus velatus*	100	4	01/04/2014						✓ 82.99
210	Moorhen, Common	Grootwaterhoender	*Gallinula chloropus*									✓ 37.42
392	Mousebird, Red-faced	Rooiwangmuisvoel	*Urocolius indicus*									✓ 16.33
390	Mousebird, Speckled	Gevlekte Muisvoel	*Colius striatus*									✓ 38.78
734	Myna, Common	Indiese Spreeu	*Acridotheres tristis*									✓ 39.46
637	Neddicky, Neddicky	Neddikkie	*Cisticola fulvicapilla*									✓ 2.04
69	Night-Heron, Black-crowned	Gewone Nagreier	*Nycticorax nycticorax*									✓ 8.84
359	Owl, Barn	Nonnetjie-uil	*Tyto alba*									✓ 28.57
361	Owl, Marsh	Vlei-uil	*Asio capensis*									✓ 40.14
387	Palm-swift, African	Palmwindswael	*Cypsiurus parvus*									✓ 1.36
311	Pigeon, Speckled	Kransduif	*Columba guinea*	75	3	01/04/2014						✓ 65.31

Ref	Species name	Afrikaans	Taxonomic name	Full protocol			Adhoc protocol			Incidentals		SABAP1
				Rep Rate (%)	n	Latest	Rep Rate (%)	n	Latest	Reports	Latest	
692	Pipit, African	Gewone Koester	*Anthus cinnamomeus*	75	3	10/02/2014						✓ 58.50
695	Pipit, Buffy	Vaalkoester	*Anthus vaalensis*									✓ 0.68
694	Pipit, Plain-backed	Donkerkoester	*Anthus leucophrys*									✓ 1.36
233	Plover, Common Ringed	Ringnekstrandkiewiet	*Charadrius hiaticula*									✓ 1.36
237	Plover, Kittlitz's	Geelborsstrandkiewiet	*Charadrius pecuarius*									✓ 2.72
238	Plover, Three-banded	Driebandstrandkiewiet	*Charadrius tricollaris*	50	2	30/08/2009						✓ 30.61
102	Pochard, Southern	Bruineend	*Netta erythrophthalma*									✓ 12.93
282	Pratincole, Black-winged	Swartvlerksprinkaanvoel	*Glareola nordmanni*									✓ 2.04
650	Prinia, Black-chested	Swartbandlangstertjie	*Prinia flavicans*	50	2	01/04/2014						✓ 52.38
189	Quail, Common	Afrikaanse Kwartel	*Coturnix coturnix*									✓ 1.36
844	Quailfinch, African	Gewone Kwartelvinkie	*Ortygospiza atricollis*	50	2	01/04/2014						✓ 25.85
805	Quelea, Red-billed	Rooibekkwelea	*Quelea quelea*	50	2	30/08/2009						✓ 36.73
197	Rail, African	Grootriethaan	*Rallus caerulescens*									✓ 0.68
606	Reed-warbler, African	Kleinrietsanger	*Acrocephalus baeticatus*									✓ 15.65
603	Reed-warbler, Great	Grootrietsanger	*Acrocephalus arundinaceus*									✓ 0.68
581	Robin-chat, Cape	Gewone Janfrederik	*Cossypha caffra*									✓ 4.08
560	Rock-thrush, Sentinel	Langtoonkliplyster	*Monticola explorator*									✓ 1.36
412	Roller, European	Europese Troupant	*Coracias garrulus*									✓ 1.36
256	Ruff, Ruff	Kemphaan	*Philomachus pugnax*									✓ 12.93
609	Rush-warbler, Little	Kaapse Vleisanger	*Bradypterus baboecala*									✓ 5.44
258	Sandpiper, Common	Gewone Ruiter	*Actitis hypoleucos*									✓ 10.20
251	Sandpiper, Curlew	Krombekstrandloper	*Calidris ferruginea*									✓ 4.76
262	Sandpiper, Marsh	Moerasruiter	*Tringa stagnatilis*									✓ 17.69
264	Sandpiper, Wood	Bosruiter	*Tringa glareola*									✓ 14.29
105	Secretarybird, Secretarybird	Sekretarisvoel	*Sagittarius serpentarius*									✓ 6.12
867	Seedeater, Streaky-headed	Streepkopkanarie	*Crithagra gularis*									✓ 2.72
94	Shoveler, Cape	Kaapse Slopeend	*Anas smithii*									✓ 13.61
708	Shrike, Red-backed	Rooiruglaksman	*Lanius collurio*									✓ 2.72
250	Snipe, African	Afrikaanse Snip	*Gallinago nigripennis*									✓ 9.52
786	Sparrow, Cape	Gewone Mossie	*Passer melanurus*	75	3	10/02/2014						✓ 97.28
784	Sparrow, House	Huismossie	*Passer domesticus*									✓ 68.71
3852	Sparrow, Northern Grey-headed	Witkeelmossie	*Passer griseus*									✓ 51.02
4142	Sparrow, Southern Grey-headed	Gryskopmossie	*Passer diffusus*	50	2	30/08/2009						✓ 51.02
780	Sparrow-weaver, White-browed	Koringvoel	*Plocepasser mahali*									✓ 0.68
484	Sparrowlark, Chestnut-backed	Rooiruglewerik	*Eremopterix leucotis*									✓ 5.44
85	Spoonbill, African	Lepelaar	*Platalea alba*									✓ 36.73
185	Spurfowl, Swainson's	Bosveldfisant	*Pternistis swainsonii*	100	4	01/04/2014						✓ 59.18
737	Starling, Cape Glossy	Kleinglansspreeu	*Lamprotornis nitens*									✓ 3.40
746	Starling, Pied	Witgatspreeu	*Spreo bicolor*	50	2	30/08/2009						✓ 5.44
745	Starling, Red-winged	Rooivlerkspreeu	*Onychognathus morio*									✓ 2.72
270	Stilt, Black-winged	Rooipootelsie	*Himantopus himantopus*									✓ 12.24
253	Stint, Little	Kleinstrandloper	*Calidris minuta*									✓ 6.80

Ref	Species name	Afrikaans	Taxonomic name	Full protocol			Adhoc protocol			Incidentals		SABAP1
				Rep Rate (%)	n	Latest	Rep Rate (%)	n	Latest	Reports	Latest	
576	Stonechat, African	Gewone Bontrokkie	*Saxicola torquatus*	75	3	01/04/2014						✓ 63.27
80	Stork, White	Witooievaar	*Ciconia ciconia*									✓ 9.52
76	Stork, Yellow-billed	Nimmersat	*Mycteria ibis*									✓ 4.08
772	Sunbird, Amethyst	Swartsuikerbekkie	*Chalcomitra amethystina*									✓ 0.68
493	Swallow, Barn	Europese Swael	*Hirundo rustica*	50	2	01/04/2014						✓ 47.62
502	Swallow, Greater Striped	Grootstreepswael	*Hirundo cucullata*	50	2	01/04/2014						✓ 50.34
501	Swallow, Red-breasted	Rooiborsswael	*Hirundo semirufa*									✓ 0.68
495	Swallow, White-throated	Witkeelswael	*Hirundo albigularis*	50	2	01/04/2014						✓ 40.82
604	Swamp-warbler, Lesser	Kaapse Rietsanger	*Acrocephalus gracilirostris*									✓ 29.25
208	Swamphen, African Purple	Grootkoningriethaan	*Porphyrio madagascariensis*									✓ 12.24
378	Swift, Common	Europese Windswael	*Apus apus*									✓ 2.04
384	Swift, Horus	Horuswindswael	*Apus horus*	25	1	01/04/2014						✓ 2.04
385	Swift, Little	Kleinwindswael	*Apus affinis*	25	1	10/02/2014						✓ 56.46
383	Swift, White-rumped	Witkruiswindswael	*Apus caffer*	25	1	01/04/2014						✓ 48.30
98	Teal, Cape	Teeleend	*Anas capensis*									✓ 3.40
99	Teal, Hottentot	Gevlekte Eend	*Anas hottentota*									✓ 0.68
97	Teal, Red-billed	Rooibekeend	*Anas erythrorhyncha*	50	2	01/04/2014						✓ 40.14
290	Tern, Caspian	Reusesterretjie	*Sterna caspia*									✓ 1.36
305	Tern, Whiskered	Witbaardsterretjie	*Chlidonias hybrida*	25	1	10/02/2014						✓ 2.04
304	Tern, White-winged	Witvlerksterretjie	*Chlidonias leucopterus*									✓ 29.25
275	Thick-knee, Spotted	Gewone Dikkop	*Burhinus capensis*	25	1	01/04/2014						✓ 44.22
1104	Thrush, Karoo	Geelbeklyster	*Turdus smithi*									✓ 17.69
1105	Thrush, Olive	Olyflyster	*Turdus olivaceus*									✓ 17.69
316	Turtle-dove, Cape	Gewone Tortelduif	*Streptopelia capicola*	100	4	01/04/2014						✓ 92.52
686	Wagtail, Cape	Gewone Kwikkie	*Motacilla capensis*	50	2	01/04/2014						✓ 59.18
595	Warbler, Garden	Tuinsanger	*Sylvia borin*									✓ 0.68
607	Warbler, Marsh	Europese Rietsanger	*Acrocephalus palustris*									✓ 0.68
608	Warbler, Sedge	Europese Vleisanger	*Acrocephalus schoenobaenus*									✓ 1.36
599	Warbler, Willow	Hofsanger	*Phylloscopus trochilus*									✓ 1.36
843	Waxbill, Common	Rooibeksysie	*Estrilda astrild*	50	2	01/04/2014						✓ 18.37
838	Waxbill, Orange-breasted	Rooiassie	*Amandava subflava*									✓ 26.53
799	Weaver, Cape	Kaapse Wewer	*Ploceus capensis*									✓ 0.68
568	Wheatear, Capped	Hoeveldskaapwagter	*Oenanthe pileata*	50	2	30/08/2009						✓ 12.93
564	Wheatear, Mountain	Bergwagter	*Oenanthe monticola*	50	2	30/08/2009						✓ 10.20
1172	White-eye, Cape	Kaapse Glasogie	*Zosterops virens*									✓ 4.76
1171	White-eye, Orange River	Gariepglasogie	*Zosterops pallidus*									✓ 4.76
846	Whydah, Pin-tailed	Koningrooibekkie	*Vidua macroura*	25	1	01/04/2014						✓ 46.26
816	Widowbird, Fan-tailed	Kortstertflap	*Euplectes axillaris*	50	2	01/04/2014						✓ 10.88
818	Widowbird, Long-tailed	Langstertflap	*Euplectes progne*	100	4	01/04/2014						✓ 88.44
813	Widowbird, Red-collared	Rooikeelflap	*Euplectes ardens*									✓ 1.36
814	Widowbird, White-winged	Witvlerkflap	*Euplectes albonotatus*	50	2	30/08/2009						✓ 18.37
419	Wood-hoopoe, Green	Rooibekkakelaar	*Phoeniculus purpureus*									✓ 0.68

Ref	Species name	Afrikaans	Taxonomic name	Full protocol			Adhoc protocol			Incidentals		SABAP1
				Rep Rate (%)	n	Latest	Rep Rate (%)	n	Latest	Reports	Latest	
453	Wryneck, Red-throated	Draaihals	*Jynx ruficollis*									✓ 9.52

APPENDIX D2

HERITAGE SURVEY REPORT

TERMS OF REFERENCE (Heritage)

- Compile a Phase 1 Heritage Impact Assessments for the Basic Assessment Process in accordance with the South African Heritage Resources Act (No. 25 of 1999).
- The identification and mapping of all heritage resources in the area affected, as defined in Section 2 of the National Heritage Resources Act, 1999, including archaeological and palaeontological sites on or close (within 100 m) of the proposed developments.
- The assessment of the significance of such resources in terms of the heritage assessment criteria as set out in the regulations.
- An assessment of the impact of development and any alternatives on such heritage resources.
- An evaluation of the impact of the development on heritage resources relative to the sustainable social and economic benefits to be derived from the development.
- The identification of heritage resources that will be adversely affected by the proposed development.
- Prepare a heritage sensitivity map (GIS-based), based on the findings of the study. Submit shapefiles (Hartebeetshoek 94) to Nemai Consulting
- Identify heritage resources to be monitored.
- Comply with specific requirements and guidelines of Provincial Heritage Resources Authority for Gauteng

PHASE 1 HERITAGE IMPACT ASSESSMENT (HIA) FOR THE PROPOSED KRIEL - MATLA ASH TRANSFER LINK

Leonie Marais-Botes
Heritage Practitioner

868 Endeman Street
Wonderboom South
Pretoria
0084
Mobile: 082 576 6253
E-mail: leoniembotes@gmail.com

BA (Cultural History and Archaeology) (UP), BA (Hons) Cultural History (UP), Post Grad Dip Museology (UP), Cert Conservation of Traditional Buildings (Univ of Canberra) Post Grad Dip: Heritage (Wits)

Accredited member: SA Society for Cultural History (CH002)

For:

Nemai Consulting
PO Box 1673
SUNNINGHILL
2157

October 2015

DISCLAIMER:

Although all possible care is taken to identify/find all sites of cultural importance during the initial survey of the study area, the nature of archaeological and historical sites are as such that it is always possible that hidden or sub-surface sites could be overlooked during the study. Leonie Marais-Botes Heritage Practitioner will not be held liable will not be held liable for such oversights or for the costs incurred as a result thereof.

ACKNOWLEDGEMENTS

Australia ICOMOS. *The Burra Charter*.

Bergh, J.S. Geskiedenis Atlas van Suid-Afrika. Die vier Noordelike Provinsies. Van Schaik Uitgewers, 1998.

Beyers C.J. (Editor-in-Chief). Dictionary of South African Biography (Vol I – V). Pretoria, 1987.

Coertze, P.J. & Coertze, R.D. Verklarende vakwoordeboek vir Antropologie en Argeologie. Pretoria, 1996.

Graham, J. Interview on 18 September 2014.

Huffman, T.N. A Handbook to the Iron Age: The Archaeology of Pre- Colonial Farming Societies in Southern Africa. University of KwaZulu-Natal Press, 2007

Human Tissues Act (Act 65 of 1983 as amended)

Government Printers. 1: 50 000

National Heritage Legislation (Act 25 of 1999)

National Environmental Management Act (Act 107 of 1998)

Ordinance on Exhumations (no 12 of 1980)

Potgieter, D.J. (editor-in-chief) Standard Encyclopaedia of Southern Africa. London 1971.

Rosenthal E. (Editor) Encyclopaedia of Southern Africa, 1973

The National Archives of South Africa databases.

www.eskom.co.za

Contents page

Contents	**Page**

ABOUT THIS REPORT

The heritage report must reflect that consideration has been given to the history and heritage significance of the study area and that the proposed activities is sensitive towards the heritage resources and does not significantly alter or destroy the heritage significance of the study area.

The heritage report must refer to the heritage resources currently in the study area.

The opinion of an independent heritage consultant is required to evaluate if the proposed work generally follows a good approach that will ensure the conservation of the heritage resources.

The National Heritage Resources Act (Act 25 of 1999), the National Environmental Management Act (Act 107 of 1998), Ordinance on Exhumations (no 12 of 1980) and the Human Tissues Act (Act 65 of 1983 as amended) are the guideline documents for a report of this nature.

Leonie Marais-Botes was appointed by Nemai Consulting to carry out a Phase 1 Heritage Impact Assessment (HIA) for the proposed Kriel – Matla Ash Transfer Link. The site visit took place on 6 October 2015.

DEFINITION OF TERMS:

''alter'' means any action affecting the structure, appearance or physical properties of a place or object, whether by way of structural or other works, by painting, plastering or other decoration or any other means.

"archaeological'' means—
(a) material remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years, including artefacts, human and hominid remains and artificial features and structures;
(b) rock art, being any form of painting, engraving or other graphic representation on a fixed rock surface or loose rock or stone, which was executed by human agency and which is older than 100 years, including any area within 10m of such representation;
(c) wrecks, being any vessel or aircraft, or any part thereof, which was wrecked in South Africa, whether on land, in the internal waters, the territorial waters or in the maritime culture zone of the Republic, as defined respectively in sections 3, 4 and 6 of the Maritime Zones Act, 1994 (Act No. 15 of 1994), and any cargo, debris or artefacts found or associated therewith, which is older than 60 years or which SAHRA considers to be worthy of conservation; and
(d) features, structures and artefacts associated with military history which are older than 75 years and the sites on which they are found.

''conservation'', in relation to heritage resources, includes protection, maintenance, preservation and sustainable use of places or objects so as to safeguard their cultural significance.

''cultural significance'' means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance.

''development'' means any physical intervention, excavation, or action, other than those caused by natural forces, which may in the opinion of a heritage authority in any way result in a change to the nature, appearance or physical nature of a place, or influence its stability and future well-being, including—
(a) construction, alteration, demolition, removal or change of use of a place or a structure at a place;
(b) carrying out any works on or over or under a place;
(c) subdivision or consolidation of land comprising, a place, including the structures or airspace of a place;
(d) constructing or putting up for display signs or hoardings;
(e) any change to the natural or existing condition or topography of land; and
(f) any removal or destruction of trees, or removal of vegetation or topsoil; object that is specifically designated by that state as being of importance.

''grave'' means a place of interment and includes the contents, headstone or other marker of such a place, and any other structure on or associated with such place.

''heritage resource'' means any place or object of cultural significance.

''heritage resources authority'' means the South African Heritage Resources Agency, or in respect of a province, a provincial heritage resources authority.

''heritage site'' means a place declared to be a national heritage site by SAHRA or a place declared to be a provincial heritage site by a provincial heritage resources authority.

''improvement'', in relation to heritage resources, includes the repair,
restoration and rehabilitation of a place protected in terms of Act 25 of 1999.
''living heritage'' means the intangible aspects of inherited culture, and may include—
(a) cultural tradition;

(b) oral history;
(c) performance;
(d) ritual;
(e) popular memory;
(f) skills and techniques;
(g) indigenous knowledge systems; and
(h) the holistic approach to nature, society and social relationships.

''local authority'' means a municipality as defined in section 10B of the Local Government Transition Act, 1993 (Act No. 209 of 1993).

''management'', in relation to heritage resources, includes the conservation, presentation and improvement of a place protected in terms of Act 25 of 1999.

''meteorite'' means any naturally-occurring object of extraterrestrial origin.

''object'' means any movable property of cultural significance which may be protected in terms of any provisions of Act 25 of 1999, including—
(a) any archaeological artefact;
(b) palaeontological and rare geological specimens;
(c) meteorites; and
(d) other objects.

''palaeontological'' means any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trance.

''place'' includes—
(a) a site, area or region;
(b) a building or other structure which may include equipment, furniture, fittings and articles associated with or connected with such building or other structure;
(c) a group of buildings or other structures which may include equipment, furniture, fittings and articles associated with or connected with such group of buildings or other structures;
(d) an open space, including a public square, street or park; and
(e) in relation to the management of a place, includes the immediate surroundings of a place.

''presentation'' includes—
(a) the exhibition or display of;
(b) the provision of access and guidance to;
(c) the provision, publication or display of information in relation to; and
(d) performances or oral presentations related to, heritage resources protected in terms of Act 25 of 1999.

''public monuments and memorials'' means all monuments and memorials—
(a) erected on land belonging to any branch of central, provincial or local government, or on land belonging to any organisation funded by or established in terms of the legislation of such a branch of government; or
(b) which were paid for by public subscription, government funds, or a public-spirited or military organisation, and are on land belonging to any private individual.

''site'' means any area of land, including land covered by water, and including any structures or objects thereon.
''structure'' means any building, works, device or other facility made by people and which is fixed to land, and includes any fixtures, fittings and equipment associated therewith.
''victims of conflict'' means—

(a) certain persons who died in any area now included in the Republic as a direct result of any war or conflict as specified in the regulations, but excluding victims of conflict covered by the Commonwealth War Graves
Act, 1992 (Act No. 8 of 1992);
(b) members of the forces of Great Britain and the former British Empire who died in active service in any area now included in the Republic prior to 4 August 1914;
(c) persons who, during the Anglo-Boer War (1899-1902) were removed as prisoners of war from any place now included in the Republic to any place outside South Africa and who died there; and
(d) certain categories of persons who died in the ''liberation struggle'' as defined in the regulations, and in areas included in the Republic as well as outside the Republic.

EXECUTIVE SUMMARY

Leonie Marais-Botes Heritage Practitioner was requested by Nemai Consulting to conduct a Phase 1 Heritage Impact Assessment (HIA) for the proposed Kriel – Matla Ash Transfer Link.

A field survey was conducted after which a survey of literature was undertaken.

No heritage sites are evident in the study area.

It should be noted that the sub-surface archaeological and/or historical deposits and graves are always a possibility. Care should be taken during any work in the entire area and if any of the above is discovered, an archaeologist/heritage practitioner should be commissioned to investigate.

1. INTRODUCTION

Kriel Power Station is a coal fired power station comprising of six units which produce a combined base load of 3 000 MW. The power station has a remaining operating life of 26 years and is scheduled to be decommissioned in 2039. To generate 3 000 MW of electricity coal is burnt by the boilers which produces ash as a waste product. The ash is then disposed of and stored on the Ash Dam.

Kriel Power Station Ash Dam will reach its maximum capacity in approximately June 2017 and Eskom is currently in the process of designing and undertaking the environmental authorisation for a new Ash Dam. However, according to the latest schedule a new ash dam will only be commissioned in September 2020, thus Kriel will not have sufficient capacity to deal with the ash generated between 2017 and 2020.

Eskom has therefore proposed the Kriel-Matla Ash Transfer Link which will involve the following, as an intermediate solution for a period of approximately 3.5 - 4 years until the new Kriel Ash Dam is developed:

- The transferring of 100% of Kriel Power Station Ash to Matla Power Station Ash Dam.
- The return of all Kriel Ash Water from the Matla Power Station Ash Dam to Kriel Power Station.

1.1 WHY A PHASE 1 HERITAGE IMPACT ASSESSMENT IS REQUIRED?

This project may potentially impact on any types and ranges of heritage resources that are outlined in Section 3 of the National Heritage Resources Act (Act 25 of 1999). Subsequently a Phase 1 Heritage Impact Assessment (HIA) was commissioned by Nemai Consulting and conducted by Leonie Marais-Botes.

1.1.1 METHOD

The objective of this Phase 1 Heritage Impact Assessment (HIA) was to gain an overall understanding of the heritage sensitivities of the area and indicate how they may be impacted on through development activities. The site survey took place on 6 October 2015.

In order to establish heritage significance the following method was followed:

- Investigation of primary resources (archival information)
- Investigation of secondary resources (literature and maps)
- Physical evidence (site investigation)
- Determining Heritage Significance.

1.2 PROJECT DESCRIPTION

The proposed project will involve the development of four new ash pipelines from Kriel to Matla as well as an Ash Water Return (AWR) System comprising of three AWR pipelines. In addition, a new Booster Pump house will be constructed adjacent to the existing pumphouse at Matla to accommodate three new boosters. New solution trenches will also be put in place.

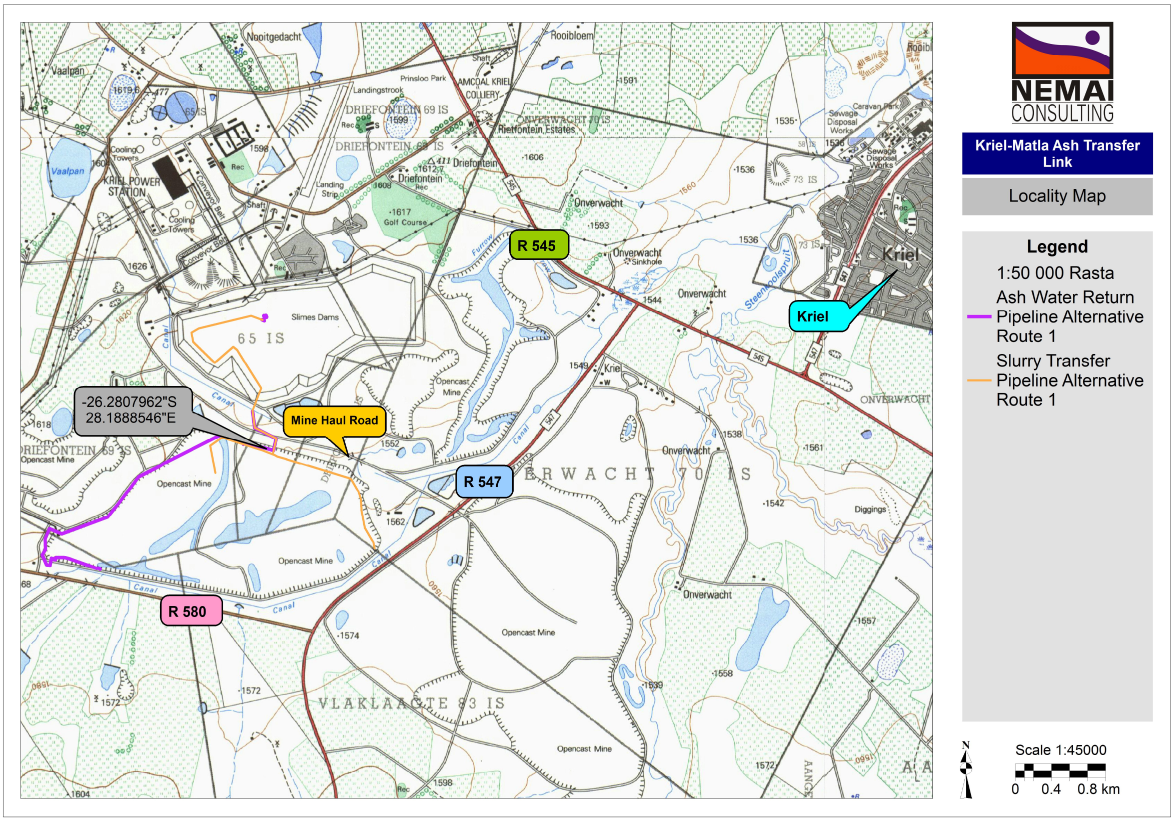


Figure 1: Preferred locality route map of the Kriel-Matla Transfer Link.

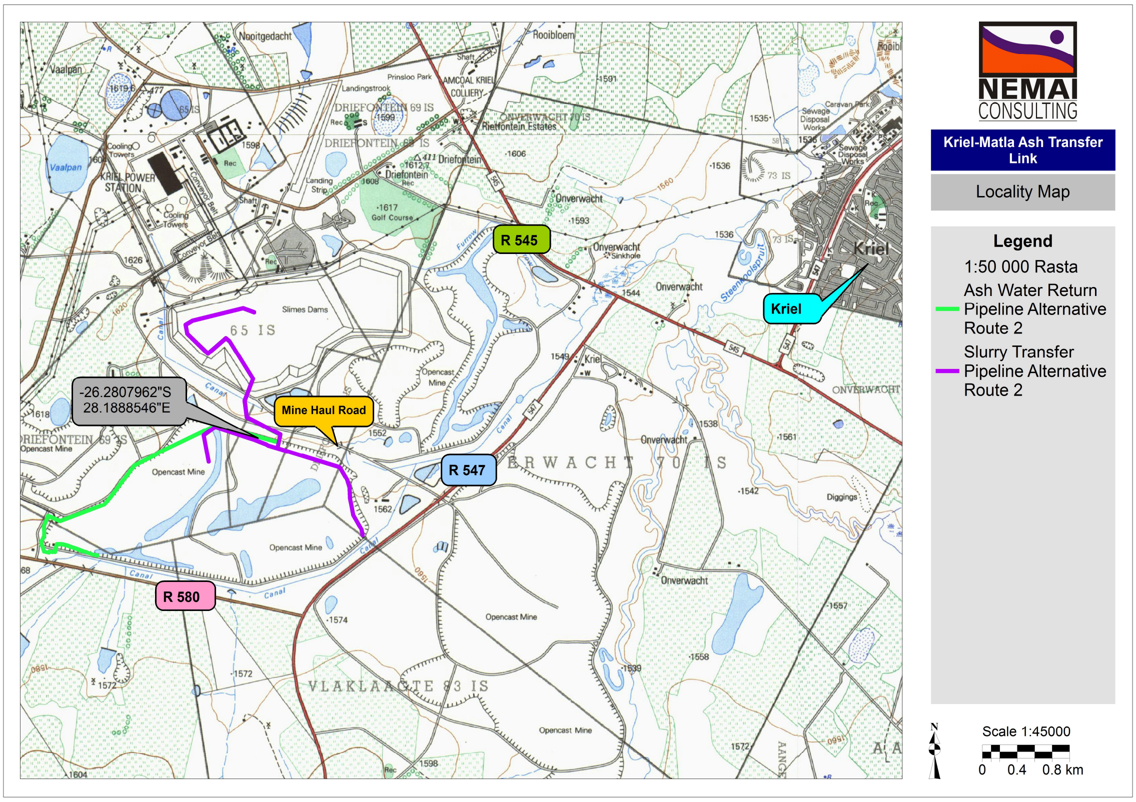


Figure 2: Alternative locality route map Kriel-Matla Transfer Link.

1.3 HISTORIY OF THE STUDY AREA

Matla, which means strength or power in SeSotho, is a coal-fired power station, situated near Kriel on the Mpumalanga highveld, approximately 200km from Johannesburg. It is a base-load plant, which means it operates continuously, except for regular scheduled stoppages for inspection and maintenance on the individual units.

Matla consists of six 600MW units at an installed capacity of 3 600MW, the first of the giant 3600MW coal-fired power station to be commissioned in the 1980's. Average availability over the last 3 years is at 93.84%. There's approximately 718 employees (excluding students and contractors) at this station. Matla is one of a few power stations in the world with a concrete boiler house superstructure, giving it an outward appearance very different from other power stations in South Africa. The use of concrete reduced the construction lead time and capital costs at a time when there was a worldwide shortage of steel. The planning and design of Matla Power station commenced in the early 1970s. It was designed for an operating life of 30 years, but its lifespan has since been extended to 60 years. Construction started late 1974, and the first of the 600MW sets started feeding power into the national grid towards the end of 1979. Matla reached full operational capacity in early July, 1983.

The planning and design of Kriel Power Station began in the early seventies. Construction also started in the early seventies and the station began operating at full capacity early 1979. When Kriel was completed in 1979, it was the largest coal-fired station in the Southern Hemisphere.

Kriel was instrumental in breaking ground for the large 3600 MW power stations such as Duvha, Matla, Kendal, Matimba and Lethabo. Kriel was one of the first stations to be supplied with coal from a fully mechanised coal mine, with the coal arriving at the boilers from the mine - untouched by hand.

Kriel is unique in that each turbine generator set is separate, whereas in Eskom's other stations, all the turbines are housed in a single turbine hall, all placed along the same axis. Kriel is a winning station in terms of its plant performance. It was awarded the Jan H Smith trophy for being the best power station Eskom in 1991 and 1995.

Kriel performed very well with all operational indicators being satisfactory and some outstanding technical achievements, particularly in the area of plant performance. We had set ourselves the goal of a unit capability factor of 90%; a planned outage rate of 7% and a forced outage rate of 3% and by the year 2000. This was already bettered in 1996, placing us in the best quartile of the UNIPEDE member countries.

Kriel continues to benchmark itself against other business units and utilities worldwide and for a long period it has been Eskom's goal to become the world's lowest-cost producer of electricity. Business efficiency has improved year by year and has allowed a steady reduction in the real price of electricity. In the light of the immense efforts it required, it is of great satisfaction to all at Eskom that the latest international survey indicate that South Africans now enjoy one of the lowest electricity in the world.

Kriel Power Station, generating 3000 MW, was the forerunner of the new generation of giant coal-fired power stations developed to generate the increasing supply of electricity demanded by South Africa's constant growth. Kriel was actually the forerunner on all the major performance criteria's since 1991[1].

1.4 LOCATION AND PHOTOGRAPHIC RECORD OF STUDY AREA

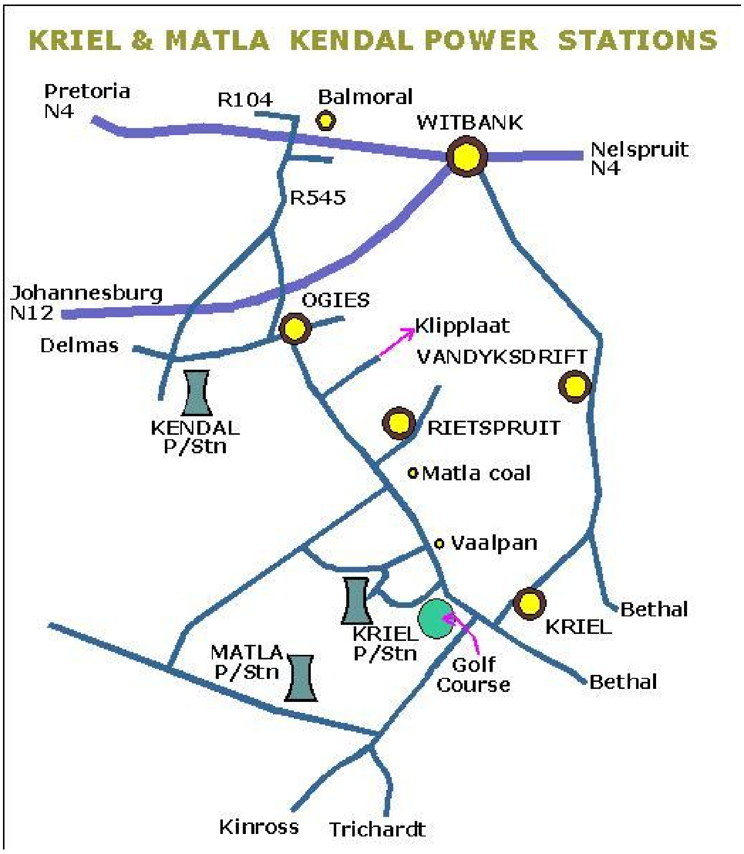


Figure 3: Location Map: Kriel and Matla Power Stations.

[1] www.eskom.co.za

Figure 4: Starting point of proposed ash transfer pipelines at Kriel Power Station ash dams.

Figure 5: Site earmarked for development, proposed pipeline route towards Matla Power Station.

Figure 6: Site earmarked for development. Proposed pipeline route towards Matla Power Station ash dams.

Figure 7: Site earmarked for development. Proposed pipeline route towards Matla Power Station ash dams.

Figure 8: Area between Kriel Power Station ash dams and Matla Power Station ash dams.

Figure 9: Site earmarked for development, Matla Power Station

Figure 10: Site earmarked for development, *en route* to Matla Power Station ash dams.

Figure 11: Site earmarked for development, *en route* to Matla Power Station ash dams.


Figure 12: Site earmarked for development, *en route* to Matla Power Station ash dams.


Figure 13: Site earmarked for development, Matla Power Station ash dams.

2. FINDINGS

2.1 PRE-COLONIAL HERITAGE SITES

Possibilities: Greater study area taken into account.

Stone Age

The Stone Age is the period in human history when stone material was mainly used to produce tools[2]. In South Africa the Stone Age can be divided in three periods[3];

- Early Stone Age 2 000 000 – 150 000 years ago
- Middle Stone Age 150 000 – 30 000 years ago
- Late Stone Age 40 000 years ago - +/- 1850 AD

Iron Age

The Iron Age is the period in human history when metal was mainly used to produce artefacts[4]. In South Africa the Iron Age can be divided in three periods;

- Early Iron Age 250-900 AD
- Middle Iron Age 900-1300 AD
- Late Iron Age 1300-1840 AD[5]

There are no pre-colonial heritage sites evident in the study area. This can be attributed to previous farming and other infra-structure development activities in the study area.

2.2 HISTORICAL PERIOD HERITAGE SITES

Possibilities: Greater study area taken into account.

- Pioneer sites;
- Sites associated with early mining;
- Structures older than 60 years;
- Graves (Graves younger than 60 years, graves older than 60 years, but younger than 100 years, graves older than 100 years, graves of victims of conflict or of individuals of royal descent).

There are no historical period sites situated on the site earmarked for development.

2.3 ORIGINAL LANDSCAPE

Farming and other infrastructure development have altered the original landscape in the study area.

---

[2] P. J. Coertze & R.D. Coertze, Verklarende vakwoordeboek vir Antropologie en Argeologie.
[3] S.A. Korsman & A. Meyer, *Die Steentydperk en rotskuns* in J.S. Bergh (red) Geskiedenisatlas van Suid-Afrika. Die vier noordelike provinsies.
[4] P.J. Coertze & R.D. Coertze, Verklarende vakwoordeboek vir Antropologie en Argeologie.
[5] M.M. van der Ryst & A Meyer. *Die Ystertydperk* in J.S. Bergh (red) Geskidenisatlas van Suid-Afrika. Die vier noordelike provinsies and T.N Huffman, A Handbook to the Iron Age: The Archaeology of Pre-Colonial Farming Societies in Southern Africa.

2.4 INTANGIBLE HERITAGE

The intangible heritage of the greater study area can be found in the stories of past and present inhabitants.

3 CATEGORIES OF HERITAGE VALUE (ACT 25 OF 1999)

The National Heritage Resources Act (Act 25 of 1999) identifies the following categories of value under section 3(1) and (2) of the Act under the heading "National Estate":

"3 (1) For the purpose of this Act, those heritage resources of South Africa which are of cultural significance or other special value for the present community and for future generations must be considered part of the national estate and fall within the sphere of operations of heritage resources authorities.

(2) Without limiting the generality of subsection (1), the national estate may include-
- (a) places, buildings, structures and equipment of cultural significance;
- (b) places which oral traditions are attached or which are associated with living heritage;
- (c) historical settlements and townscapes;
- (d) landscapes and natural features of cultural significance;
- (e) geological sites of scientific or cultural importance;
- (f) archaeological and palaeontological sites;
- (g) graves and burial grounds, including-
  - (i) ancestral graves;
  - (ii) royal graves and graves of traditional leaders;
  - (iii) graves of victims of conflict;
  - (iv) graves of individuals designated by the Minister by notice in the Gazette
  - (v) historical graves and cemeteries; and
  - (vi) other human remains which are not covered in terms of the Human Tissue Act, 1983 (Act No. 65 of 1983);
- (h) sites of significance relating to the history in South Africa;
- (i) movable objects, including-
  - (i) objects recovered from the soil or waters of South Africa including archaeological and palaeontological objects and material, meteorites and rare geological specimens;
  - (ii) objects to which oral traditions are attached or which are associated with living heritage;
  - (iii) ethnographic art and objects;
  - (iv) military objects
  - (v) objects of decorative or fine art;
  - (vi) objects of scientific or technological interests; and
  - (vii) books, records, documents, photographic positives and negatives, graphic, film or video material or sound recordings, excluding those that are public records as defined in section I (xiv) of the National Archives of South Africa Act, 1996 (Act No. 43 of 1996).

(3) Without limiting the generality of the subsections (1) and (2), a place or object is to be considered part of the national estate if it has cultural significance or other special value because of-
- (a) It is importance in the community, or pattern of South Africa's history;
- (b) Its possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;
- (c) Its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;

(d) Its importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural objects;
(e) Its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;
(f) Its importance in demonstrating a high degree of creative or technical achievement at a particular period;
(g) Its strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;
(h) Its strong or special association with the life and work of a person, group or organisation of importance in the history of South Africa; and
(i) Sites of significance relating to the history of slavery in South Africa."

3.1 HERITAGE VALUE OF WEIGHED AGAINST CULTURAL SIGNIFICANCE CATEGORIES

3.1.1 Spiritual value

During the site visit/field work no indication of any spiritual activity was observed on/near the proposed site. Thus no sites of spiritual value will be impacted on by the proposed project.

3.1.2 Scientific value

No sites of scientific value was observed on or near the site earmarked for development.

3.1.3 Historical value

No historical value associated with the site could be found in primary and secondary sources.

3.1.4 Aesthetic value

No heritage item with exceptional aesthetic (architectural) value was identified in the study area.

3.1.5 Social value

Social value is attributed to sites that are used by the community for recreation and formal and informal meetings regarding matters that are important to the community. These sites include parks, community halls, sport fields etc. None of the said evident in the immediate study area.

3.2 SPECIFIC CATEGORIES INVESTIGATED AS PER SECTION 3 (1) AND (2) OF THE NATIONAL HERITAGE LEGISLATION (ACT 25 OF 1999)

3.2.1 Does the site/s provide the context for a wider number of places, buildings, structures and equipment of cultural significance?

The study area does not provide context for a wider number of places, buildings, structures and equipment of cultural significance. The reason being the low density of heritage items in the study area.

3.2.2 Does the site/s contain places to which oral traditions are attached or which are associated with living heritage?

Places to which oral traditions are attached or associated with living heritage are usually find in conjunction with traditional settlements and villages which still practises age old traditions. None of these are evident near or on the proposed site.

3.2.3 Does the site/s contain historical settlements?

No historical settlements are located on or near the proposed site.

3.2.4 Does the site/s contain landscapes and natural features of cultural significance?

Due to infra-structure development and farming activities the original character of the landscape have been altered significantly in the study area. There the site does not contain natural features of cultural significance.

3.2.5 Does the site/s contain geological sites of cultural importance?

Geological sites of cultural importance include meteorite sites (Tswaing Crater and Vredefort Dome), fossil sites (Karoo and Krugersdorp area), important mountain ranges or ridges (Magaliesburg, Drakensberg etc.). The proposed site is not located in an area known for sites of this importance.

3.2.6 Does the site/s contain a wide range of archaeological sites?

The proposed site does not contain any surface archaeological deposits, a possible reason is previous farming and other infra-structure development in the greater study area.

The possibility of sub-surface findings always exists and should be taken into consideration in the Environmental Management Plan.

If sub-surface archaeological material is discovered work must stop and a heritage practitioner preferably an archaeologist contacted to assess the find and make recommendations.

3.2.7 Does the site/s contain any marked graves and burial grounds?

The site does not contain any marked graves or burial grounds.

The possibility of graves not visible to the human eye always exists and this should be taken into consideration in the Environmental Management Plan.

It is important to note that all graves and cemeteries are of high significance and are protected by various laws. Legislation with regard to graves includes the National Heritage Resources Act (Act 25 of 1999) whenever graves are 60 years and older. Other legislation with regard to graves includes those when graves are exhumed and relocated, namely the Ordinance on Exhumations (no 12 of 1980) and the Human Tissues Act (Act 65 of 1983 as amended).

If sub-surface graves are discovered work should stop and a professional preferably an archaeologist contacted to assess the age of the grave/graves and to advice on the way forward.

3.2.8 Does the site/s contain aspects that relate to the history of slavery?

This is not an area associated with the history of slavery like the Western Cape Province.

3.2.9 Can the place be considered as a place that is important to the community or in the pattern of South African history?

In primary and secondary sources the proposed site is not described as important to the community or in the pattern of South African history.[6]

3.2.10 Does the site/s embody the quality of a place possessing uncommon or rare endangered aspects of South Africa's natural and cultural heritage?

The proposed site does not possess uncommon, rare or endangered aspects of South Africa's natural and cultural heritage. These sites are usually regarded as Grade 1 or World Heritage Sites.

3.2.11 Does the site/s demonstrate the principal characteristics of South Africa's natural or cultural places?

The proposed site does not demonstrate the principal characteristics of South Africa's natural or cultural places. These characteristics are usually associated with aesthetic significance.

3.2.12 Does the site/s exhibit particular aesthetic characteristics valued by the community or cultural groups?

This part of the greater study area does not exhibit particular aesthetic characteristics valued by the community or cultural groups. The reason being the low density of heritage buildings and structures located in the greater study area.

---

[6] Standard Encyclopaedia of Southern Africa and the TAB database at the National Archives of South Africa;
J.S. Bergh (red), Geskiedenisatlas van Suid-Afrika. Die Vier Noordelike Provinsies.

3.2.13 Does the site/s contain elements, which are important in demonstrating a high degree of creative technical achievement?

The site does not contain elements which are important in demonstrating a high degree of creative technical achievement. Reason being none of the above are evident on site.

3.2.14 Does the site/s have strong and special associations with particular communities and cultural groups for social, cultural and spiritual reasons?

The proposed site does not have a strong or special association with particular communities and cultural groups for social, cultural and spiritual reasons. No comment in this regard was received during the public participation period.

3.2.15 Does the site/s have a strong and special association with the life or work of a person, group or organisation?

No indication of the above could be found in primary and secondary research sources.[7]

4. RECOMMENDATIONS

- The area earmarked for development is situated in an already greatly disturbed environment. There are no visible restrictions or negative impacts in terms of heritage associated with the preferred and alternative pipeline routes. In terms of heritage this project can proceed.
- The discovery of subsurface archaeological and/or historical material as well as graves must be taken into account in the Environmental Management Plan. See 3.2.6 and 3.2.7.

5. THE WAY FORWARD

- **Submit this report as a Section 38 application to the Mpumalanga Provincial Heritage Authority for comment/approval.**

[7] Dictionary of South African Biography (vol I-V) and the TAB database at the National Archives of South Africa

APPENDIX D3

AQUATIC SPECIALISTS REPORTS

- Wetland Assessment Report
- Aquatic Assessment Report
- Surface water Report

TERMS OF REFERENCE (Aquatics)

- Provide a description of the location of the watercourse at which the water use/s is to take place;
- Provide a locality map/s indicating the relevant catchment, surrounding land use, towns, infrastructure etc.;
- Provide the name and/or description of the affected watercourse;
- Provide a map with accompanying photographs (dated) indicating the segment and affected reach/es of the watercourse in which the water use/s is to take place and which indicates/delineates the regulated area2 including:
- The extent of the riparian habitat; and
- The 1:100 year flood line
- Describe within context of the immediate catchment and segment, the historic as well as current state (Present Ecological State or PES) of the affected reach/es of the watercourse with regards to the following characteristics (attributes):
- Flow and sediment regimes (quantity, pattern, timing, water level and assurance of in stream flow);
- Water quality (including the physical, chemical and biological characteristics of the water) in relation to the flow regime
- Riparian and In stream Habitat
- Morphology (physical structure)
- Vegetation
- Biota
- Describe the ecological importance and sensitivity (EIS)4 as well as the Socio-cultural Importance (SI)5 of the affected reach/es of the watercourse including the functions;
- Discuss existing land and water use impacts (and threats) on the characteristics of the watercourse
- List and map sensitive environments in proximity of the project locality - sensitive environments include wetlands, nature reserves, protected areas, etc.
- Describe the water use and the activities associated with the water use/s>
- Describe the project phases for each activity (i.e. planning, construction, operation and maintenance, decommissioning) including, but not limited to, the programme for and duration of the various phases;

- Provide a site lay-out plan/s (master plan) indicating the various activities and existing and proposed infrastructure in relation to the 1:100 flood line and edge of the watercourse, etc. – a letter or certificate by a qualified surveyor must also be submitted that verifies the correctness of the site lay-out plans, in particular for wetlands;
- Provide a prediction and assessment of the likely environmental and socio-economic impacts or effects associated with the water use/s for the different project phases:
- On the watercourse and its characteristics as set out in 1.2.3 above
- On other water users
- On the broader public and property
- If the water use/s is not authorised
- Provide a description of the methodologies employed to undertake impact prediction and assessment as well as a motivation for these
- Describe the alternatives considered to prevent negative impacts on the watercourse with regard to locality, procedures, materials, etc.
- Provide mitigation measures11 to prevent, reduce, remediate or compensate the pre-determined impacts; also provide emergency responses
- Assess to what extent the impacts after mitigation will bring about changes in respect of the PES (and recommended ecological category, if this information is available at the stage of study) and functionality of the watercourse; as well as the socio-economic environment (including redress considerations as well impacts on other water users)
- Provide a detailed monitoring programme and describe the auditing, compliance and reporting mechanisms to ensure execution of the mitigation measures and for informing DWAF of incidents – ensure that these measures are appropriate in relation to the impacts, mitigation measures, status of the watercourse, etc.

Matla Transfer Link

Wetlands

Project Number:

ESK2840

Prepared for:

Eskom

November 2015

Digby Wells and Associates (South Africa) (Pty) Ltd
(Subsidiary of Digby Wells & Associates (Pty) Ltd). Co. Reg. No. 2010/008577/07. Turnberry Office Park, 48 Grosvenor Road, Bryanston, 2191. Private Bag X10046, Randburg, 2125, South Africa
Tel: +27 11 789 9495, Fax: +27 11 789 9498, info@digbywells.com, www.digbywells.com

This document has been prepared by Digby Wells Environmental.

Report Type:	**Wetlands**
Project Name:	**Matla Transfer Link**
Project Code:	**ESK2840**

Name	**Responsibility**	**Date**
Crystal Rowe	Report Writer	November 2015

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 Introduction

Chapter 4 of the National Water Act, 1998 (Act No. 36 of 1998) (NWA), legislates the use of water, identifies various water uses (Section 21 water uses) and facilitates the licensing of the Section 21 water uses through the process of a Water Use License Application (WULA). The Best Practical Environmental Option (BPEO) must be implemented when using water to ensure that there is a sustainable use of water and to prevent the deterioration of water quality and/or decrease in the quantity of the water resources as a result of any development.

Eskom Holdings SOC Limited (Eskom) appointed Digby Wells Environmental (Digby Wells) as an independent Environmental Assessment Practitioner (EAP) to undertake the required WULA to obtain environmental authorisation for the proposed “Kriel-Matla Transfer Link Project” (the Project) from the Department of Water and Sanitation (DWS).

The following sections of this report have been compiled to address the specific requirements for the WULA. Therefore, this report should be considered with the various ancillary documents such as the aquatic ecology report.

2 Locality

2.1 Catchment

Kriel Power Station is located approximately 6km north-east of Matla Coal Mine in the Mpumalanga Province and is located within the Quaternary Catchment B11D (Figure 2-1), with the Steenkoolspruit River flowing in north. The Steenkoolspruit River is a tributary of the Olifants River and has been allocated a Present Ecological State (PES) of ‘D’, indicating that it is largely modified (Department of Water and Sanitation (DWS)). The dominant landuses in the catchment are agriculture and mining; resulting in marked cumulative deterioration of water quality and general wetland health. The Steenkoolspruit River has been identified as the largest source of nutrients into the Olifants River (CSIR 2012).

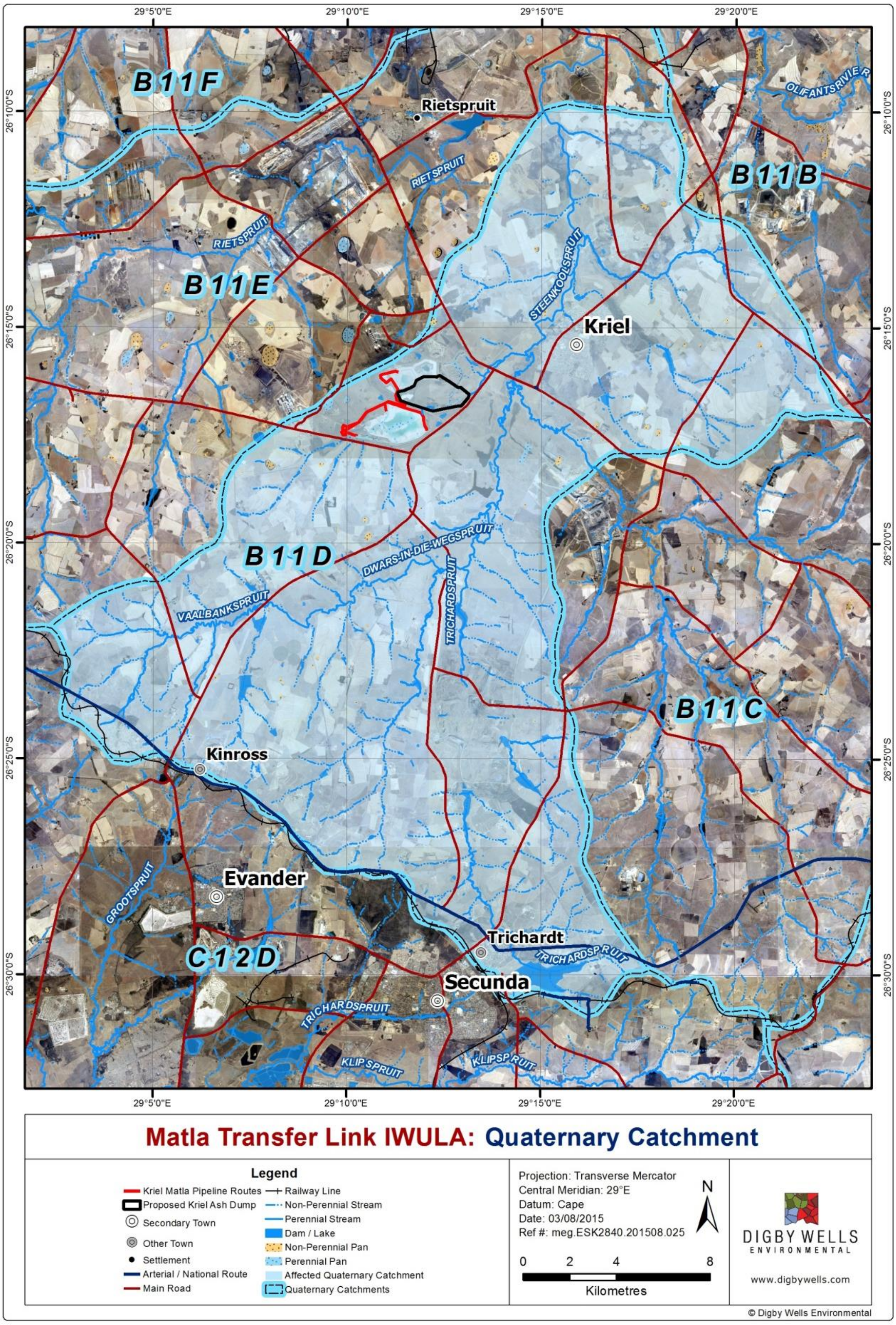


Figure 2-1: Quaternary Catchment

2.2 Name and Description

The identified wetlands were classified according to the hydro-geomorphic (HGM) determinants based on modification of the system proposed by Brinson (1993), and modified for use by Marneweck and Batchelor (2002) and subsequently revised by Kotze *et al.* (2004).

The affected watercourse is an unnamed tributary of the Steenkoolspruit River. This wetland has been significantly altered from its natural state and has been channelled by restrictive barriers in the form of roads and the northern wall of the Matla Coal Mine Ash Dam. The main watercourse associated with the proposed pipeline flows in a westerly direction. This wetland is dominated by *Phragmites australis* (Common Reed), a typical indicator of increased sedimentation. In addition, *Seriphium plumosum* (Bankrupt Bush) was prevalent, which is an indicator of overutilised, disturbed habitat. Examples of plant species recorded in wetland areas on site are listed in Table 2-1; the majority of which are alien plant species.

Table 2-1: Examples of plant species recorded in wetlands on site

Family	Species Name	Common Name	Ecological Significance
Asteraceae	*Helichrysum sp.*	/	/
Asteraceae	*Seriphium plumosum*	Bankrupt Bush	Native invader of wetlands and terrestrial grassland
Astereceae	*Tagetes minuta*	Khakibos	Alien forb
Myrtaceae	*Eucalyptus camuldulensis*	Red River Gum	Alien Invasive Tree
Poaceae	*Cortaderia selloana*	Pampas Grass	Alien Invasive Grass
Poaceae	*Digitaria eriantha*	Digit Grass	Terrestrial Grass
Poaceae	*Imperata cylindrica*	Cottonwool Grass	Permanent Hydrophyte
Poaceae	*Hyparrhenia hirta*	Common Thatching Grass	Terrestrial Grass
Poaceae	*Phragmites australis*	Common Reed	Permanent Hydrophyte
Salicaceae	*Populus x deltoides*	Cottonwood Poplar	Alien Invasive Tree
Salicaceae	*Salix babylonica*	Babylon Weeping Willow	Alien Tree

Verbenaceae	*Verbena brasiliensis*	Brazilian Verbena	Alien Forb

The pipeline crosses wetland area at 3 points, as indicated in Table 2-2. Wetlands are classified as: an altered channelled valley bottom, isolated seep and hillslope seep leading to an altered channel to the south of Matla's Ash Dump.

Table 2-2: Wetland crossing points

Pipeline Crossing	HGM unit
1	Altered Channelled Valley Bottom
2	Isolated Seep
3	Hillslope Seep leading to Channel

3 Wetland Current State

3.1.1 Approach

The WET-Health tool (as prescribed by Kotze *et al.* 2007) was used to determine the PES of wetlands associated with the study site. The health of a wetland can be determined from a measure of the deviation of wetland structure and function from the wetland's natural reference condition (Macfarlane *et al.* (2007)). The health assessment attempts to evaluate the hydrological, geomorphological and vegetation health in three separate modules to attempt to estimate similarity to or deviation from natural conditions. The PES is determined according to Table 3-1.

Table 3-1: Impact scores and Present Ecological State categories used by Wet-Health

Description	Combined Impact Score	PES Category
Unmodified, natural.	0-0.9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota has taken place.	1-1.9	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2-3.9	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9	D

Description	Combined Impact Score	PES Category
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognisable.	6-7.9	E
Modifications have reached a critical level and ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	F

3.1.2 Results

3.1.2.1 Crossing 1

The initial pipeline crossing is over the main wetland system in the study area, linked to the Steenkoolspruit River. This wetland has undergone change to ecosystem processes, hydrology, geomorphology and vegetation and has been allocated a PES of 'E'. The three modules assessed by the Wet-Health tool are described below:

3.1.2.1.1 Hydrology

Water movement through this wetland would historically have been typified by slow infiltration through relatively dense grassland vegetation over a wider reach. Channelled flow, which is characteristic of the present state of the wetland, is uncharacteristic of natural unchannelled valley bottom wetlands. Slow infiltration allows for effective nutrient assimilation and water purification; in addition to the prevention of erosion. Due to the presence of roads and the northern wall of the Matla Ash Dump, this wetland is artificially channelled. The results of the Wet-Health Assessment are represented in Table 3-2.

3.1.2.1.2 Geomorphology

The natural landscape of this wetland does not represent the natural reference state. Due to channelling and loss of natural vegetation, erosion gulleys are present. Further to this, various roads transect the wetland area, severing natural flow.

3.1.2.1.3 Vegetation

Natural vegetation that would have been present in the wetland in its reference state includes plant species that are typical of the Highveld grasslands; the Eastern Temperate Grasslands vegetation type in particular (Mucina and Rutherford 2006). Due to the largescale disturbance to the catchment, however, little natural vegetation assemblage remains. The majority of the wetland had been colonised by the native invader, *Phragmites australis* (Common Reed) as well as alien forbs and grasses representing low overall diversity of species.

3.1.2.2 Crossing 2

Crossing 2 traverses an isolated seep that has been almost entirely colonised by alien trees. The greatest impact to this wetland is the presence of roads and excavations; resulting in marked alteration of natural landscape topography. The three modules assessed by the Wet-Health tool are described below:

3.1.2.2.1 Hydrology

The dense stands of alien trees that occupy the majority of this wetland will have a considerable impact on water availability in this small system. Eucalyptus sp. in particular have high water demands for respiration. In addition, natural infiltration of water through the wetland has been hampered due to the disturbance of the topography.

3.1.2.2.2 Geomorphology

As aforementioned, the geomorphology of this system is completely altered due to the presence of roads and human disturbance to the soil.

3.1.2.2.3 Vegetation

Natural vegetation has been almost completely outcompeted by *Eucalyptus camuldulensis* and *Populus canescens*.

3.1.2.3 Crossing 3

The PES of crossing 3 was not evaluated, as this wetland is not natural and is in a completely altered state.

Table 3-2: Results of the Wet-Health Assessment

Wetland System	Module	Health Score	PES Class
Crossing 1	*Hydrology*	7.5	E→
	Geomorphology	4.9	D↓
	Vegetation	5.2	D↓
	Overall Score	6.1	E→
Crossing 2	*Hydrology*	7	E→
	Geomorphology	4.5	D↓
	Vegetation	6.3	E→
	Overall Score	6.0	E→

3.2 Ecological Importance and Sensitivity (EIS)

3.2.1 Approach

The Ecological Importance and Sensitivity (EIS) tool was derived to assess the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. In the method outlined by DWAF (1999) and Rountree (2012), a series of determinants for EIS (listed below) are assessed for the wetlands on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. Criteria for assessing the ecological importance and sensitivity of wetlands (Rountree, 2012) include:

- Primary Determinants:
  - Rare and Endangered Species;
  - Populations of Unique Species;
  - Species/taxon Richness;
  - Diversity of Habitat Types or Features;
  - Migration route/breeding and feeding site for wetland species;
  - Sensitivity to Changes in the Natural Hydrological Regime;
  - Sensitivity to Water Quality Changes; and
  - Flood Storage, Energy Dissipation & Particulate/Element Removal.
- Modifying Determinants:
  - Protected Status; and
  - Ecological Integrity.

The median of the determinants is used to determine the EIS of the wetland unit (Table 3-3).

Table 3-3: Interpretation of Median Scores (Ecological Importance and Sensitivity (EIS)) for Biotic and Habitat Determinants (DWAF, 1999)

Ecological Importance and Sensitivity Category (EIS)	Range of Median
Very high	
Floodplains that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers. Recommended Ecological Management Class: **A**	>3 and <=4
High	>2 and <=3

Ecological Importance and Sensitivity Category (EIS)	Range of Median
Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers. Recommended Ecological Management Class: **B**	
Moderate	>1 and <=2
Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers. Recommended Ecological Management Class: **C**	
Low/marginal	>0 and <=1
Floodplains that is not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers. Recommended Ecological Management Class: **D**	

3.2.2 Results

Due to large modification of natural habitat as a result of a history of farming and mining, the study area as a whole is not regarded as ecologically sensitive. The wetland crossings were assigned an EIS of ‘D’ – a low ecological importance. Crossing 3 was not assessed for EIS since this is not a natural wetland.

Table 3-4: Ecological Importance and Sensitivity

	Crossing 1		Crossing 2	
Determinant	**Score**	**Confidence**	**Score**	**Confidence**
1. Rare & Endangered Species	0	4	0	4
2. Populations of Unique Species	0	4	0	4
3. Species/taxon Richness	1	4	1	4
4. Diversity of Habitat Types or Features	1	4	1	4
5. Migration route/breeding and feeding site for wetland species	1	2	1	2
6. Sensitivity to Changes in the Natural Hydrological Regime	2	2	1	2

7. Sensitivity to Water Quality Changes	2	3	2	3
8.Flood Storage, Energy Dissipation & Particulate/Element Removal	3	2	1	2
9. Protected Status	0	4	0	4
10. Ecological Integrity	0	4	0	4
Total	**10**		**7**	
Median	**1**		**1**	
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE	**D**		**D**	

4 General Site Sensitivity

The study area does not fall within any formally protected areas, or any areas that are earmarked for future protected status according to the National Protected Areas Expansion Strategy (NPAES). The Mpumalanga Aquatic Conservation Plan (C-Plan) does not identify the study area as ecologically important and has assigned the entire Kriel study area a status of 'not required'. Further to this, the Mpumalanga Biodiversity Sector Plan has classified the areas as 'moderately modified'.

4.1.1 National Freshwater Ecosystems Priority Areas

The National Freshwater Ecosystem Priority Areas (NFEPA) strategic spatial priorities for conserving the country's freshwater ecosystems and supporting sustainable use of water resources were considered to evaluate the importance of the wetland areas located within the project area (Nel *et al.* 2011).

Spatial layers used include the wetland classification and ranking. The NFEPA wetlands have been ranked in terms of importance in the conservation of biodiversity. Table 4-1 below indicates the criteria which were considered for the ranking of wetland areas. Figure 4-1 represents the NFEPA wetlands identified on site. Not all of the wetland area present on site has been identified by NFEPA and this may be attributed to the large-scale desktop nature of the NFEPA assessment.

The main watercourse that intersects the pipeline route has not been identified by NFEPA. The artificial channelled valley bottom wetland to the south of the Matla Ash Dump has been assigned a rank of 5, indicating that this wetland has been identified as a Working for Wetlands site. Working for Wetlands is a joint initiative with the Department of Environmental Affairs (DEA) and DWS that places focus on the rehabilitation, wise use and protection of wetlands in a manner that maximises employment creation, supports small businesses and transfers relevant and marketable skills to beneficiaries.

Table 4-1: NFEPA wetland classification ranking criteria

Criteria	Rank

Wetlands that intersect with a RAMSAR site.	1
Wetlands within 500 m of an IUCN threatened frog point locality; Wetlands within 500 m of a threatened waterbird point locality; Wetlands (excluding dams) with the majority of their area within a sub-quaternary catchment that has sightings or breeding areas for threatened Wattled Cranes, Grey Crowned Cranes and Blue Cranes; Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands of exceptional Biodiversity importance, with valid reasons documented; and Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands that are good, intact examples from which to choose.	2
Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands of biodiversity importance, but with no valid reasons documented.	3
Wetlands (excluding dams) in A or B condition AND associated with more than three other wetlands (both riverine and non-riverine wetlands were assessed for this criterion); and Wetlands in C condition AND associated with more than three other wetlands (both riverine and non-riverine wetlands were assessed for this criterion).	4
Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing Impacted Working for Wetland sites.	5
Any other wetland (excluding dams).	6

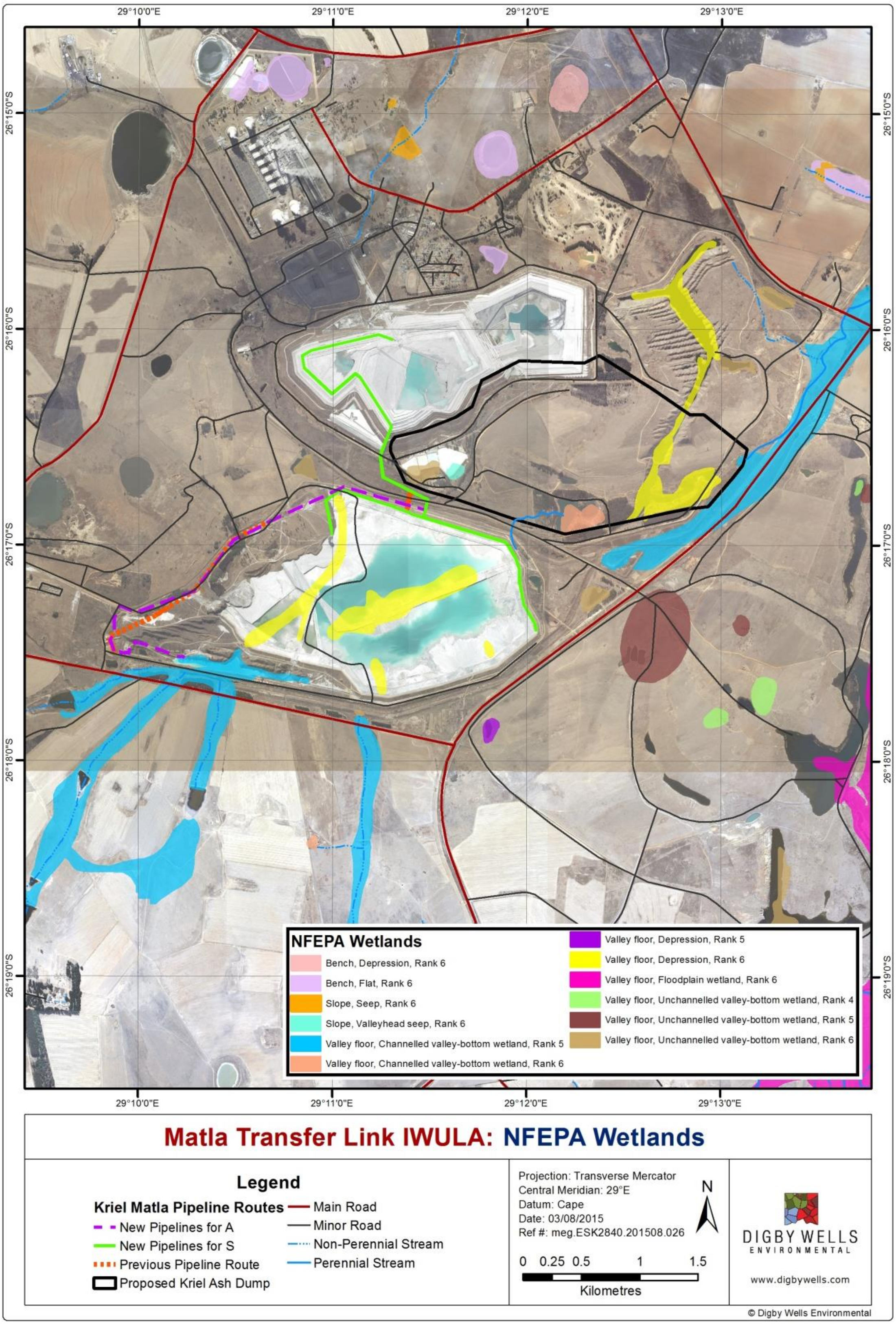


Figure 4-1: NFEPA wetlands

5 Impact Prediction and Assessment

The aim of the Impact Assessment is to strive to avoid damage or loss of ecosystems and services that they provide, and where they cannot be avoided, to reduce and mitigate these impacts (DEA 2013). Offsets to compensate for loss of habitat are regarded as a last resort, after all efforts have been made to avoid, reduce and mitigate. The mitigation hierarchy is described in Table 5-1.

Table 5-1: Mitigation Hierarchy

↓	**Avoid or Prevent**	Refers to considering options in project location, sitting, scale, layout, technology and phasing to avoid impacts on biodiversity, associated ecosystem services and people. This is the best option, but is not always possible. Where environmental and social factors give rise to unacceptable negative impacts, mining should not take place. In such cases, it is unlikely to be possible or appropriate to rely on the other steps in the mitigation.
	Minimise	Refers to considering alternatives in the project location, sitting, scale, layout, technology and phasing that would minimise impacts on biodiversity, associated ecosystem services. In cases where there are environmental constraints, every effort should be made to minimise impacts.
	Rehabilitate	Refers to rehabilitation of areas where impacts are unavoidable and measures are provided to return impacted areas to near natural state or an agreed land use after mine closure. Rehabilitation may, however, fall short of replicating the diversity and complexity of natural systems.
	Offset	Refers to measures over and above rehabilitation to compensate for the residual negative impacts on biodiversity after every effort has been made to minimise and then rehabilitate the impacts. Biodiversity offsets can provide a mechanism to compensate for significant residual impacts on biodiversity.

The proposed transfer link will be in operation for four years. Considerations for the design included following the shortest possible route, easy accessibility for maintenance purposes, use of the existing culvert underneath the mine haul road and minimal interference with roads and natural features.

The system will require three of the four currently installed ash pumps to be in operation. In the event of the ash pump house not being available, dust can be stored in fly ash storage silos on site, which has a storage capacity of 780 Tons per silo.

The proposed transfer link pipeline crosses wetlands at 3 points. The wetland areas that are traversed by the proposed route have been significantly altered from their natural state, and no longer serve many of their natural ecological services. Despite the degraded state of the wetlands, further deterioration should be avoided, particularly for the wetland associated with crossing 1, which is linked to the greater stream network of the Steenkoolspruit River catchment.

5.1 Impacts of the proposed development

The construction of the transfer link pipeline is not anticipated to have any major direct negative impacts on wetlands. It is not envisaged that the construction or operation of the pipeline will result in a change in PES to the affected wetlands, since these wetlands are already largely altered.

5.1.1 Disturbance of due to presence of heavy machinery/vehicles

Movement of heavy machinery through wetland areas during the construction of the pipeline may result in compaction of sediment in the wetland, reducing natural infiltration through those areas. Further to this, minor disturbance of soil will result; which will promote the spread of alien or invasive plant species already present in the wetland, such as: *Cortaderia selloana, Tagetes minuta* and *Seriphium plumosum.* Increased erosion and sedimentation may incur as an additional impact of soil disturbance.

During the operational phase, regular maintenance will be required. Due to the short-term operation of the pipeline (4 years), it is recommended that maintenance only takes bi-annually (or less frequent if possible) to prevent disturbance to the wetland. Minor disturbance to the wetland is expected during the operational phase. It is assumed that the pipeline will be left *in situ* after operation and that there will not be a decommissioning phase.

Parameters	***Severity***	***Spatial scale***	***Duration***	***Probability***	***Significance***
Impact 2	***Disturbance to the soil – erosion, compaction and sedimentation***				
Construction Phase					
Pre-mitigation	Moderate (3)	Local (3)	Permanent (6)	Likely (6)	Medium-Low (66)
Post-mitigation	Moderate (3)	Local (3)	Short-term (2)	Likely (6)	Medium-Low (42)
Operation Phase					
Pre-mitigation	Moderate (3)	Limited (2)	Short-term (2)	Likely (6)	Medium-Low (42)
Post-mitigation	Minor (2)	Limited (2)	Short-term (2)	Likely (6)	Low (30)

5.2 Potential Risks of the proposed development

Potential risks of the proposed transfer link are discussed separately to the impacts associated with the construction, operation and decommissioning activities. Risks are regarded as unexpected negative impacts to the watercourses in question that are unlikely to occur. The following risks should be managed:

- The risk of failure of the pipeline to contain the ash slurry, in the event of a burst pipe, is regarded to have a significant negative impact to the wetland should the ask spill into the wetland channel and
- The risk of hydrocarbon spillage from vehicles will result in deteriorated water quality.

5.3 Mitigation Measures

Wetland areas should be avoided as far as possible during the construction and decommissioning phases. The following mitigation measures have been prescribed:

- To prevent soil compaction in the wetland, the surface sediments should be lightly loosened after heavy machinery and vehicles have passed through the wetland areas.
- Areas of bare soil should be revegetated with plugs or mats of *Cynodon dactylon* (Couch Grass) and *Imperata cylindrica* (Cottonwool Grass) to prevent erosion during floods;
- Steel containment structures should be fitter along the length of the section of pipeline that crosses the wetland and
- Diesel/oil spills should be reported within 24 hours and a spillkit should be readily available within proximity to the site to clean up the spill.

6 References

Brinson, M.M. 1993. A hydrogeomorphic classification for wetlands. Wetlands Research Program Technical Report WRP-DE-4. U.S. Army Corps of Engineers, Waterway Experimental Station. Vicksburg, MS: Bridgham and Richardson.

CSIR 2012. Upper Olifants River Study: Phase 2. Risk assessment of pollution in surface waters of the Upper Olifants River System: Implications for aquatic ecosystem health and health of human users of water.

Driver A., Nel J.L., Murray K., Roux D.J., Hill L., Swartz E.R., Manuel J. and Funke N. Implementation manual for freshwater ecosystem priority areas. Water Research Commission. WRC Report No. 1801/1/11.

DWAF, 1999. Determining the Ecological Importance and Sensitivity (EIS) and Ecological Management Class (EMC). Version 1.0. 24 September 1999.

DWAF, 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Department of Water Affairs and Forestry, Pretoria.

Macfarlane, D.M., Kotze, D.C., Ellery, W.N., Walters, D., Koopman, V., Goodman, P. and Goge, C. 2007. A technique for rapidly assessing wetland health: WET-Health. WRC Report TT 340/08.

Marneweck, G.C. and Batchelor, A.L. 2002. Wetland inventory and classification. In Palmer, R.W., Turpie, J., Marneweck, G.C. and Batchelor, A.L. (Eds). Ecological and Economic Evaluation of Wetlands in the Upper Olifants River Catchment. Water Research Commission Report No K5/1162.

Mucina, L. and Rutherford, M.C. (eds) 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19: South African National Biodiversity Institute, Pretoria.

Rountree, M.W., H. Malan and B. Weston (editors). 2012. Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Version 2.0). Joint Department of Water Affairs/Water Research Commission Study.

Matla Transfer Link

Aquatic Ecology

Project Number:

ESK2840

Prepared for:

Eskom

November 2015

Digby Wells and Associates (South Africa) (Pty) Ltd
(Subsidiary of Digby Wells & Associates (Pty) Ltd). Co. Reg. No. 2010/008577/07. Turnberry Office Park, 48 Grosvenor Road, Bryanston, 2191. Private Bag X10046, Randburg, 2125, South Africa
Tel: +27 11 789 9495, Fax: +27 11 789 9498, info@digbywells.com, www.digbywells.com

This document has been prepared by Digby Wells Environmental.

Report Type:	**Aquatic Ecology**
Project Name:	**Matla Transfer Link**
Project Code:	**ESK2840**

Name	**Responsibility**	**Signature**	**Date**
Russell Tate	Report Writer		November 2015

This report is provided solely for the purposes set out in it and may not, in whole or in part, be used for any other purpose without Digby Wells Environmental prior written consent.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 Introduction

Chapter 4 of the National Water Act, 1998 (Act No. 36 of 1998) (NWA), legislates the use of water, identifies various water uses (Section 21 water uses) and facilitates the licensing of the Section 21 water uses through the process of a Water Use License Application (WULA). The Best Practical Environmental Option (BPEO) must be implemented when using water to ensure that there is a sustainable use of water and to prevent the deterioration of water quality and/or decrease in the quantity of the water resources as a result of any development.

Eskom Holdings SOC Limited (Eskom) appointed Digby Wells Environmental (Digby Wells) as an independent Environmental Assessment Practitioner (EAP) to undertake the required WULA to obtain environmental authorisation for the proposed "Kriel-Matla Transfer Link Project" (the Project) from the Department of Water and Sanitation (DWS).

The following sections of this report have been compiled to address the specific requirements for the WULA. Therefore, this report should be considered with the various ancillary documents such as the Wetland report.

2 Water Course Attributes

2.1 Locality

2.1.1 Location of Watercourse

The subject river system is located approximately 6.3 km west of Kriel, within the Mpumalanga province, South Africa.

2.1.2 Locality Map and Land Use

The location of the watercourse is presented in Figure 2-1. Land use activities associated with the subject river system were originally primarily cattle and maize agricultural activities, however, coal mining and power generating activities have occurred in the area with vast regions being covered in remediated land as well as active coal mining operations. Within the immediate catchment area large ash dumps are present.

2.1.3 Catchment Reference Number

The potentially affected river system is located within the B11D quaternary catchment of the Olifants Water Management Area (WMA). This river system forms a tributary of the B11D-01424 Sub Quaternary Reach (SQR). The subject tributary is unnamed and unclassified according to the SQR data (DWS, 2014). Considering the downstream SQR, the river reach potentially affected is a tributary of the Steenkoolspruit.

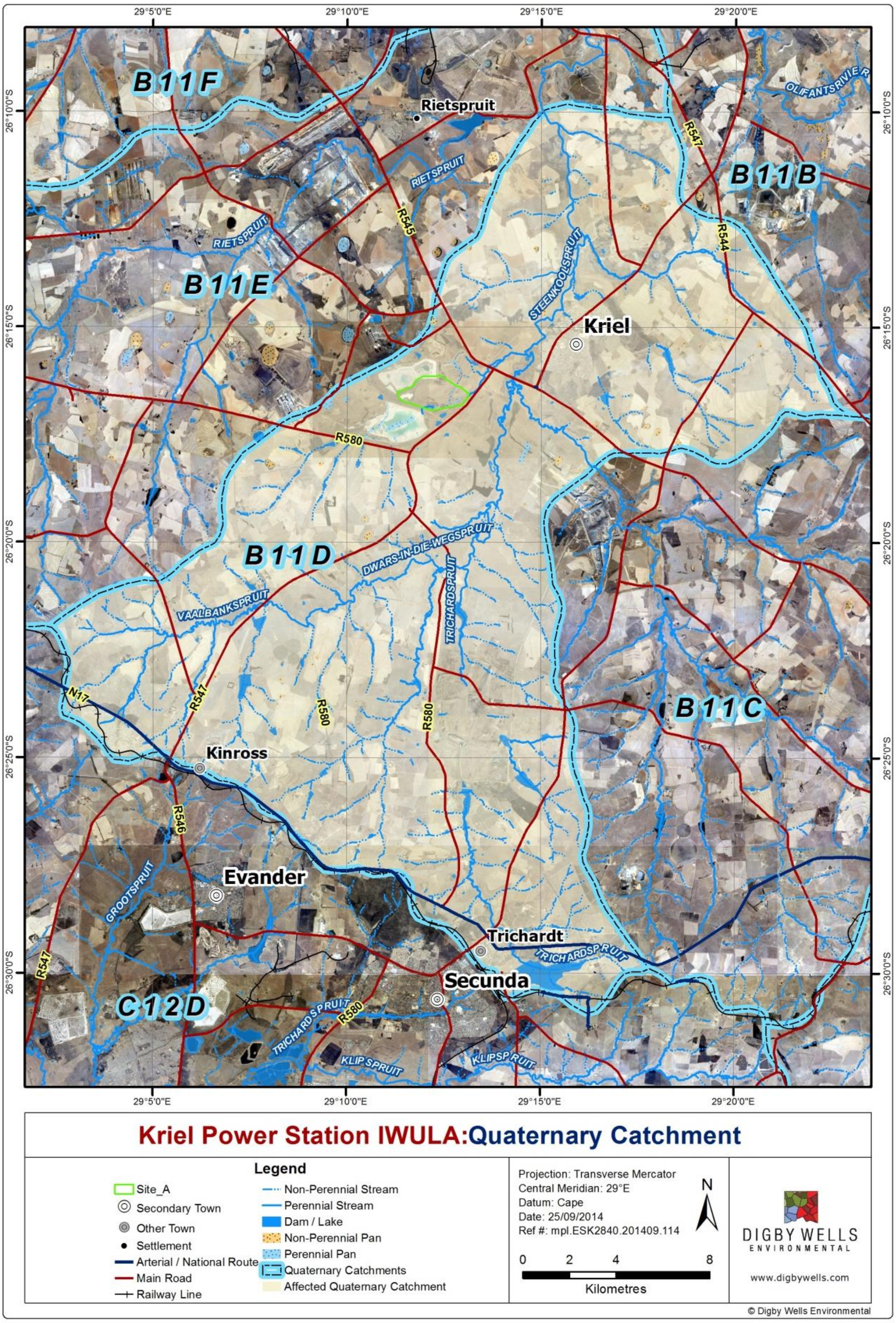


Figure 2-1: Location of the effected river course.

2.2 Description

2.2.1 Name and Description of the Watercourse

As stated above the subject river system forms a tributary of the Steenkoolspruit (B11D-01424).

2.2.2 Map and Photographs

This required information is provided in the wetland component for this project.

2.2.3 Present Ecological Status

A study completed by Digby Wells Environmental in 2014 was used to supplement the available information pertaining to the Present Ecological Status (PES) and is presented in the table below (Table 2-1). The Recommended Ecological Category and Default Ecological Management Class were obtained from DWS (2014).

Table 2-1: Summary of the findings of this study.

Catchment	Desktop	This study
Present Ecological Status	Class D (Largely modified)	Class D (confirmed)
Ecological Importance	Moderate	Moderate
Ecological Sensitivity	High	High
Default Ecological Management Class	Class B	Class C/D
Recommended Ecological Category	Class B	Class C/D

2.2.3.1 Flow and Sediment Regimes

The subject watercourse is a wetland ecosystem and therefore does not comply with standard river system features. Typically, due to the nature of the watercourse sediment is deposited within the wetland and therefore the erosional capacity of the system is limited. Flows in this system are increased during the summer period between November and March. Lower flows and inundation states are present from April to October.

2.2.3.2 Water Quality

The results of the *in situ* water quality analysis completed by Digby Wells (2014) during surveys in October and November 2014 are presented in the table below (Table 2-2).

Table 2-2: Water quality results obtained during the October and November 2014 surveys.

Constituent	Range	Kriel EWR (October)	Kriel EWR (November)
pH	6–9	7.72	8.78
Temperature (°C)	5–30	24	21.8
Conductivity (µS/cm)	<700	1585	2120
DO (mg/l)	>5	6.4	9.6
DO (% saturation)	60-120	102	106
*Shading denotes exceeding recommended guidelines (DWAF, 1996)			

The results presented in the above table (Table 2-2) indicate that there is an excessive concentration of dissolved solids. These concentrations would be seen as a limiting factor for sensitive aquatic organisms. With the exception of the conductivity levels, all other constituents considered were within guideline values stipulated in the guidelines for aquatic ecosystems (DWAF, 1996).

2.2.3.3 Riparian and in Stream Habitat

2.2.3.3.1 Morphology

A stream diversion at the Kriel PowerStation has resulted in the creation of a channeled valley bottom wetland. This diversion was implemented in 1977 without the necessary environmental authorisation (Buchan *et al.* 1980). As a consequence, considerable alteration to the hydrology, geomorphology and ecological functioning of this aquatic ecosystem has taken place as seen in the figure below (Figure 2-2).

Figure 2-2: River diversion at the Kriel PowerStation. Photograph captured during a site visit on the 6th of October 2014.

2.2.3.3.2 Vegetation

The riparian vegetation associated with the subject watercourse is described in the wetland component of this study.

2.2.3.3.3 Biota

The results of the Digby Wells (2014) study considered the macroinvertebrate communities associated with the subject watercourse. The results for the South African Scoring System 5 (SASS5) assessment are presented in Table 2-3.

Table 2-3: SASS 5 results for the low and high flow period (October and November) at subject river system.

Survey	October	November
Taxa	18	20
ASPT	4.7	4.5
SASS 5	85	89

Survey	October	November
Biological Band	B/C	B/C

Based on the results of the low flow survey the SASS 5 score was 85 with an ASPT of 4.7, with the high flow survey results presenting a SASS 5 score of 89 and an ASPT of 4.5. This would place the invertebrate community in a Class B or largely natural category. However, it should be noted that the biological banding provided in Dallas (2007) is meant as a guide. Therefore, based on the absence of families such as Heptageniidae, Perlidae, Tricorythidae and other sensitive families belonging to Odonata the site is classified as Class C or moderately modified.

Despite attempts by Digby Wells (2014) no fish have been captured within the subject watercourse. However, an expected fish species list was generated according DWA 2013 (Table 2-4). As there is no available data on expected species in the Steenkoolspruit, expected species are taken from the upper Olifants catchment area, specifically B11A and B11B catchment areas.

Sensitivity of expected species of aquatic biota is considered highly tolerant to moderately tolerant to pollution. The absence of sensitive species indicates low habitat availability (due to anthropogenic impacts and low habitat diversity) and serious physico-chemical impacts which have been attributed to activities such as mining, cultivation, irrigation (i.e. agricultural return flows), sewage works, urban areas and industries (DWAF, 2013)

Table 2-4: Expected fish species in the upper Olifants catchment area (DWAF, 2013).

Fish species	Common name
Barbus anoplus	Chubbyhead Barb
Barbus neefi	Sidespot barb
Barbus paludinosus	Straightfin Barb
Clarius gariepinus	Sharptooth Catfish
Cyprinus carpio	Carp (Exotic)
Labeo umbratus	Moggel
Labeobarbus polylepis	Smallscale yellowfish
Micropterus salmoides	Largemouth bass (Exotic)
Pseudocrenilabrus philander	Southern Mouthbrooder
Tilapia sparrmanii	Banded Tilapia

None of the fish species listed above are considered red data species or form part of the protected species list of South Africa (Government Gazette, 16 April 2013). The almost threatened species *Labeobarbus polylepis* was found to be expected in the quaternary catchment, however, habitat in the subject watercourse is deemed not sufficient to support this species and therefore can only be expected downstream.

2.2.4 Ecological Importance, Sensitivity and Cultural Importance

Considering the desktop information as well as results in Digby Wells (2014) the ecological importance is moderate with high ecological sensitivity.

The watercourse is located on industrial property and therefore social use of the system is limited (due to limited access).

2.2.5 Existing Land and Water Use

According to Dabrowski and de Klerk 2012, the upper Olifants catchment area is under stress due to active mining, abandoned mines, agriculture, wastewater treatment works and industry. Nitrogen: phosphorous ratios within a large portion of the river systems indicate that nutrient concentrations are high within the catchment, and indicative of eutrophic to hypertrophic conditions. Sulphate concentrations are increasing due to mining activities between upstream and downstream which have a progressively greater impact on water quality with increasing distance downstream. While dissolved metal concentrations frequently exceeded chronic and acute effect aquatic ecosystem health guidelines. Steenkoolspruit toxicity analyses conducted by the CSIR in 2011 indicate the water quality from the system negatively affects organisms, resulting in decreased chlorophyll content in algae.

The abovementioned river diversion as well as the various ash dumps present has significantly altered the natural conditions of the considered watercourse.

2.2.6 Sensitive Environments

The figures and mapping of sensitive environments have been provided in the wetland component of this study.

3 Impact Assessment and Management

3.1 Impact Prediction and Assessment

3.1.1 Assessment of Likely Environmental Impacts on Aquatic Ecology

3.1.1.1 The Predicted Impacts on the Ecology of the Watercourse

It is noted that the impacts provided below are the expected impacts before mitigation actions are provided.

3.1.1.1.1 Construction Phase

The impacts of the proposed pipeline crossing during the construction phase are presented below. The following impacts are expected to potentially occur as a result of the proposed water use.

Increased runoff as a result of vegetative cover loss could result in instream and riparian habitat modification or destruction through erosion, flow, bed, channel and water quality modification. Water quality modification can be related to an increase in the amount of suspended/dissolved solids which can result in increased sedimentation and changes to the physical chemistry of the water in downstream regions. These physical impacts could lead to reduced aquatic biodiversity.

Watercourse pipeline crossing			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	2 (Short term)	The impacts are anticipated to occur for the duration of the construction phase which is predicted to be less than 1 year.	30 (Negligible)
Extent	2 (Limited)	The impacts are likely to be isolated around the construction activities.	
Intensity	2 (Minor)	Only minor rated intense impacts are anticipated.	
Probability	5 (Likely)	The impacts are likely to occur.	
Nature	Negative		

Based on the above results for the impact assessment, negligible impacts are anticipated as a result of the proposed project during the construction phase.

3.1.1.1.2 Operation Phase

The impacts of the proposed pipeline crossing during the operation phase are presented below. The following impacts are expected to potentially occur as a result of the proposed water use.

Habitat impacts resulting in flow, bed and channel modification could potentially occur within a limited area downstream of the proposed infrastructure.

Watercourse pipeline crossing			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			

Duration	5 (Project life)	The impacts are anticipated to occur for the duration of the operation phase which is predicted as the time period in which the project will occur.	36 (Negligible)
Extent	2 (Limited)	The impacts are likely to be isolated around the pipeline activities.	
Intensity	2 (Minor)	Only minor rated intense impacts are anticipated.	
Probability	4 (Probable)	The impacts are probable to occur.	
Nature	Negative		

The operation phase is expected to have a negligible impact on local aquatic biota before mitigation.

3.1.1.2 On Other Water Users

This section is described in the surface water component of this study.

3.1.1.3 On the Broader Public and Property

This section is described in the surface water component of this study.

3.1.1.4 If the Water Use is Not Authorised

Should the proposed project not be authorised the impact on local aquatic biota from an ash spill emanating from the full capacity Kriel ash dump could have potentially significant impacts. The ash from an overflow could enter into the downstream aquatic ecosystems resulting in significant water and habitat quality modification.

3.1.2 Description of Methods Employed to Assess Impacts

These methods have been provided in section 5.

3.2 Risk Assessment

3.2.1 Risks and Unplanned Events Associated with the Proposed Project

Table 3-1: Unplanned events, low risks and their management measures.

Unplanned event	Potential impact	Mitigation/ Management/ Monitoring
Hydrocarbon Spillage	Water quality degradation	■ Bunded storage of hydrocarbons outside 1:100 floodline or 500m buffer, whichever is greater. ■ Hydrocarbon spill kits and employee training in their use; ■ Regular inspection for leakages and subsequent repair (maintenance); and ■ The refuelling/oiling of vehicles in contained areas (bundeded areas) built to the capacity of the facility provided with sumps.
Leakage and rupturing of pipelines	Water and habitat quality degradation	■ No flanges should be installed over river systems or within the buffer zones. ■ Cut-off and continuous spillage monitoring systems. ■ Emergency remediation plan should spillage occur.

3.3 Alternatives

Due to the limited impacts expected from the proposed project no alternatives have been considered.

3.4 Mitigation and Management Measures

3.4.1 Mitigation Actions

During the construction phase vehicles will be used in proximity to aquatic resources. The use of these vehicles presents risk of persistent hydrocarbon pollution events which can be avoided through the use of the following management actions:

- Hydrocarbon spill kits and employee training in their use;
- Regular inspection for leakages and subsequent repair (maintenance); and
- The refuelling/oiling of vehicles in contained areas (bunded areas) built to the capacity of the facility provided with sumps.

The removal of vegetative cover as well as the construction of roads has been recognised as being responsible for increased runoff, sedimentation and subsequent water and habitat quality degradation in downstream portions of river systems (WRC, 2014). As such the careful management of vegetation removal and sedimentation control should take place. This can be achieved through the brief points below:

- Minimise the removal of vegetation in the infrastructure footprint area;
- Revegetation of the construction footprint as soon as possible;

- Where storm water enters river systems, sediment/silt and debris trapping, as well as energy dissipation control measures must be put in place;
- Storm water must be diverted from construction activities and managed in such a manner to disperse runoff and prevent the concentration of storm water flow;
- Sequential removal of the vegetation (not all vegetation immediately); and
- The vegetation of unpaved roadsides.

The construction and operation of pipeline infrastructure over the subject watercourse would potentially negatively influence the local aquatic habitat. As such, it is important to consider the following management actions:

- No crossings should take place over riffle/rapid habitats as these are the most sensitive; slow deep/shallow habitats should be favoured;
- The crossing points should be stabilised to reduce the resulting erosion and downstream sedimentation;
- Structures must not be damaged by floods exceeding the magnitude of those which are may occur on average once in every 100 years;
- The indiscriminate use of heavy vehicles and machinery within the instream and riparian habitat will result in the compaction of soils and vegetation and must be controlled;
- Erosion prevention mechanisms must be employed to ensure the sustainability of all structures to prevent instream sedimentation;
- The crossing points should be unobtrusive (above 1:100 water mark) to prevent the obstruction and subsequent habitat modification of downstream portions;
- Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff;
- Soils adjacent the river that has been compacted must be loosened to allow for germination;
- Stockpiling of removed soil and sand must be done outside the 1:100 floodline or delineated riparian habitat (whichever is greater). This will prevent solids from washing into the river;
- Unpaved roads used to inspect and construct the pipelines should have their sides vegetated;
- No hinges/flanges should be present within the pipeline over the river system as these points are prone to leakages. Therefore, an elongated section devoid of flanges/hinges should be used; and
- Should a spillage occur an emergency management plan, including rehabilitation plan, with emergency cut off valves should be in place.

3.4.2 Limits of Disturbance

Please refer to the infrastructure layout map.

3.4.3 Management and Maintenance of Infrastructure

The proposed project will be developed and maintained by Eskom.

3.5 Changes to the Watercourse

3.5.1 Impacts after Mitigation

Considering the established PES the following impact assessment was compiled.

3.5.1.1 Construction Phase

The impacts of the proposed pipeline crossing during the construction phase are presented below. The impacts that are expected to occur are provided above.

Watercourse pipeline crossing			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
After mitigation/ management			
Duration	2 (Short term)	The impacts are anticipated to occur for the duration of the construction phase which is predicted to be less than 1 year.	16 (Negligible)
Extent	2 (Limited)	The impacts are likely to be isolated around the construction activities.	
Intensity	2 (Minor)	Only minor rated intense impacts are anticipated.	
Probability	2 (Improbable)	The impacts are improbable.	
Nature	Negative		

Based on the above results for the impact assessment, negligible impacts are anticipated as a result of the proposed project during the construction phase.

3.5.1.2 Operation Phase

The impacts of the proposed pipeline crossing during the operation phase are presented below. The following impacts are expected to potentially occur as a result of the proposed water use.

Habitat impacts resulting in flow, bed and channel modification could potentially occur within a limited area downstream of the proposed infrastructure.

Watercourse pipeline crossing

Dimension	Rating	Motivation	Significance
Impact Description: Water and habitat quality modification			
After mitigation/ management			
Duration	5 (Project life)	The impacts are anticipated to occur for the duration of the operation phase which is predicted to the time period in which the project will occur.	18 (Negligible)
Extent	2 (Limited)	The impacts are likely to be isolated around the pipeline activities.	
Intensity	2 (Minor)	Only minor rated intense impacts are anticipated.	
Probability	2 (Improbable)	The impacts are improbable.	
Nature	Negative		

The operation phase is expected to have a negligible impact on local aquatic biota before mitigation.

3.5.1.3 Impact Conclusion

Following the impact assessment it is unlikely that the proposed project will negatively impact on the PES of the subject watercourse in terms of aquatic biota.

Presently the default and recommended ecological categories are not being attained. However, the proposed project was assessed to have a negligible impact and therefore would not deteriorate conditions further from the current status.

3.6 Monitoring and Compliance

The monitoring programme for the proposed project is illustrated in Table 3-2.

Table 3-2: Monitoring programme for the proposed infrastructure.

Location	Monitoring objectives	Frequency of monitoring	Parameters to be monitored
-26.273653; 29.222952	Determine if habitat deterioration is occurring.	Bi-annual	Water clarity should not vary between surveys, by more than 40%.
-26.273653; 29.222952	Determine if water quality deterioration is occurring.	Bi-annual	SASS5 scores should not decrease as a result of the WRTRP (currently impacts are related to sewage/urban runoff).

Location	Monitoring objectives	Frequency of monitoring	Parameters to be monitored
-26.273653; 29.222952	Determine if water/habitat quality deterioration is occurring.	Bi-annual	Monitor for presence of fish.

4 References

Department of Water Affairs, South Africa. 2013. Classification of Significant Water Resources in the Olifants Water Management Area (WMA4): Management Classes in the Olifants WMA. Report No: RDM/WMA04/00?CON/CLA/0213.

Digby Wells Environmental. 2014. Kriel Powerstation Ash Dump Exstension IWULA, Aquatic Assessment, ESK2840.

DWA (Department of Water Affairs) 2013. A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Draft. Compiled by RQS-RDM.

JM Dabrowski and LP de Klerk. 2012. An assessment of the impact of different land use activities on water quality in the upper Olifants River catchment. Water SA Vol. 39 No. 2. p 231-246

5 Impact Assessment Methodology

The impacts are assessed based on the impact's magnitude as well as the receiver's sensitivity, culminating in an impact significance which identifies the most important impacts that require management.

Based on international guidelines and South African legislation, the following criteria are taken into account when examining potentially significant impacts:

- Nature of impacts (direct/indirect, positive/ negative);
- Duration (short/medium/long-term, permanent(irreversible) / temporary (reversible), frequent/seldom);
- Extent (geographical area, size of affected population/habitat/species);
- Intensity (minimal, severe, replaceable/irreplaceable);
- Probability (high/medium/low probability); and
- Possibility to mitigate, avoid or offset significant adverse impacts.

Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below.

The significance rating process follows the established impact/risk assessment formula:

Significance = Consequence x Probability x Nature

Where

Consequence = Intensity + Extent + Duration

And

Probability = Likelihood of an impact occurring

And

Nature = Positive (+1) or negative (-1) impact

Note: In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts

The matrix calculates the rating out of 147, whereby Intensity, Extent, Duration and Probability are each rated out of seven as indicated in Table 5-1. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in this aquatic impact assessment report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table 5-2, which is extracted from Table 5-1. The description of the significance ratings is discussed in Table 5-1.

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, i.e. there may already be certain types of mitigation measures included in the design (for example due to legal requirements). If the potential impact is still considered too high, additional mitigation measures are proposed.

Table 5-1: Impact Assessment Parameter Ratings

RATING	INTENSITY/REPLACABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	Positive impacts			
7	Irreplaceable damage to highly valued items of great natural or social significance or complete breakdown of natural and / or social order.	Noticeable, on-going natural and / or social benefits which have improved the overall conditions of the baseline.	International The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	Irreplaceable damage to highly valued items of natural or social significance or breakdown of natural and / or social order.	Great improvement to the overall conditions of a large percentage of the baseline.	National Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain / Highly probable: It is most likely that the impact will occur. <80% probability.
5	Very serious widespread natural and / or social baseline changes. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	Province/ Region Will affect the entire province or region.	Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.
4	On-going serious natural and / or social issues. Significant changes to structures / items of natural or social significance.	Average to intense natural and / or social benefits to some elements of the baseline.	Municipal Area Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.

RATING	INTENSITY/REPLACABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	**Positive impacts**			
3	On-going natural and / or social issues. Discernible changes to natural or social baseline.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	Local Local extending only as far as the development site area.	Medium term: 1-5 years and impact can be reversed with minimal management.	Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability.
2	Minor natural and / or social impacts which are mostly replaceable. Very little change to the baseline.	Low positive impacts experience by a small percentage of the baseline.	Limited Limited to the site and its immediate surroundings.	Short term: Less than 1 year and is reversible.	Rare / improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability.
1	Minimal natural and / or social impacts, low-level replaceable damage with no change to the baseline.	Some low-level natural and / or social benefits felt by a very small percentage of the baseline.	Very limited Limited to specific isolated parts of the site.	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely / None: Expected never to happen. <1% probability.

Table 5-2: Probability/Consequence matrix

Significance

Probability																																						
7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	-21	**-20**	**-19**	**-18**	**-17**	**-16**	**-15**	**-14**	**-13**	**-12**	**-11**	**-10**	**-9**	**-8**	**-7**	**-6**	**-5**	**-4**	**-3**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**

Consequence

Table 5-3: Significance rating description

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Major (positive)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Moderate (positive)
36 to 72	An important positive impact. The impact is insufficient by itself to justify the implementation of the project. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment	Minor (positive)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment	Negligible (positive)
-3 to -35	An acceptable negative impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative)
-36 to -72	An important negative impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment	Minor (negative)
-73 to -108	A serious negative impact which may prevent the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe effects	Moderate (negative)
-109 to -147	A very serious negative impact which may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Major (negative)

DIGBY WELLS ENVIRONMENTAL

Integrated Water Use Licence Application (IWULA) for the Pipeline Transfer Link

Surface Water Assessment Report

Project Number:

ESK2840

Prepared for:

Eskom Holdings SOC Limited

August 2015

Digby Wells and Associates (South Africa) (Pty) Ltd
(Subsidiary of Digby Wells & Associates (Pty) Ltd). Co. Reg. No. 2010/008577/07. Turnberry Office Park, 48 Grosvenor Road, Bryanston Private Bag X10046, Randburg, 2125, South Africa
Tel: +27 11 789 9495, Fax: +27 11 789 9498, info@digbywells.com, www.digbywells.com

This document has been prepared by Digby Wells Environmental.

Report Type:	**Surface Water Assessment Report**
Project Name:	**Integrated Water Use Licence Application (IWULA) for the Pipeline Transfer Link**
Project Code:	**ESK2840**

Name	Responsibility	Signature	Date
Rafundisani Mashudu	Report Writer		August 2015
Riaan Swemmer	Review		August 2015

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF PLANS

1 Introduction

1.1 Project Description

Kriel Power Station (Kriel) is located approximately 6 km northeast of Matla Coal Mine in the Mpumalanga Province. The regional and local settings of the project area are shown in Plan 1 and Plan 2 (Appendix A) respectively. The existing ash dam at Kriel is reaching its full capacity and the Power Station therefore requires the construction of a new ash dam in order to continue operations. During construction of the new ash dam, the station plans to transfer ash to the neighbouring Matla Power Station and/or increase the height of the existing facilities at Kriel.

Digby Wells conducted a Surface Water Assessment Study for the proposed New Ash DAM Extension in December 2014.

In August 2015, the Department of Water and Sanitation requested a detailed memo providing information for the Pipeline Transfer Link project.

The Terms of Reference for the Surface Water Specialist Study for the Pipeline Transfer Link was based on the DW781 form provided by the Department of Water and Sanitation. Therefore, this report will only provide information based on the form requirements, hence the Storm Water Management Plan and Water Balance was not included on this report.

2 Hydrological Setting

2.1.1 Location of the affected Watercourse

The affected water course is called the Onverwachtspruit, located on the south and 6.3 km west of Kriel power station and 6.3 km west Kriel Town, within the Mpumalanga province, South Africa. This stream has been diverted in 1986 around the historical Kriel Mine's opencast pits (Cut 1 and Cut 2 known as Pit 1 area and it currently flows between the two ash dams via a diversion channel. The stream is a tributary to the Steenkoolspruit.

2.1.2 Locality Map and Land Use

The location of the watercourse and the surface water monitoring points are presented in Figure 2-1. Land use activities associated with the subject river system were originally primarily cattle and maize agricultural activities, however, coal mining and power generating activities have occurred in the area with vast regions being covered in remediated land as well as active coal mining operations. Within the immediate catchment area large ash dumps are present.

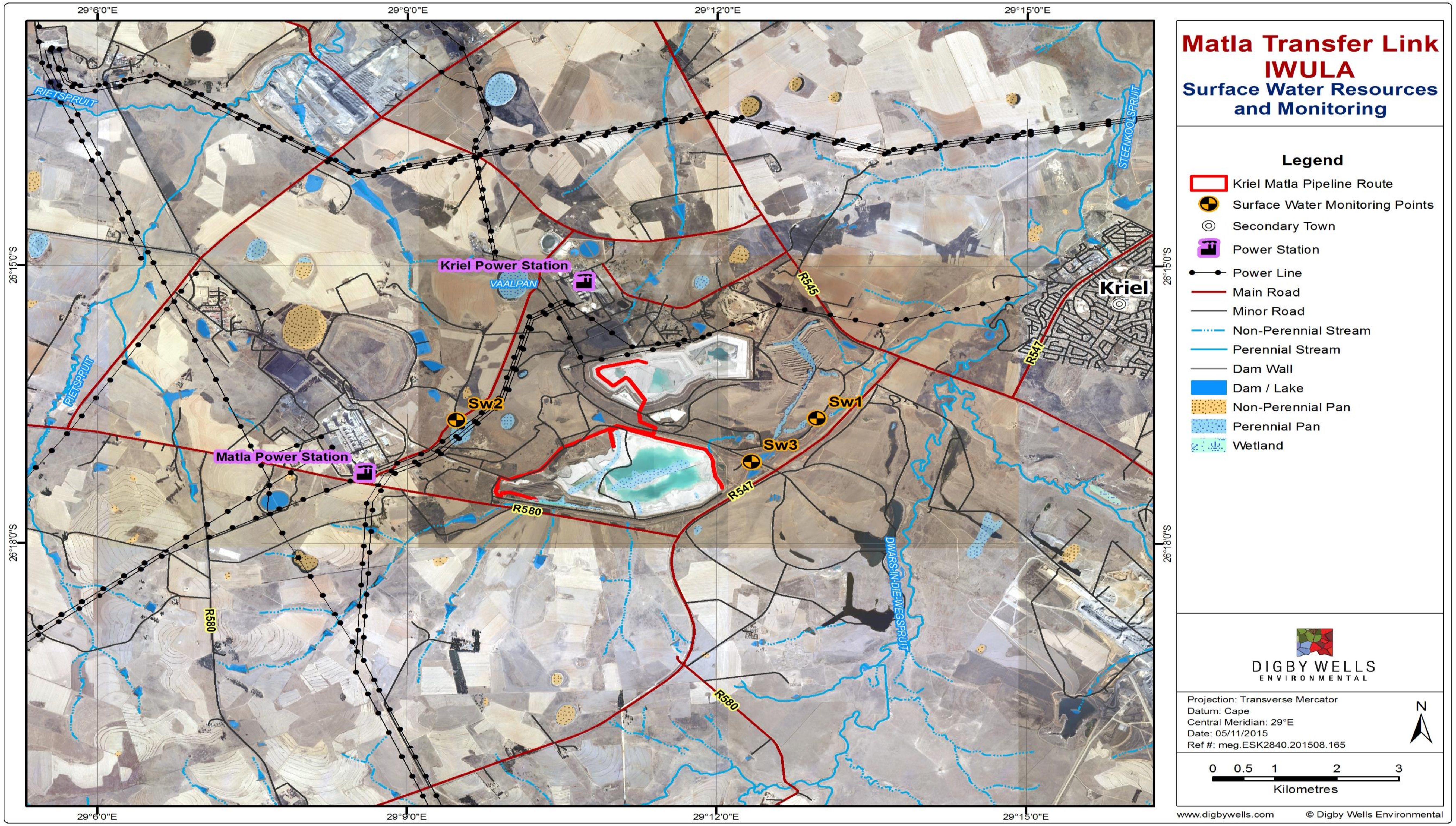


Figure 2-1: Surface Water Resources and Monitoring points (Digby Wells, 2014)

2.1.3 Catchment Reference Number

The Onverwachtspruit is located in the Olifants Water Management Area (WMA 04) on the watershed between the B11D-01424 quaternary catchments, which forms part of the Steenkoolspruit sub-catchment. The Rietspruit, Steenkoolspruit, Onverwachtspruit and Pampoenspruit are the main rivers located in close proximity to the Kriel Power Station project area. The quaternary catchment is shown on Figure 2-2

2.2 Description

2.2.1 Name and Description of the Watercourse

As stated above, The Onverwachtspruit is located in the Olifants Water Management Area (WMA 04) on the watershed between the B11D-01424 quaternary catchments, which forms part of the Steenkoolspruit sub-catchment. The Rietspruit, Steenkoolspruit, Onverwachtspruit and Pampoenspruit are the main rivers located in close proximity to the Kriel Power Station project area.

2.2.2 Map and Photographs

2.2.2.1 Extent of the riparian habitat

This required information is provided in the wetland report for this project.

2.2.2.2 The 1:100 year Floodlines

The pipeline is crossing over the diversion channel of the Onverwachtspruit; the Civil engineering report indicated that the worst possible flood flow for the 1:100 year recurrence period of has been chosen as the design flow from the four alternative methods of calculating runoff. At this flow the design non"scour velocity is not exceeded in the channels. Due to the high freeboard on the channels and the haul road bridge, the channel will however cater for the 1 in 100 year flood although average velocity does increase marginally (from 1.2 m/s to 1.4 m/s). It is considered that there is high margin of safety in the design of this channel provided channel maintenance is carried out while mining are in progress.

The Civil engineering report is attached in Appendix B.

2.2.3 Present Ecological Status

This required information is provided in the Aquatics report for this project.

2.2.3.1 Flow and Sediment Regimes

This required information is provided in the Aquatics component for this project.

2.2.3.2 Water Quality

The Onverwachtspruit water quality results for the study completed by Digby Wells (2014) during surveys in October are presented in the table below. Water quality monitoring points are shown Figure 2-1

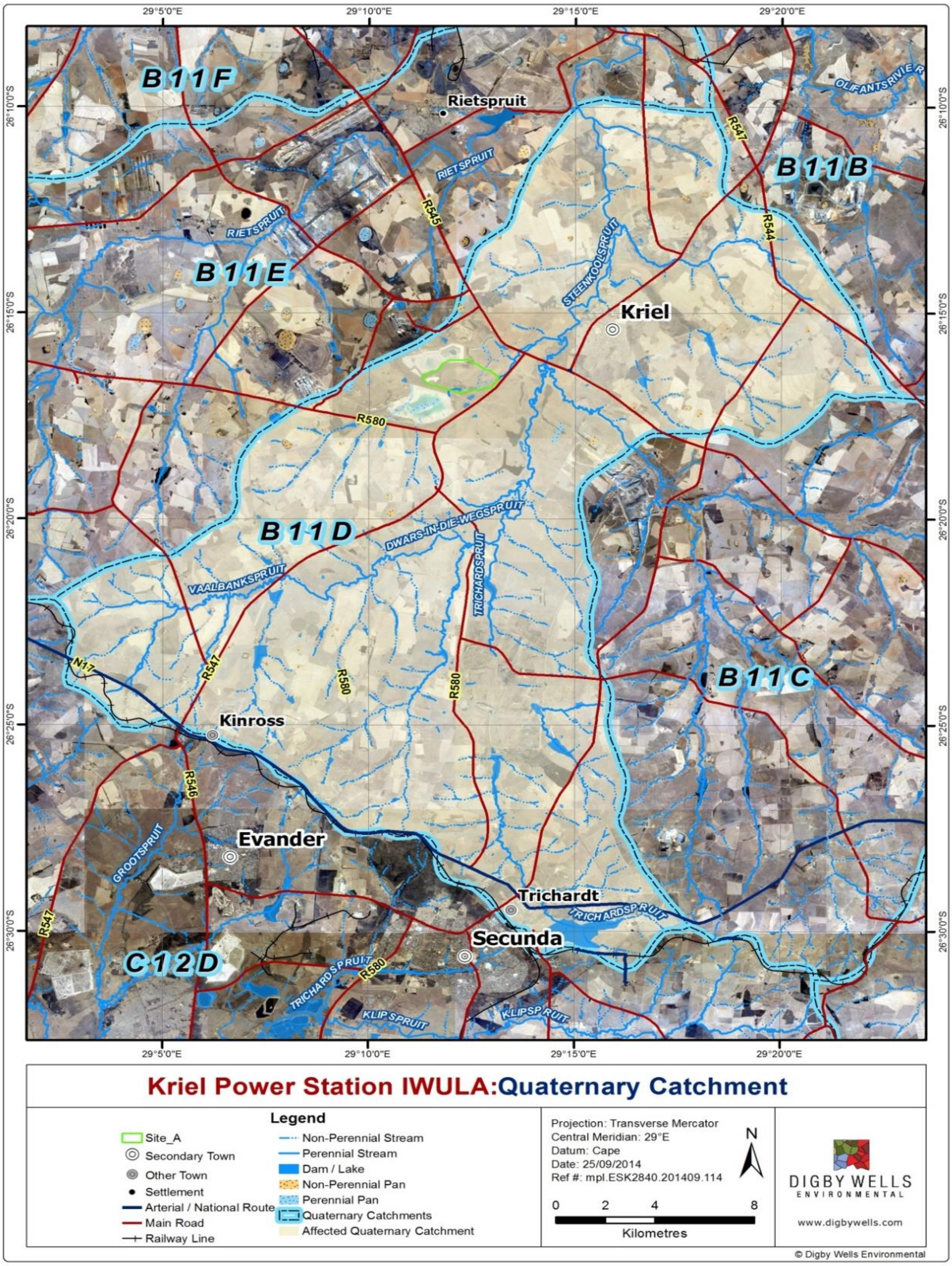


Figure 2-2: Location of the effected river course.

Table 2-1: Water Quality Results benchmarked against the SANS 241-1:2011 Drinking Water Quality Standards

Date	Sample ID		Total Dissolved Solids	Nitrate NO_3 as N	Chlorides as Cl	Total Alkalinity as $CaCO_3$	Sulphate as SO_4	Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Iron as Fe	Manganese as Mn	Conductivity at 25° C in mS/m	pH-Value at 25° C	Aluminium as Al	Free and Saline Ammonia as N	Fluoride as F
	Class I	(Recommended)	<1000	<10	<200	N/S	<400	<150	<70	<200	<50	<0.2	<0.1	<150	5-9.5	<0.3	<1	<1
	Class II	(Max. Allowable)	1000-2400	10-20	200-600	N/S	400-600	150-300	70-100	200-400	50-100	0.2-2	0.1-1	150-370	4-5 or 9.5-10	0.3-0.5	1-2	1-1.5
		Duration	7 years	7 years	7 years	N/S	7 years	7 years	7 years	7 years	7 years	7 years	7 years	7 years	No Limit	1 year	None	1 year
2014/10/06	SW1		**1744.00**	0.13	54.70	284.00	**958.00**	**209.00**	**112.00**	184.00	**51.10**	0.00	0.00	**255.00**	8.61	0.00	0.07	0.42
2014/10/06	SW2		948.00	0.13	74.50	616.00	125.00	57.20	44.60	**200.00**	**56.70**	0.00	0.68	**156.00**	8.51	0.00	**7.44**	**3.83**
2014/10/06	SW3		713.00	0.13	91.20	184.00	271.00	67.30	44.80	108.00	16.20	0.00	0.00	115.00	8.64	0.00	0.17	0.86

Table 2-2: Water Quality Results benchmarked against resource quality objectives of the Olifants water management area

Date	Sample ID		Total Dissolved Solids	Nitrate NO_3 as N	Chlorides as Cl	Total Alkalinity as $CaCO_3$	Sulphate as SO_4	Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Iron as Fe	Manganese as Mn	Conductivity at 25° C in mS/m	pH-Value at 25° C	Aluminium as Al	Free and Saline Ammonia as N	Fluoride as F
	Class I	(Ideal)	<200	<6	<40	20	<80	<10	<70	<70	<25	-	-	<30	<8	-	<0.015	<0.7
	Class II	(Acceptable)	350	<10	<120	97.5	<165	<80	<100	<92.5	<50	-	-	<50	8.4	-	0.044	<1
2014/10/06	SW1		**1744.00**	0.13	54.70	284.00	**958.00**	**209.00**	**112.00**	184.00	**51.10**	0.00	0.00	**255.00**	8.61	0.00	0.07	0.42
2014/10/06	SW2		948.00	0.13	74.50	616.00	125.00	57.20	44.60	**200.00**	**56.70**	0.00	**0.68**	**156.00**	8.51	0.00	**7.44**	**3.83**
2014/10/06	SW3		713.00	0.13	91.20	184.00	271.00	67.30	44.80	108.00	16.20	0.00	0.00	115.00	8.64	0.00	0.17	0.86

The chemical results of the three sampled water resources can be summarised as follows (benchmarked against SANS 241-1:2011):

- Sample SW1 shows elevated concentrations of SO_4, Ca, Mg, K and subsequently high TDS and EC, and exceeds the SANS Class I drinking water quality standards. Calcium and K concentrations; and TDS/ EC are within the Class II water quality guideline concentrations. However, SO_4 and Mg exceed the maximum allowable limit; thus Class III water. This sampling point is an old mine void filled with water and therefor the high level of dissolved salts in the water. The water in this void is not suitable for human consumption due to the high sulfate and magnesium concentrations.
- Sample SW2 is a natural pan located on the western boundary of the Project site. The results show elevated concentrations of manganese (112.0 mg/L), sulfate (958.0 mg/L), ammonia (7.44 mg/L) and fluoride (3.83 mg/L). High ammonia might be an indication of animal waste. Manganese and sulfate might emanate from the storm water runoff that reports into the pan, as the area is surrounded by mine voids, rehabilitated areas and an un-rehabilitated ash dam. Fluoride is a naturally occurring substance, but can also be supplemented by agricultural fertilisers and combustion of coal. Phosphate fertilisers contribute to fluoride in irrigated lands (K, Brindha, 2011).
- Sample SW3 is a sampling point on the unnamed, non-perennial stream located on southeast of the Project site. Water quality results indicate a water quality where all analysed constituents fall within the recommended guideline limits and therefore the water from this stream can be classified as Class I water.

When benchmarked against the resource quality objectives of the Olifants water management area, the chemical results of the three sampled water resources can be summarised as follows:

Note that the water quality objectives for the Olifants water management are more stringent than that of SANS and the standards have been classified as 'Ideal' and 'Acceptable'.

- In sample SW1 TDS, Cl, Ca, K and EC were exceeding the Olifants WQO, but are still within the acceptable level. $CaCO_3$, pH, SO_4 and Mg exceeded the acceptable level; and
- Samples SW1 and SW2 indicated the same water quality when compared against the Olifants WQO. The water quality can be classified as Acceptable for ecological purposes, but not ideal for domestic use.

2.2.3.3 Riparian and in Stream Habitat

This required information is provided in the Aquatics component for this project.

2.2.4 Ecological Importance, Sensitivity and Cultural Importance

This required information is provided in the Aquatics component for this project.

2.2.5 Existing Land and Water Use

According to Dabrowski and de Klerk 2012, the upper Olifants catchment area is under stress due to active mining, abandoned mines, agriculture, wastewater treatment works and industry. Nitrogen: phosphorous ratios within a large portion of the river systems indicate that nutrient concentrations are high within the catchment, and indicative of eutrophic to hypertrophic conditions. Sulphate concentrations are increasing due to mining activities between upstream and downstream which have a progressively greater impact on water quality with increasing distance downstream. While dissolved metal concentrations frequently exceeded chronic and acute effect aquatic ecosystem health guidelines. Steenkoolspruit toxicity analyses conducted by the CSIR in 2011 indicate the water quality from the system negatively affects organisms, resulting in decreased chlorophyll content in algae.

The abovementioned river diversion as well as the various ash dumps present has significantly altered the natural conditions of the considered watercourse.

2.2.6 Sensitive Environments

The figures and mapping of sensitive environments have been provided in the wetland component of this study.

3 Impact Assessment

3.1 Impact Assessment Methodology

The impacts are assessed based on the impact's magnitude as well as the receiver's sensitivity, culminating in an impact significance which identifies the most important impacts that require management.

Based on international guidelines and South African legislation, the following criteria are taken into account when examining potentially significant impacts:

- Nature of impacts (direct/indirect, positive/ negative);
- Duration (short/medium/long-term, permanent(irreversible) / temporary (reversible), frequent/seldom);
- Extent (geographical area, size of affected population/habitat/species);
- Intensity (minimal, severe, replaceable/irreplaceable);
- Probability (high/medium/low probability); and
- Possibility to mitigate, avoid or offset significant adverse impacts.

Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below.

The significance rating process follows the established impact/risk assessment formula:

Significance = Consequence x Probability x Nature

Where

Consequence = Intensity + Extent + Duration

And

Probability = Likelihood of an impact occurring

And

Nature = Positive (+1) or negative (-1) impact

Note: In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts

The matrix calculates the rating out of 147, whereby Intensity, Extent, Duration and Probability are each rated out of seven as indicated in Table 3-1. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in this aquatic impact assessment report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table 3-2, which is extracted from Table 3-1. The description of the significance ratings is discussed in Table 3-1.

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, i.e. there may already be certain types of mitigation measures included in the design (for example due to legal requirements). If the potential impact is still considered too high, additional mitigation measures are proposed.

Table 3-1: Impact Assessment Parameter Ratings

RATING	INTENSITY/REPLACABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	Positive impacts			
7	Irreplaceable damage to highly valued items of great natural or social significance or complete breakdown of natural and / or social order.	Noticeable, on-going natural and / or social benefits which have improved the overall conditions of the baseline.	International The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	Irreplaceable damage to highly valued items of natural or social significance or breakdown of natural and / or social order.	Great improvement to the overall conditions of a large percentage of the baseline.	National Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain / Highly probable: It is most likely that the impact will occur. <80% probability.
5	Very serious widespread natural and / or social baseline changes. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	Province/ Region Will affect the entire province or region.	Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.
4	On-going serious natural and / or social issues. Significant changes to structures / items of natural or social significance.	Average to intense natural and / or social benefits to some elements of the baseline.	Municipal Area Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.

RATING	INTENSITY/REPLACABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	**Positive impacts**			
3	On-going natural and / or social issues. Discernible changes to natural or social baseline.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	Local Local extending only as far as the development site area.	Medium term: 1-5 years and impact can be reversed with minimal management.	Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability.
2	Minor natural and / or social impacts which are mostly replaceable. Very little change to the baseline.	Low positive impacts experience by a small percentage of the baseline.	Limited Limited to the site and its immediate surroundings.	Short term: Less than 1 year and is reversible.	Rare / improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability.
1	Minimal natural and / or social impacts, low-level replaceable damage with no change to the baseline.	Some low-level natural and / or social benefits felt by a very small percentage of the baseline.	Very limited Limited to specific isolated parts of the site.	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely / None: Expected never to happen. <1% probability.

Table 3-2: Probability/Consequence matrix

Probability	Significance																																					
7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	-21	**-20**	**-19**	**-18**	**-17**	**-16**	**-15**	**-14**	**-13**	**-12**	**-11**	**-10**	**-9**	**-8**	**-7**	**-6**	**-5**	**-4**	**-3**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
	Consequence																																					

Table 3-3: Significance rating description

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Major (positive)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Moderate (positive)
36 to 72	An important positive impact. The impact is insufficient by itself to justify the implementation of the project. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment	Minor (positive)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment	Negligible (positive)
-3 to -35	An acceptable negative impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative)
-36 to -72	An important negative impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment	Minor (negative)
-73 to -108	A serious negative impact which may prevent the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe effects	Moderate (negative)
-109 to -147	A very serious negative impact which may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Major (negative)

4 Potential Surface Water Impacts

This section identifies the possible impacts on the surface water and downstream users that may occur as a result of the construction, operation and decommissioning of the pipeline.

4.1 Construction Phase

A number of activities, especially those relating to the access of construction vehicles along the alignment of the pipeline can result in damage to and impacts on surface water resources. Construction vehicles and machinery that move along the alignment of a pipeline during construction would typically cross drainage lines. New access routes may be required should existing access for vehicles not be sufficient. Below are the activities and their associated impacts on the surface water resource;

4.1.1 Removal of Vegetation

- The removal of vegetation around a construction area exposes the surface area leaving the soil prone to erosion. This may result in siltation of the water resource and this will have impact on the downstream water users and the aquatic life as well.
- Inadequate storm water management and soil stabilisation measures in cleared areas could lead to erosion and associated sedimentation of nearby watercourses;

4.1.2 Installation of Pipelines

- The use of machinery during construction and installation of pipelines have the potential of hydrocarbons (fuel and oil) leakages which can result in the contamination of the receiving water resources.
- Movement of heavy construction machinery around stream may result in disturbance of the river banks, and destabilises the soil. This will increase the chance of erosion during rainfall thereby result in sedimentation of the water resources.
- The uncontrolled interaction of construction workers with the watercourses could lead to pollution of the water in the river. Examples of this may be the washing of equipment within the watercourse;
- Establishing of new access paths for construction across watercourses may lead to the erosion of banks and disturbance of riparian vegetation that may trigger the further development of gulley (donga) erosion thereby reducing the quality of water.

4.1.3 Mitigation measures for the construction phase

The following recommendations are made as mitigation measures that must be implemented to prevent and/or minimise the above potential impacts:

- The construction phase should be limited to the dry months of the year (May-October) to limit mobilisation of sediments or hydrocarbon runoff;

- Engineered solutions such as sediment fences or silt traps should be used as appropriate to limit increased sedimentation of surface water resources during construction;
- Minimise the removal of vegetation in the infrastructure footprint area;
- Revegetation of the construction footprint as soon as possible;
- Existing access roads must be prioritized to avoid construction of new access roads in the area;
- The river must not be utilised for abstraction, or washing of equipment, etc., in order to minimise the risk of water pollution during construction activities. All necessary water abstractions from any surface water resource must be authorised as prescribed by the National Water Act (Act 36 of 1998) and be subject to the provisions of a water use licence and general authorisation.

The table below present the pre-mitigation and post-mitigation impact significance rating of the above impacts.

Table 4-1: Impact Rating During Construction Phase

Activity: Removal of Vegetation			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Siltation of Water Resources			
Prior to mitigation/ management			
Duration	2 (Short term)	The impacts are anticipated to occur for the duration of the construction phase which is predicted to be less than 1 year.	30 (Negligible)
Extent	2 (Limited)	The impacts are likely to be isolated around the construction activities.	
Intensity	2 (Minor)	Only minor rated intense impacts are anticipated.	
Probability	5 (Likely)	The impacts are likely to occur.	
Nature	Negative		
Post mitigation/ management			
Duration	2 (Short term)	The impacts are anticipated to occur for the duration of the construction phase which is predicted to be less than 1 year.	16 (Negligible)
Extent	2 (Limited)	The impacts are likely to be isolated around the construction activities.	

Intensity	2 (Minor)	Only minor rated intense impacts are anticipated.	
Probability	2 (Improbable)	The impacts are improbable.	
Nature	Negative		
Activity: Pipeline Installation			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Contamination of Water (Hydrocarbon Spillages)			
Prior to mitigation/ management			
Duration	2 (Short term)	The impacts are anticipated to occur for the duration of the construction phase which is predicted to be less than 1 year.	40 (Minor Negative)
Extent	2 (Limited)	The impacts are likely to be isolated around the construction activities.	
Intensity	4 (Moderate)	Moderately negative impacts are anticipated	
Probability	5 (Likely)	The impacts are likely to occur.	
Nature	Negative		
Post mitigation/ management			
Duration	2 (Short term)	The impacts are anticipated to occur for the duration of the construction phase which is predicted to be less than 1 year.	28 (Negligible Negative)
Extent	2 (Limited)	The impacts are likely to be isolated around the construction activities.	
Intensity	3 (Moderate)	Moderately negative impacts are anticipated	
Probability	4 (probable)	The impacts are improbable.	
Nature	Negative		

4.2 Operational Phase

- The risk associated with the operation of the pipelines would be spills or leaks associated with either poor seals or more significant faults such as breaks/bursts. This could lead to contamination of water resource when the slurry enters the stream.

4.2.1 Mitigation Measures for the operational phase

The following mitigation actions are recommended:

- It is recommended that pipeline structure at the river crossing should cover the bottom part of the pipeline, this should be designed and placed in way that enables it to contain and divert any spill/leakages away from the stream;
- Monitoring of pipeline leakages on the section where it crosses the stream should regularly be undertaken. This will ensure detection of leaks or faults in the pipeline and immediately repair before significant spill/burst occur;
- It is recommended that water quality monitoring should be undertaken to ensure detection of impacts from leakages of the slurry;
- If pipeline spills/leakage occurs the following mitigation approach is recommended:
  - Ensure that the emergency spillage response plan is drafted and accessible to the responsible monitoring team;
  - Containment of waste as much as possible using berms and cut off trenches;
  - Waste which is present within the river reaches should be removed by mechanical means;
- Accidental spills or leaks or pipe bursts should be reported to the authorities and downstream communities/water users should be cautioned until any potential impacts are sufficiently mitigated; and
- Storm water management channels or catchment paddocks should be put in place, these is necessary to both contain any spillage as well as to contain runoff generated during normal and extreme rainfall events.

Table 4-2: Impact Rating During Construction Phase

Activity: Pipeline Installation			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Contamination of Water (Hydrocarbon Spillages)			
Prior to mitigation/ management			
Duration	5 (Project Life)	The impacts are anticipated to occur for the duration of the project.	60 (Minor Negative)
Extent	3 (Local)	The impact might extend only as far as the development site area.	
Intensity	4 (Moderate)	Moderately negative impacts are anticipated.	

Probability	5 (Likely)	The impact may occur. <65% probability.	
Nature	Negative		
Post mitigation/ management			
Duration	5 (Project Life)	The impacts are anticipated to occur for the duration of the project.	30 (Negligible Negative)
Extent	2 (Limited)	The impacts are limited to the site and its immediate surroundings	
Intensity	3 (Moderate)	Moderately negative impacts are anticipated	
Probability	3 (probable)	The impacts are improbable.	
Nature	Negative		

4.3 Decommissioning Phase

- The decommissioning of the pipelines is set to leave the pipes in-situ. This does not pose any risk of contamination to the surface water resources assuming pipelines contain no residual contaminant.

4.3.1 Description of Methods Employed to Assess Impacts

This is detailed in section 3 of this report

4.4 Alternatives

Due to the limited impacts expected from the proposed project no alternatives have been considered.

4.5 Mitigation and Management Measures

The following mitigation actions are recommended under the construction phase:

- The construction phase should be limited to the dry months of the year (May-October) to limit mobilisation of sediments or hydrocarbon runoff;
- Engineered solutions such as sediment fences or silt traps should be used as appropriate to limit increased sedimentation of surface water resources during construction;
- Minimise the removal of vegetation in the infrastructure footprint area;
- Revegetation of the construction footprint as soon as possible;

- Existing access roads must be prioritized to avoid construction of new access roads in the area;
- The river must not be utilised for abstraction, or washing of equipment, etc., in order to minimise the risk of water pollution during construction activities. All necessary water abstractions from any surface water resource must be authorised as prescribed by the National Water Act (Act 36 of 1998) and be subject to the provisions of a water use licence and general authorisation.

The following mitigation actions are recommended under the operational phase:

- It is recommended that pipeline structure at the river crossing should cover the bottom part of the pipeline, this should be designed and placed in way that enables it to contain and divert any spill/leakages away from the stream;
- Monitoring of pipeline leakages on the section where it crosses the stream should regularly be undertaken. This will ensure detection of leaks or faults in the pipeline and immediately repair before significant spill/burst occur;
- It is recommended that water quality monitoring should be undertaken to ensure detection of impacts from leakages of the slurry;
- If pipeline spills/leakage occurs the following mitigation approach is recommended:
  - Ensure that the emergency spillage response plan is drafted and accessible to the responsible monitoring team;
  - Containment of waste as much as possible using berms and cut off trenches;
  - Waste which is present within the river reaches should be removed by mechanical means;
- Accidental spills or leaks or pipe bursts should be reported to the authorities and downstream communities/water users should be cautioned until any potential impacts are sufficiently mitigated; and
- Storm water management channels or catchment paddocks should be put in place, these is necessary to both contain any spillage as well as to contain runoff generated during normal and extreme rainfall events.

4.5.1.1 Impact Conclusion

Following the impact assessment it is unlikely that the proposed project will negatively impact quality of the affected watercourse.

However, monitoring of water quality should continue to detect any impact that may occur as a result of the proposed pipeline. The section below provides the monitoring program.

4.6 Monitoring and Compliance

The objective of the monitoring programme would be to monitor the potential water quality impacts resulting from the proposed pipeline during construction and operations. A monitoring programme is essential as a management tool to detect negative impacts as they arise and to ensure that the necessary mitigation measures are implemented.

The water quality parameters that should be monitored include TDS, pH, EC, SO_4, Al, PO_4, CN-, Fe, Mn, Ca, Mg, NO_3, NH_3, F, Cl, Na, K, SS, Turbidity and hydrocarbons. All surface water features should be sampled, including upstream and downstream of the proposed ash dam to establish if there is a change in water quality status due to the proposed activities. The monitoring programme should allow for a sampling frequency as indicated in Table 4-3 and Table 4-4.

Table 4-3: Monitoring program sampling frequency over the respective project phase

Phase	Variables	Frequency
Construction	All	Monthly
Operation	All	Quarterly Where negative impacts are detected, immediate remediation measures should be undertaken and monitor monthly for a reasonable period until such impact has been mitigated.

Samples should be submitted to a SANAS accredited laboratory for water quality analysis.

Table 4-4: Monitoring Locations

Location	Description
$26^0$16’47.9” S; $29^0$11’23.3”	A proposed monitoring point upstream of the proposed pipeline.
SW3 26°17'9.01"S; 29°12'18.96"E	Downstream monitoring point

5 References

Anglo American coporation of South Africa limited, Civil Engineering Report, Kriel Phase 1, Phase 2 Open Cast Mine. Stream Diversion

Brindha, K. and Elango, L. (2011) Fluoride in Groundwater: Causes, Implications and Mitigation Measures. In: Monroy, S.D. (Ed.), Fluoride Properties, Applications and Environmental Management, https://www.novapublishers.com/catalog/product_info.php?products_id=15895.

Digby Wells Environmental. 2014. Kriel Powerstation Ash Dump Exstension IWULA, Surface Water Assessment, ESK2840.

JM Dabrowski and LP de Klerk. 2012. An assessment of the impact of different land use activities on water quality in the upper Olifants River catchment. Water SA Vol. 39 No. 2. p 231-246

South African Bureau of Standards (SABS). 2011. South African National Standard (SANS): 241-1:2011 Drinking Water

Appendix A: Plans

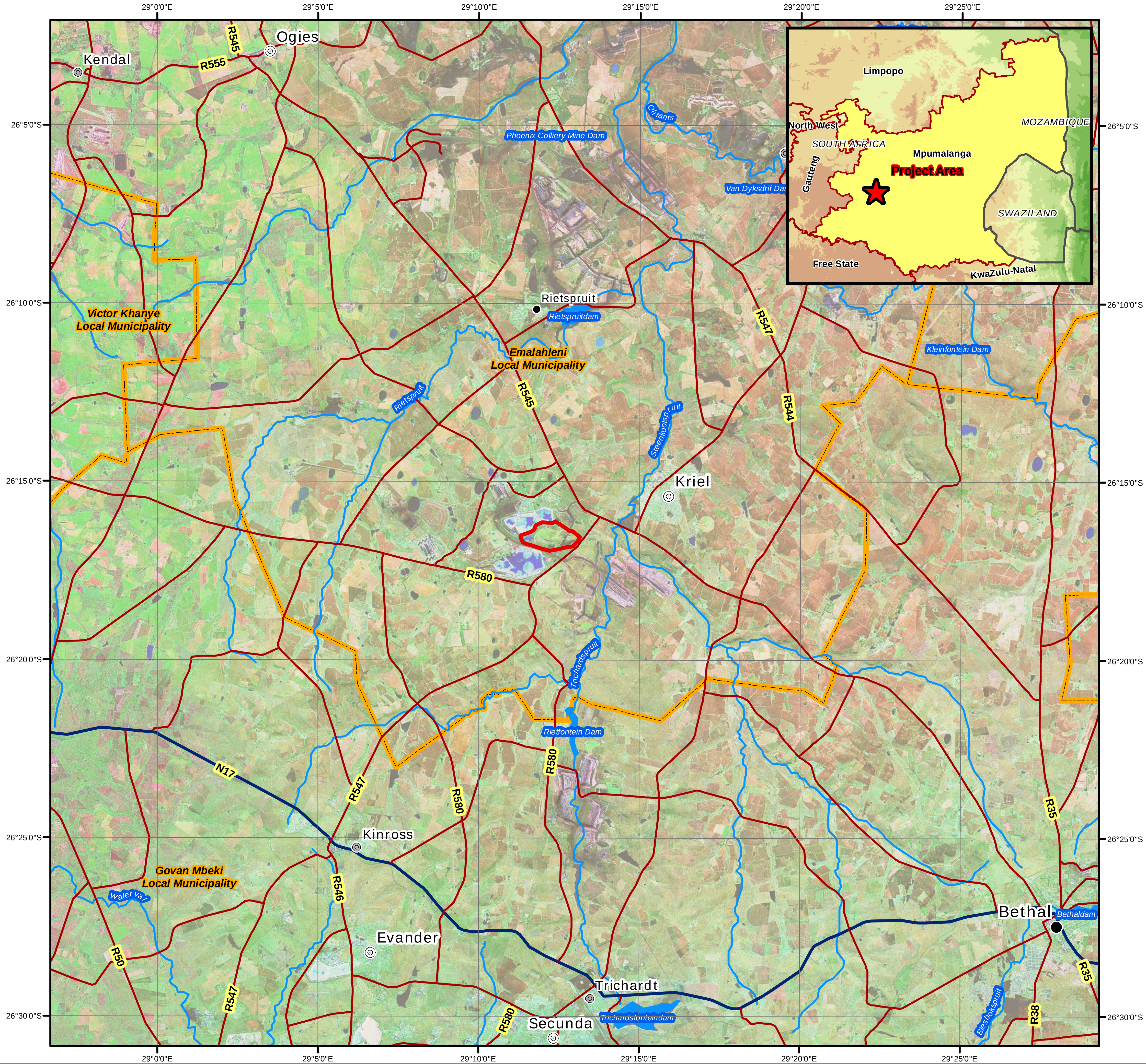
Plan 1: Regional Setting

Plan 2: Local Setting

Plan 1

Kriel Power Station IWULA

Regional Setting



Legend

- Project Area
- Major Town
- Secondary Town
- Other Town
- Settlement
- Main Road
- Arterial/ National Route
- Perennial Stream
- Dam/ Lake
- Local Municipal Boundary

DIGBY WELLS
ENVIRONMENTAL

• Sustainability • Service • Positive Change • Professionalism • Future Focused • Integrity

Projection: Transverse Mercator
Datum: Cape
Central Meridian: 29°E

Ref #: mpl.ESK2840.201411.001
Revision Number: 1
Date: 31/10/2014

N

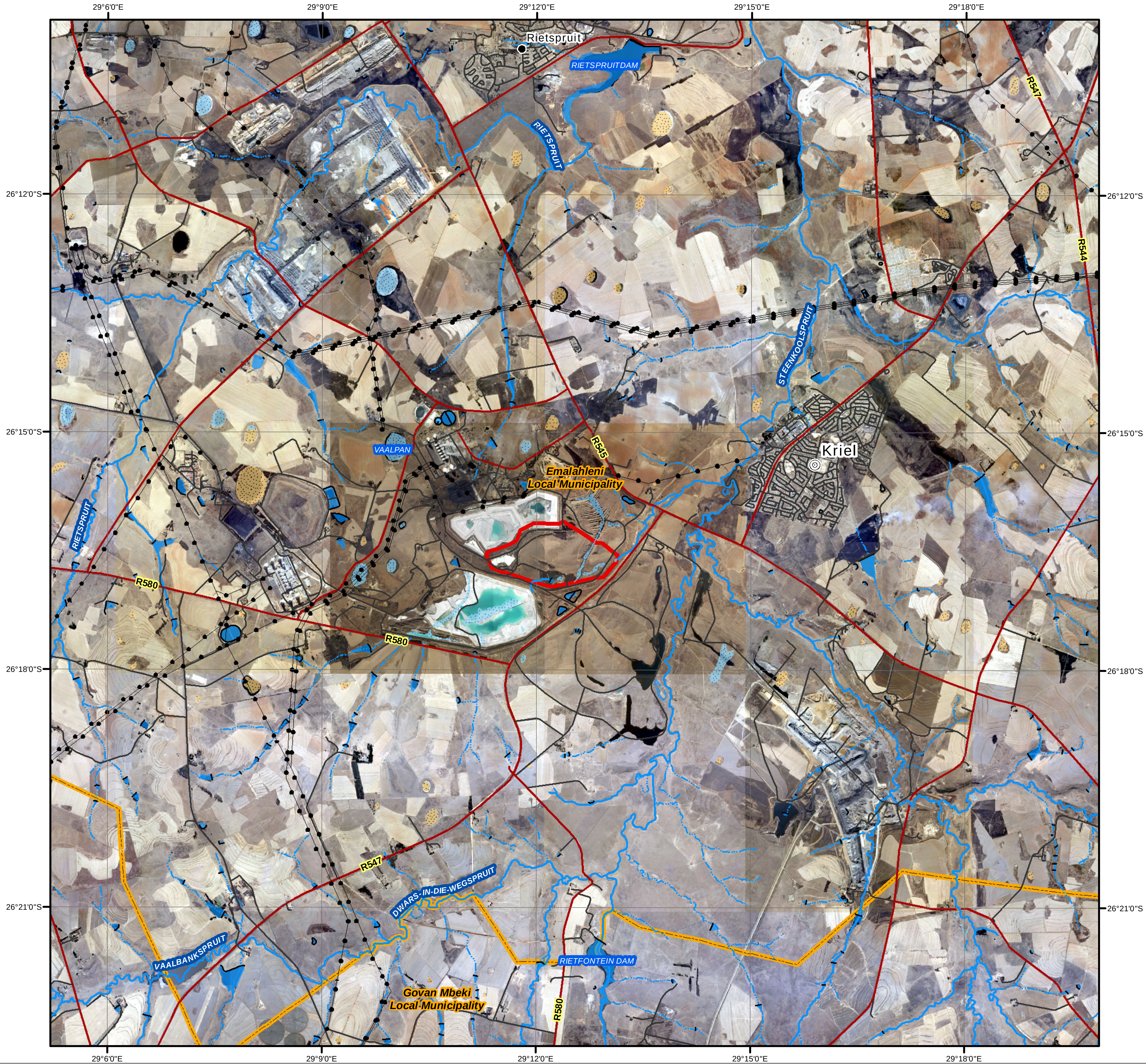
0 2.5 5 10
Kilometres
1:200 000

www.digbywells.com

Plan 2

Kriel Power Station IWULA

Local Setting



Legend

- Project Area
- Secondary Town
- Settlement
- Power Line
- Main Road
- Minor Road
- Dam Wall
- Non-Perennial Stream
- Perennial Stream
- Dam / Lake
- Non-Perennial Pan
- Perennial Pan
- Local Municipal Boundary

DIGBY WELLS ENVIRONMENTAL

• Sustainability • Service • Positive Change • Professionalism • Future Focused • Integrity

Projection: Transverse Mercator
Datum: Cape
Central Meridian: 29°E

Ref #: mpl.ESK2840.201409.113
Revision Number: 1
Date: 31/10/2014

N

0 1 2 4
Kilometres
1:90 000

www.digbywells.com

Appendix B: Civil Engineering Report

Appendix 94

Rei Openca
FJ

aac

ANGLO AMERICAN CORPORATION OF SOUTH AFRICA LIMITED

CIVIL ENGINEERING REPORT

by

A.J. FODEN, J.F. CAMERON & F.J. JOUBERT

Consulting Civil Engineer,
(Attention:____________________)
Anglo American Corporation of South Africa Limited,
3rd Floor – "Edura" Bldg.
41, Fox Street,
JOHANNESBURG. TVL.

61587
Marshalltown,
2107 Transvaal.
ANMERCOSA JHB
838-8111 / 838-4126 / 4181
Telex No: 43/7167 SA.

ANGLO POWER COLLIERIES
(PTY) LTD.

KRIEL DIVISION

KRIEL 1 PHASE 2 OPENCAST MINE

STREAM DIVERSION

ANGLO AMERICAN CORPORATION OF SOUTH AFRICA LIMITED

CIVIL ENGINEERING

ANGLO POWER COLLIERIES (PTY.) LIMITED

KRIEL DIVISION

4.5mTPA OPENCAST MINING PROJECT

DESIGN CALCULATIONS FOR STREAM DIVERSIONS

C O N T E N T S

ANGLO AMERICAN CORPORATION OF SOUTH AFRICA LIMITED

CIVIL ENGINEERING

SUMMARY OF DESIGN CALCULATIONS FOR STREAM DIVERSIONS

ANGLO POWER COLLIERIES (PTY) LTD

KRIEL DIVISION

1. BASIC REASONING - Ref. Drg. 479/0/3755

The planning for the initial phase of the open cast mining operation at Kriel indicates that coal has to be mined from beneath the bed of the existing stream in the area. Whilst under normal flow conditions the flow of water in the stream could be dealt with by pumping even if it entered the opencast workings, flood conditions would fill the mine workings and cause considerable disruption. It has therefore been decided to reroute the stream outside of the mined area and wherever possible to use a route which is not underlain by coal.

The main diversion ABCDE will be constructed first (commence July, 1976) so that the low lying areas of pit 1 can be mined early. It is probable that this channel will remain as the final course of the stream after mining in the area has ceased, however a final decision can only be made once mining is well advanced and rehabilitation is in progress.

The diversion TUVWXYZ will be constructed initially between W and Z as an upper runoff barrier to pit 3. This will be adequate until pit 3 advances too close to the natural stream bed when the channel will be extended to cut off the stream well above pit 3 at T. Since part of this channel runs above useful coal, the channel will probably not be a permanent feature. Once pit 3 has been mined and re-habilitated (approx. 15 years) the stream will be routed approximately on its old course between the backfilled mounds to meet the main diversion at A.

Various other minor ditches of a temporary nature will be used to control surface runoff around the open workings. These ditches do not affect the stream flow significantly.

2. DESIGN CRITERIA

2.1 For rational method of calculation coefficient of runoff for grasslands 0.40.

2.2 For unit graph method of calculation the unit graph for "grasslands of interior plateau" is adopted.

2.3 Mean Annual Preparation - 695mm.

2.4 Under the worst flood conditions expected with a recurrence interval of 1000 years, no river water will be permitted to flow into the open pit workings.

2.5 Diversion channels are designed to contain at least a flood with a 20 year recurrence interval.

2.6 Limited damage to roads etc. will be tolerated in areas outside the pits and adjacent to the diversion channels.

2.7 Banks and levees forming channels will be accessible for maintenance.

2.8 At design depth of flow in channels mean velocity of flow is limited to 1.3m/sec. This is to ensure that an unlined earth channel will not erode dangerously.

3. PRECIPITATION

Precipitation,
Ref. "Surface Water Resources of S.A." by D.C. Midgley and W.V. Pitman.

Mean Annual precipitation:	Trichardt	478/419	669.1mm
	Kinross	478/175	721.5mm
	Average		695 mm

4. CATCHMENT AREAS

Ref. Maps in Appendix 1.

5. RUNOFF BY RATIONAL METHOD

Ref. "design Flood Determination in S.A." by D.C. Midgley, R.A. Pullen and W.V. Pitman.

5.1 Summary of Channel Flow Calculations

	Units	Total Catchment Point Ƶ	Channel AƵ Point A	Channel TƵ Point T	Channel TƵ Point W	Channel TƵ Point Ƶ	Channel AƵ Point Ƶ TƵ Working	Channel AƵ Point Ƶ WƵ Working
Catchment Area	Km^2	51,9	13,5	14,9	25,2	31,3	20,6	45,3
Longest Path	Km	11,8	3,6	6,0	9,3	11,8	6,0	11,8
Elevation Difference	m	86,6	55,4	68,6	72,4	86,6	57,6	86,6
Time of Concentration	hours	2,94	0,89	1,46	2,38	2,94	1,58	2,94
Depth of precipitation (100 year)	mm	135	110	125	135	135	130	135
Intensity (100 year)	mm/hr	45,9	123,6	85,6	56,7	45,9	82,3	45,9
Runoff Coefficient	c	0,25	0,25	0,25	0,2	0,25	0,25	0,25
Runoff in Channel	m^3/sec	165,5	115,9	88,6	99,3	99,7	117,7	144,4
Runoff Coefficient	c	0,3	0,3	0,3	0,3	0,3	0,3	0,3
Runoff in Channel	m^3/sec	198,6	139,1	106,3	119,1	119,7	141,2	173,3
Runoff Coefficient	c	0,4	0,4	0,4	0,4	0,4	0,4	0,4
Runoff in Channel	m^3/sec	264,8	185,4	141,8	158,8	159,5	188,3	231,0

These flows and flows at other rainfall intensity recurrence intervals are plotted on Powell/Gumbel paper as in section 7 of these calculations.

5.2 <u>Detailed example of runoff calculation</u>
<u>Total catchment area at point Z</u>

Time of concentration.

Longest path	L	=	11,8 Km
Elevation Difference	H	=	86,6 m
From fig. E1 (Appendix 2)	Tc	=	$\left(\frac{0,87L^3}{H}\right)^{0,385}$
		=	2,94 hours

Depth of precipitation (d)

From fig. C2 (Appendix 3):-

Use mean annual precipitation of 695mm.
Find intersection with 2,94 hour duration curve.
Find intersection with 2, 5, 10, 20, 50, 100 year recurrence interval years.
Using summer rainfall region graph find depth of precipitation for each recurrence interval.

(years)	Probability of Occurrence (%)	Depth of Precipitation (mm)	Intensity (d/Tc) (mm/hr)	RUNOFF cu.m./sec C = 0,25	C =0,3	C =0
2	50	37	13,3	47,9	57,5	76,7
5	20	65	22,1	79,7	95,6	127,5
10	10	83	28,2	101,7	122,0	162,7
20	5	100	34,0	122,6	147,1	196,1
30	2	120	40,8	147,1	176,5	235,3
100	1	135	45,9	165,5	198,6	264,8
250	0,4	165	56,1	202,2	242,7	323,6
1000	0,1	240	81,6	294,2	353,0	470,9

4.

Runoff example for Q(100) where C = 0,4
Use rational formula Q = CIA

i.e. $Q = 0,40 \times \frac{45,9 \times 10^{-3}}{3600} \times 51.9 \times 10^{6}$

$= 264,8$ cu.m./sec.

The 100 year recurrence interval flows are used for channel design puposes.

6. RUNOFF BY SYNTHETIC HYDROGRAPH METHOD

6.1 Summary of Channel Flow Calculations

This data is shown graphically in section 7.

Recurrence Interval (Yrs)	Items	Units	Channel AZ Point A	Channel TZ Point T	Channel TZ Point W	Channel TZ Point Z AZ Working	Channel AZ Point Z TZ Working	Channel AZ Point Z Whole Catchment	Channel ZE Points Z and E Whole Catchment
	Catchment Area	sq.km.	13,5	14,9	25,2	31,3	20,6	45,9	51,9
2	Critical Duration	hours	0,50	0,50	0,50	2	0,75	0,50	1-2
	Depth of Precipitation	mm	24	24	24	39	30	24	32
	Runoff	cu.m./s	39,1	18,6	25,3	17,0	36,7	31,5	28,5
5	Critical Duration	hours	0,25	0,50	1-2	1	0,50	0,50	1-2
	Depth of Precipitation	mm	28	41	55	55	41	41	55
	Runoff	cu.m./s	68,7	43,3	37,0	40,2	53,3	72,5	67,2
10	Critical Duration	hours	0,25	0,50	1-2	1-2	0,75	0,50	1-2
	Depth of Precipitation	mm	34	52	79	68	62	52	64
	Runoff	cu.m./s	89,1	61,9	50,5	55,2	71,9	103,1	86,4
20	Critical Duration	hours	0,50	0,50	2	1-2	0,50	0,50	2
	Depth of Precipitation	mm	63	63	96	96	63	63	96
	Runoff	cu.m./s	109,2	84,6	68,3	72,8	93,2	143,3	114,5
50	Critical Duration	hours	0,50	0,50	2	2	0,75	0,50	2
	Depth of Precipitation	mm	74	74	120	120	86	74	120
	Runoff	cu.m./s	138,4	103,7	95,8	100,1	116,9	178,3	154,6
100	Critical Duration	hours	0,50	0,50	1	1	0,75	0,50	1
	Depth of Precipitation	mm	89	89	120	120	105	89	120
	Runoff	cu.m./s	180,1	134,7	110,9	126,6	155,9	222,9	182,9
300	Critical Duration	hours							4
	Depth of Precipitation	mm							240
	Runoff	cu.m./s							470,9

Duration (hrs)	1/4	1/2	3/4	1	2	3	4	6	8	
2yr Recurrence Interval										
Point Rainfall depth (mm)	17	24	30	32	37	39	43	45	47	
Intensity (mm/hr)	68	48	40	32	19	13	11	7,5	6	4
Reduction Factor	—	0,92	—	0,945	0,968	0,976	0,981	0,990	0,993	0,
Average Depth (mm)		22,1		30,2	35,8	38,1	42,2	44,6	46,7	5.
Effective Rain (mm)		3,1		5,4	7,2	8,0	9,4	10,3	10,8	1
5yr Recurrence Interval										
Point Rainfall depth (mm)	28	41	49	55	64	67	72	74	76	8
Intensity (mm/hr)	112	82	65	55	32	22	18	12	9,5	7
Reduction Factor	—	0,862	—	0,902	0,945	0,963	0,971	0,979	0,986	0,9
Average Depth (mm)		35,3		49,6	60,5	64,5	69,9	72,4	74,9	85
Effective Rain (mm)		7,2		11,9	16,2	18,1	20,6	22,1	23,4	2.
10yr Recurrence Interval										
Point Rainfall depth (mm)	34	52	62	68	79	83	89	93	96	11
Intensity (mm/hr)	136	104	83	68	40	28	22	15,5	12	9,
Reduction Factor	—	0,825	—	0,880	0,930	0,950	0,963	0,974	0,977	0,9
Average Depth (mm)		43,1		59,8	73,5	78,9	85,7	90,6	94,0	111,
Effective Rain (mm)		10,8		16,1	22,8	25,2	28,3	31,4	33,1	43,
20yr Recurrence Interval										
Point Rainfall Depth (mm)	41	63	73	81	96	100	110	115	121	13
Intensity (mm/hr)	164	126	97	81	48	33	27,5	19	15	11
Reduction Factor	—	0,795	—	0,865	0,92	0,942	0,953	0,965	0,974	0,9
Average Depth (mm)		50,1		70,1	88,3	94,2	104,8	111,3	117,9	134
Effective Rain (mm)		12,0		21,0	30,2	33,2	39,6	43,4	48,3	59,
50yr Recurrence Interval										
Point Rainfall Depth (mm)	48	74	86	98	120	124	131	137	144	16
Intensity (mm/hr)	192	148	115	98	60	41	33	23	18	16
Reduction Factor	—	0,764	—	0,833	0,895	0,928	0,942	0,961	0,971	0,9
Average Depth (mm)		56,5		81,6	107,4	115,1	123,4	131,7	137,8	163,
Effective Rain (mm)		14,7		26,1	40,8	46,2	51,2	57,0	63,6	8
100yr Recurrence Interval										
Point Rainfall Depth (mm)	58	89	105	120	130	140	150	163	175	19
Intensity (mm/hr)	232	178	140	120	65	47	37,5	27	22	16
Reduction Factor	—	0,724	—	0,803	0,886	0,922	0,938	0,955	0,963	0,
Average Depth (mm)		64,4		96,4	115,2	129,1	140,7	155,6	168,5	19
Effective Rain (mm)		18,0		34,7	46,2	55,1	64,4	75,0	83,9	106

6.2 Detailed example of Runoff Calculation
Total Catchment Area at Point Z

Ref.:
1. "Design Flood Determination in South Africa" - Report No. 1/72" by the Hydrological Research Unit, University of the Witwatersrand.
2. "Hydrology for Engineers" by R.K. Linsley, M.A. Kohler and J.L.H. Paulhus.
3. "Engineering Hydrology" by E.M. Wilson.
4. "Water Resources Engineering" by R.K. Linsley and J.B. Franzini.

6.2.1 Basin Lag

Catchment Area — $A = 51,9$ sq.km.

Longest Path — $L = 11,8$ km

Distance of Area Centre to Catchment Outlet — $Lc = 4,3$ km

From the channel longitudinal profile (Appendix 1(a) obtain the average slope — $S = 0,0052$

Hence the Catchment Index is $= \frac{LLc}{S^{\frac{1}{2}}}$

$= 710,3$

From fig. F1 (Appendix 5)
obtain the "Generalized veld type zone" — Zone 4

From fig. F2 (Appendix 6):
Use the catchment index of 710,3
Find the intersection with the zone 4 line
Hence obtain the Basin Lag — $T_L = 3,8$ hours.

6.2.2 Design Storms

From fig. C.2 (Appendix 3):
Use mean annual precipitation of 695mm.
Find the intersections with ½,1,2,3,4,6,8,12 hour duration curve.
Find the intersection with the 2,5,10,20,50,100,250,1000 year recurrence interval years.
Using summer rainfall region graph find depth of precipitation (point rainfall depth) for each recurrence interval and duration.
Divide point rainfall depth by duration to obtain the storm intensity.

From fig. C.6 (Appendix 7):
Find the intersection of each intensity with the 51,9sq.km. Areal reduction curve.
Hence read off the area reduction factor in each case.
Multiply the point rainfall depths by the areal reduction factor in each case to obtain the average depth.

From fig. G2 (Appendix 8):
Find the intersection of each average depth with the veld zone 4 curve.
Find the intersection with the (0 - 1000)sq.km. Catchment area curve.
Find the storm runoff percentage in each case.
Obtain the effective rain in each case by multiplying the average depth by the storm runoff percentage.
Hence obtain the Table shown overleaf.

CIVIL ENGINEERING

DWG. REF. .... DATE .... INITIALS ....

MINE OR COST

FILING REF

SHEET

2 HR UNIT GRAPH

Time hrs.	1hr UG	S Curve Additions	S Curve	Lagged S Curve	S Curve Difference	2hr U.G.
0,0	0,00		0,00		0,00	
0,5	0,21		0,21		0,21	
1,0	0,41	0,00	0,41		0,41	
	0,76	0,21	0,95		0,95	
2,0	1,69	0,41	2,10	0,00	2,10	
	3,16	0,76	4,11	0,21	3,9	
3,0	5,01	1,69	7,11	0,41	6,7	
	3,27	3,16	7,38	0,95	6,43	
4,0	2,56	5,01	9,67	2,10	7,57	3,79
	1,91	3,27	9,29	4,11	5,18	
5,0	1,71	2,56	11,38	7,11	4,27	
	1,32	1,91	10,61	7,38	3,23	
6,0	1,16	1,71	12,54	9,67	2,87	
	0,90	1,32	11,51	9,29	2,22	
7,0	0,74	1,16	13,28	11,38	1,90	
	0,60	0,90	12,11	10,61	1,50	
8,0	0,47	0,74	13,75	12,54	1,21	
	0,40	0,60	12,51	11,51	1,00	
9,0	0,29	0,47	14,04	13,28	0,76	
	0,23	0,40	12,74	12,11	0,63	
10,0	0,20	0,29	14,24	13,75	0,69	
	0,15	0,23	12,89	12,51	0,38	
11,0	0,13	0,20	14,37	14,04	0,33	
	0,11	0,15	13,00	12,74	0,26	
12,0	0,05	0,13	14,42	14,24	0,18	
	0,04	0,11	13,04	12,89	0,15	
13,0	0,03	0.05	14,45	14,37	0,08	
13,5	0,00	0,04	13,04	13,00	0,04	

6.2.3 Unit-Graph Synthesis

From table F4 (Appendix 9)
the value of K_u for zone 4 is 0,386.
Evaluate the one-hour unit graph peak:-

$$Q_p = K_u \frac{A}{T_L}$$

$$= 0,386 \frac{51,9}{3,8}$$

$$= 5,27 \text{ cu.m./sec.}$$

From fig. F6 (Appendix 10):
Select the solid line dimension-less one-hour unit graph.
Use lag time of T_L = 3,8 hours.
Considering time intervals of 0,5 hours determine ratio $\frac{T}{T_L}$ is in the range 0 - 3,5.

Find intersection with selected unit graph in each case.
Hence obtain value of ratio $\frac{Q}{Q_p}$ in each case.

Use calculated unit graph peak of 5,25 cu.m./sec. to obtain runoff value Q in each case.

Tabulate results to get the one hour unit graph:-

Time (hours)	$\frac{T}{T_L}$ -	$\frac{Q}{Q_p}$ -	1 hr. Unit Graph (cu.m./sec.)
0,0	0,0	0,00	0,00
0,5	0,13	0,04	0,21
1,0	0,26	0,08	0,41
1,5	0,39	0,14	0,74
2,0	0,53	0,32	1,69
2,5	0,66	0,60	3,16
3,0	0,79	0,95	5,01
3,5	0,92	0,62	3,27
4,0	1,05	0,49	2,56
4,5	1,18	0,36	1,91
5,0	1,32	0,33	1,71
5,5	1,45	0,25	1,32
6,0	1,58	0,22	1,16
6,5	1,71	0,17	0,90
7,0	1,84	0,14	0,74
7,5	1,97	0,11	0,60
8,0	2,11	0,09	0,47
8,5	2,24	0,08	0,40
9,0	2,37	0,06	0,29
9,5	2,50	0,05	0,23
10,0	2,63	0,04	0,20
10,5	2,76	0,03	0,15
11,0	2,89	0,025	0,13
11,5	3,03	0,02	0,11
12,0	3,16	0,015	0,05
12,5	3,29	0,01	0,04
13,0	3,42	0,005	0,03
13,5	3,55	0,00	0,00

CIVIL ENGINEERING

DWG. REF. .... DATE .... INITIALS ....

MINE OR COST

FILING REF

SHEET OF

3 HR Unit Graph

Time hrs.	1hr UG	S Curve Additions	S Curve	Lagged S Curve	S Curve Difference	hr U.G.
0,0	0,00		0,00		0,00	
0,5	0,21		0,21		0,21	
1,0	0,41	0,00	0,41		0,41	
	0,74	0,21	0,95		0,95	
2,0	1,69	0,41	2,10		2,10	
	3,16	0,74	4,11		4,11	
3,0	5,01	1,69	7,11	0,00	7,11	
	3,27	3,16	7,38	0,21	7,17	
4,0	2,56	5,01	9,67	0,41	9,26	
	1,91	3,27	9,29	0,95	8,34	
5,0	1,71	2,56	11,38	2,10	9,28	3,09
	1,32	1,91	10,61	4,11	6,50	
6,0	1,16	1,71	12,54	7,11	5,43	
	0,90	1,32	11,51	7,38	4,13	
7,0	0,74	1,16	13,28	9,67	3,61	
	0,60	0,90	12,11	9,29	2,82	
8,0	0,47	0,74	13,75	11,38	2,37	
	0,40	0,60	12,51	10,61	1,90	
9,0	0,29	0,47	14,04	12,54	1,50	
	0,23	0,40	12,74	11,51	1,23	
10,0	0,20	0,29	14,24	13,28	0,96	
	0,15	0,23	12,89	12,11	0,78	
11,0	0,13	0,20	14,37	13,75	0,62	
	0,11	0,15	13,00	12,51	0,49	
12,0	0,05	0,13	14,42	14,04	0,38	
	0,04	0,11	13,04	12,74	0,30	
13,0	0,03	0,05	14,45	14,24	0,21	
13,5	0,00	0,04	13,04	12,89	0,15	

CIVIL ENGINEERING

DWG. REF. .... DATE .... INITIALS ....

CODE NO. MINE OR COST C... FILING ... SHEET ... OF ...

4 HR UNIT GRAPH

Time hrs.	1 hr UG	S Curve Additions	S Curve	Lagged S Curve	S Curve Difference	hr U.G.
0,0	0,00		0,00		0,00	
0,5	0,21		0,21		0,21	
1,0	0,41	0,00	0,41		0,41	
	0,76	0,21	0,95		0,95	
2,0	1,69	0,41	2,10		2,10	
	3,16	0,76	4,11		4,11	
3,0	5,01	1,69	7,11		7,11	
	3,27	3,16	7,38		7,38	
4,0	2,56	5,01	9,67	0,00	9,67	
	1,91	3,27	9,29	0,21	9,08	
5,0	1,71	2,56	11,35	0,41	10,97	2,74
	1,32	1,91	10,61	0,95	9,66	
6,0	1,16	1,71	12,54	2,10	10,44	
	0,90	1,32	11,51	4,11	7,40	
7,0	0,74	1,16	13,28	7,11	6,17	
	0,60	0,90	12,11	7,38	4,73	
8,0	0,47	0,74	13,75	9,67	4,08	
	0,40	0,60	12,51	9,29	3,22	
9,0	0,29	0,47	14,04	11,38	2,66	
	0,23	0,40	12,74	10,61	2,13	
10,0	0,20	0,29	14,24	12,54	1,70	
	0,15	0,23	12,89	11,51	1,38	
11,0	0,13	0,20	14,37	13,28	1,07	
	0,11	0,15	13,00	12,11	0,89	
12,0	0,05	0,13	14,42	13,75	0,67	
	0,04	0,11	13,04	12,51	0,53	
13,0	0,03	0,05	14,45	14,04	0,41	
13,5	0,00	0,04	13,54	12,74	0,30	

CIVIL ENGINEERING

DWG. REF. .... DATE .... INITIALS .... SHEET ...... OF

6 HR Unit Graph

Time hrs.	1hr UG	S Curve Additions	S Curve	Lagged S Curve	S Curve Difference	hr U.G.
0,0	0,00		0,00		0,00	
0,5	0,21		0,21		0,21	
1,0	0,41	0,00	0,41		0,41	
	0,76	0,21	0,95		0,95	
2,0	1,69	0,41	2,10		2,10	
	3,16	0,76	4,11		4,11	
3,0	5,07	1,69	7,11		7,11	
	3,27	3,16	7,38		7,38	
4,0	2,56	5,01	9,67		9,67	
	1,91	3,27	9,29		9,29	
5,0	1,71	2,56	11,38		11,38	
	1,32	1,91	10,61		10,61	
6,0	1,16	1,71	12,54	0,00	12,54	
	0,90	1,32	11,51	0,21	11,30	
7,0	0,74	1,76	13,28	0,41	12,57	2,15
	0,60	0,90	12,11	0,95	11,16	
8,0	0,47	0,74	13,75	2,10	11,65	
	0,40	0,60	12,51	4,11	8,40	
9,0	0,29	0,47	14,04	7,11	6,93	
	0,23	0,40	12,74	7,38	5,36	
10,0	0,20	0,29	14,26	9,67	4,57	
	0,15	0,23	12,89	9,29	3,6	
11,0	0,13	0,20	14,37	11,38	2,77	
	0,11	0,15	13,00	10,61	2,39	
12,0	0,05	0,13	14,42	12,54	1,88	
	0,04	0,11	13,04	11,51	1,53	
13,0	0,03	0,05	14,45	13,28	1,17	
13,5	0,00	0,04	13,04	12,11	0,93	

CIVIL ENGINEERING

DWG. REF. .... DATE .... INITIALS .... SHEET OF

8 HR UNIT GRAPH

Time hrs.	1hr UG	S Curve Additions	S Curve	Lagged S Curve	S Curve Difference	hr U.G.
0,0	0,00		0,00		0,00	
0,5	0,21		0,21		0,21	
1,0	0,41	0,00	0,41		0,41	
	0,74	0,21	0,95		0,95	
2,0	1,69	0,41	2,10		2,10	
	3,16	0,74	4,11		4,11	
3,0	5,01	1,69	7,11		7,11	
	3,27	3,16	7,38		7,38	
4,0	2,56	5,01	9,67		9,67	
	1,91	3,27	9,29		9,29	
5,0	1,71	2,56	11,38		11,38	
	1,32	1,91	10,61		10,61	
6,0	1,16	1,71	12,54		12,54	
	0,90	1,32	11,51		11,51	
7,0	0,74	1,16	13,28		13,28	
	0,60	0,90	12,11		12,11	
8,0	0,47	0,74	13,75	0,00	13,75	1,72
	0,40	0,60	12,51	0,21	12,30	
9,0	0,29	0,47	14,04	0,41	13,63	
	0,23	0,40	12,74	0,95	11,79	
10,0	0,20	0,29	14,24	2,10	12,14	
	0,15	0,23	12,89	4,11	8,78	
11,0	0,13	0,20	14,37	7,11	7,26	
	0,11	0,15	13,00	7,38	5,62	
12,0	0,05	0,13	14,42	9,67	4,75	
	0,04	0,11	13,04	9,29	3,75	
13,0	0,03	0,05	14,45	11,38	3,07	
13,5	0,00	0,04	13,64	10,61	2,43	

Hence, by means of the "S-curve" Method, obtain the ½, 2, 3, 4, 6, 8 and 12 hour unit graphs.

6.2.4 Critical Storm Duration

From each unit graph above obtain the peak runoff. From the design rainfall details consider the effective rain. Multiply, for each recurrence interval and duration, the effective rain value by the corresponding unit graph peak. Tabulate the results as shown overleaf (top table). Select the peak flood value and its corresponding duration for each recurrence interval and hence tabulate the design flood details (Bottom table).

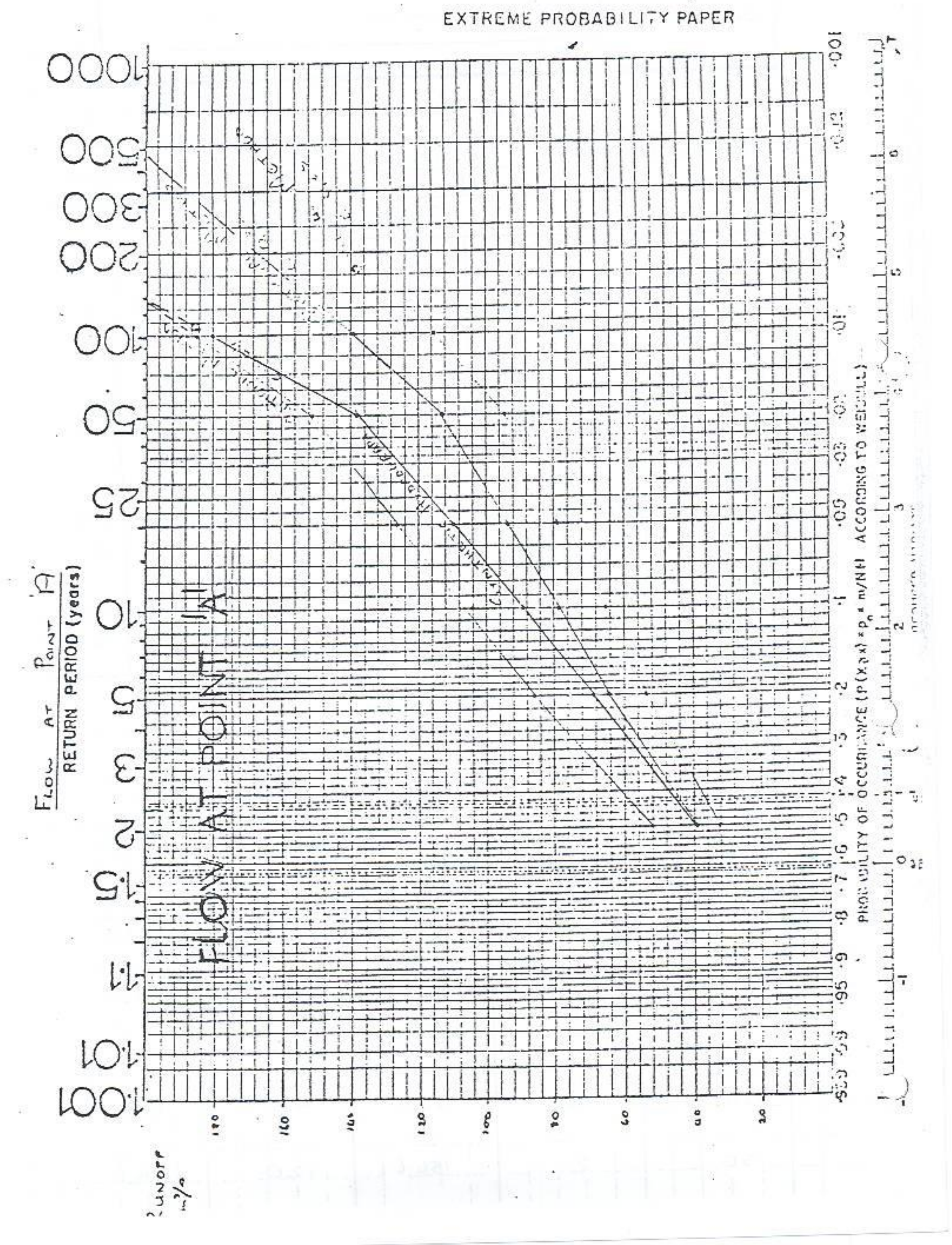
Hence considering the peak values of the synthetic hydrograph

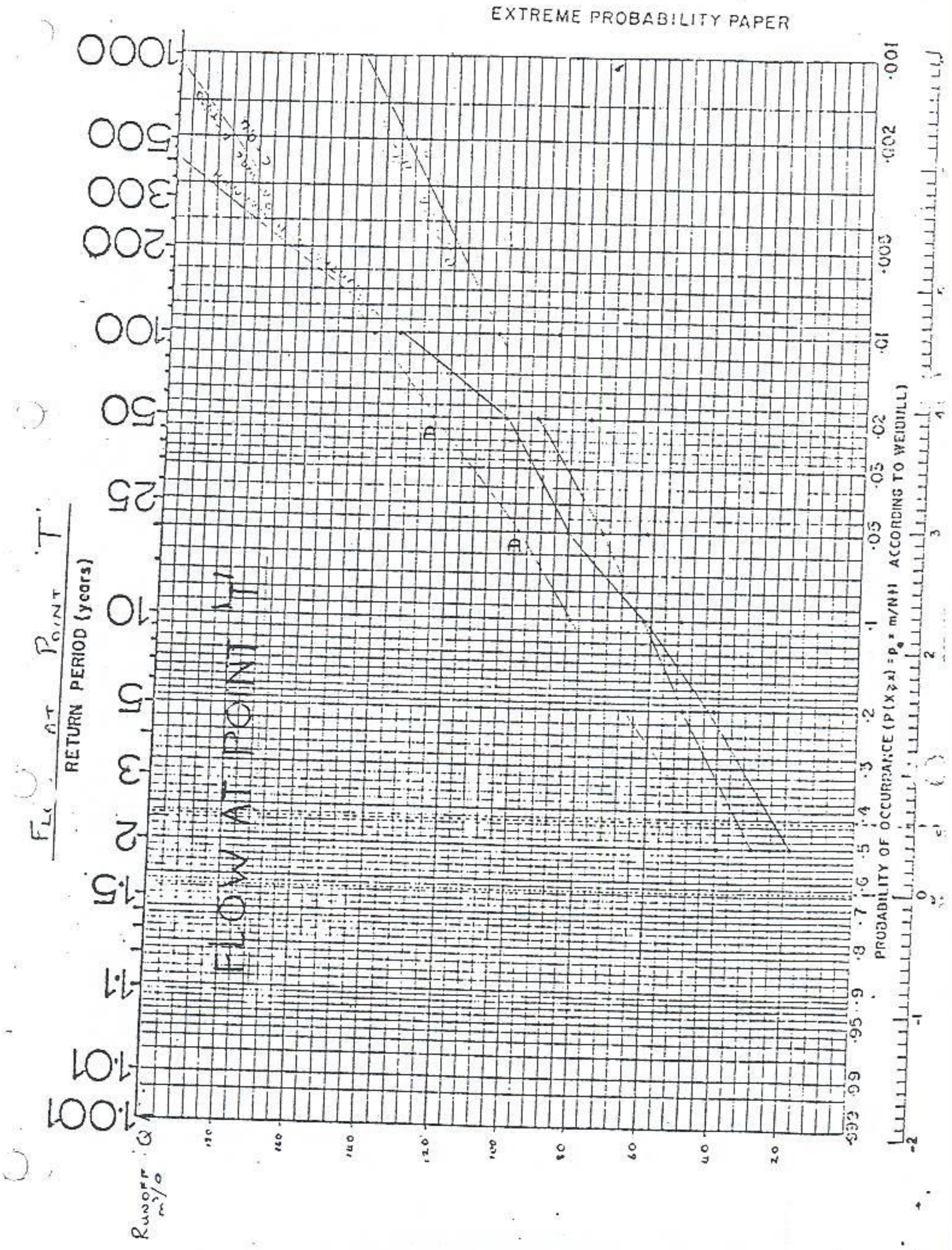
DURATION hrs	U. G. PEAK m³/s	RECURRENCE INTERVAL 2	5	10	20	50	100
		SYNTHETIC HYDROGRAPH PEAK (m³/s)					
1/4							
1/2	6,54	20,3	47,1	70,6	78,5	96,1	117,7
3/4							
1	5,27	28,5	62,7	84,8	110,7	137,5	183,7
2	3,79	27,3	61,4	86,4	114,5	154,6	195,1
3	3,09	24,7	55,9	77,9	102,6	142,8	170,3
4	2,74	25,8	56,4	77,5	108,5	140,3	176,5
6	2,15	22,1	47,5	67,5	93,3	122,6	161,3
8							
8	1,72	18,6	40,2	56,9	53,1	102,4	142,7
12	1,20	15,6	34,0	52,1	70,9	98,3	127,7

Hence the design flood details are

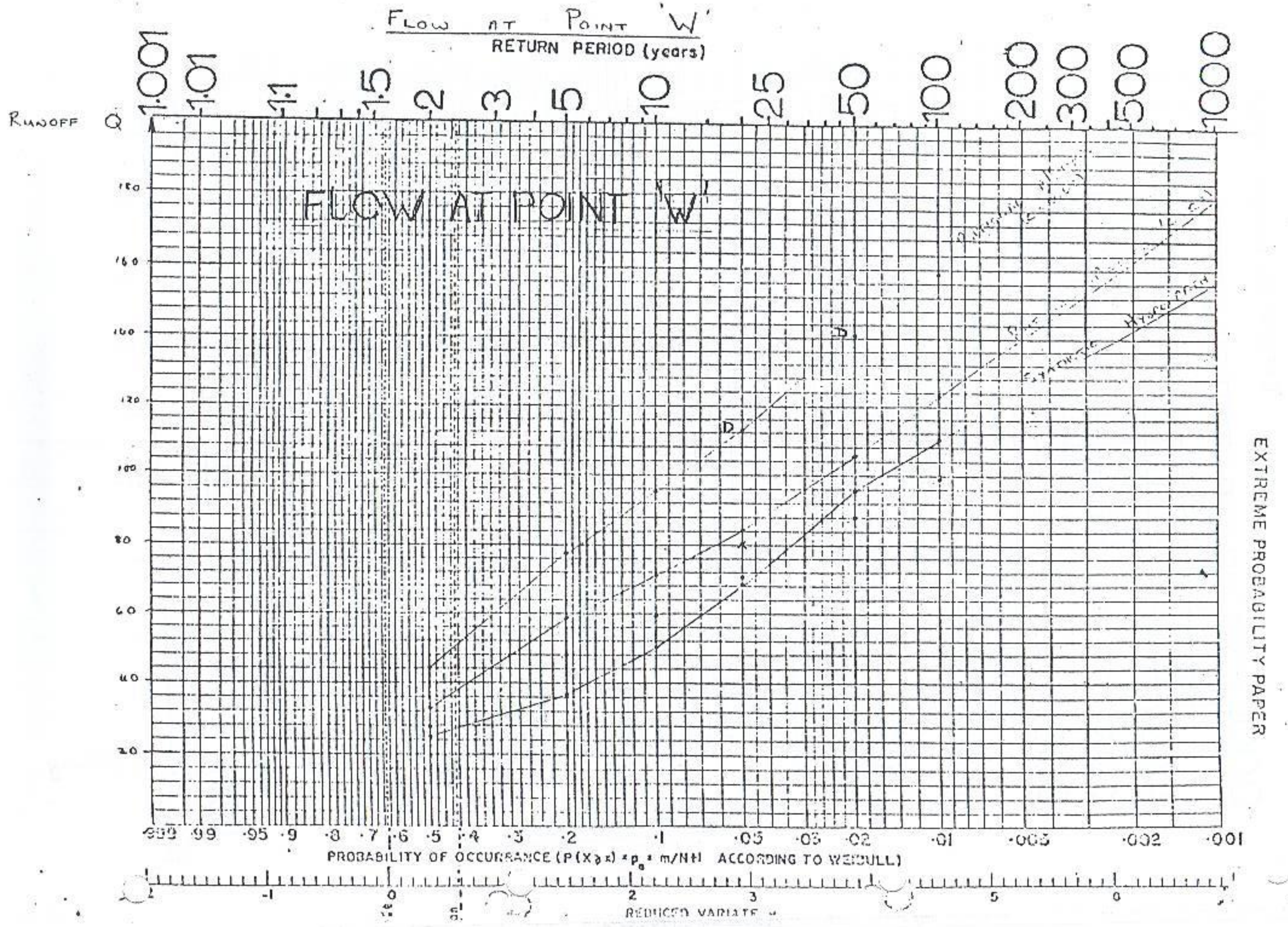
RECURRENCE INTERVAL (years)	CRITICAL DURATION (hours)	FLOOD PEAK (m³/s)	DEPTH OF PRECIP. (mm)	RUNOFF (m³/s)
2	1 - 2	28,5	32	28,5
5	1 - 2	62,7	55	62,7
10	1 - 2	86,4	64	86,4
20	2	114,5	96	114,5
50	2	154,6	120	154,6

7. POWELL / GUMBEL PLOT OF FLOWS

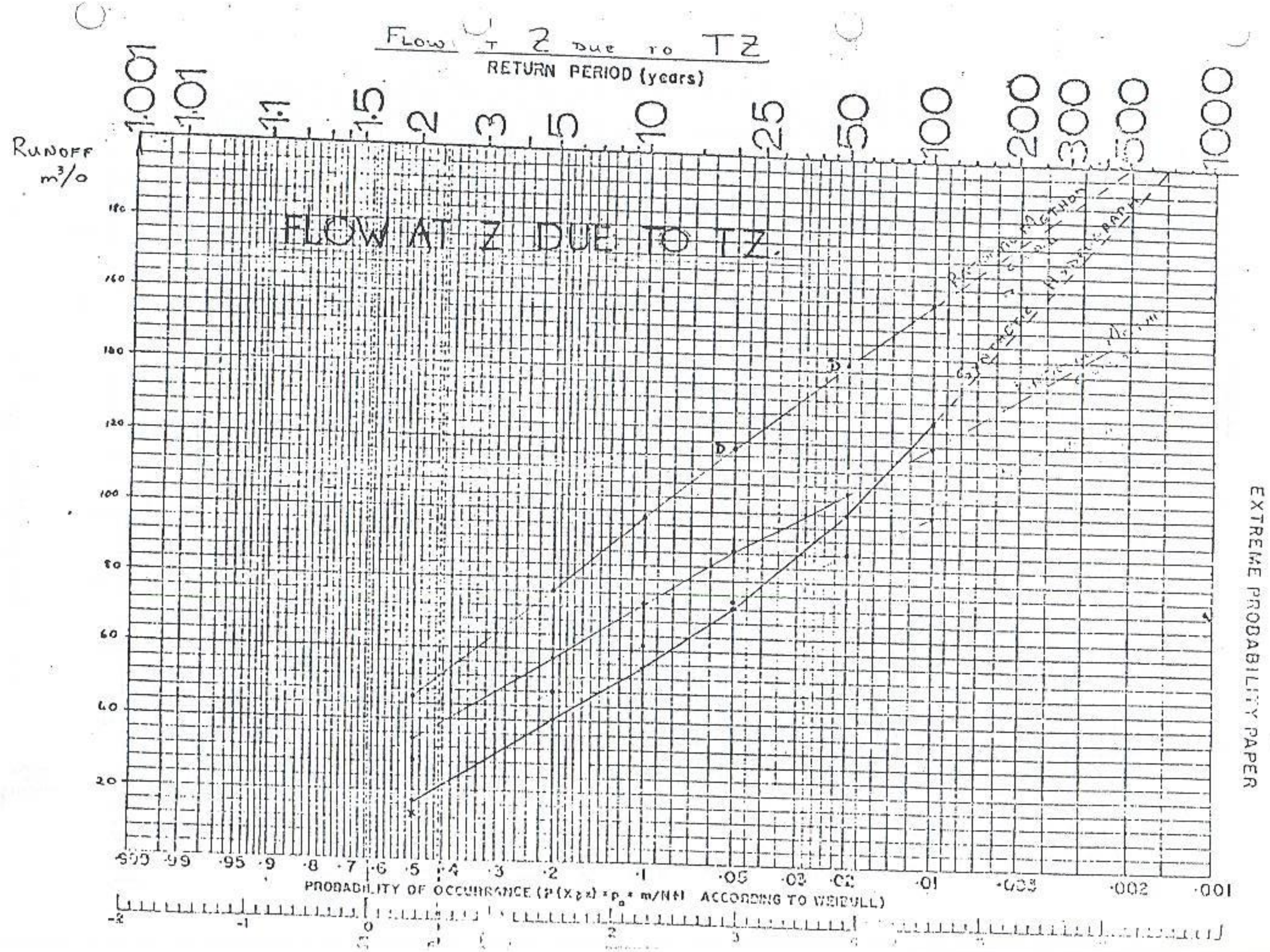


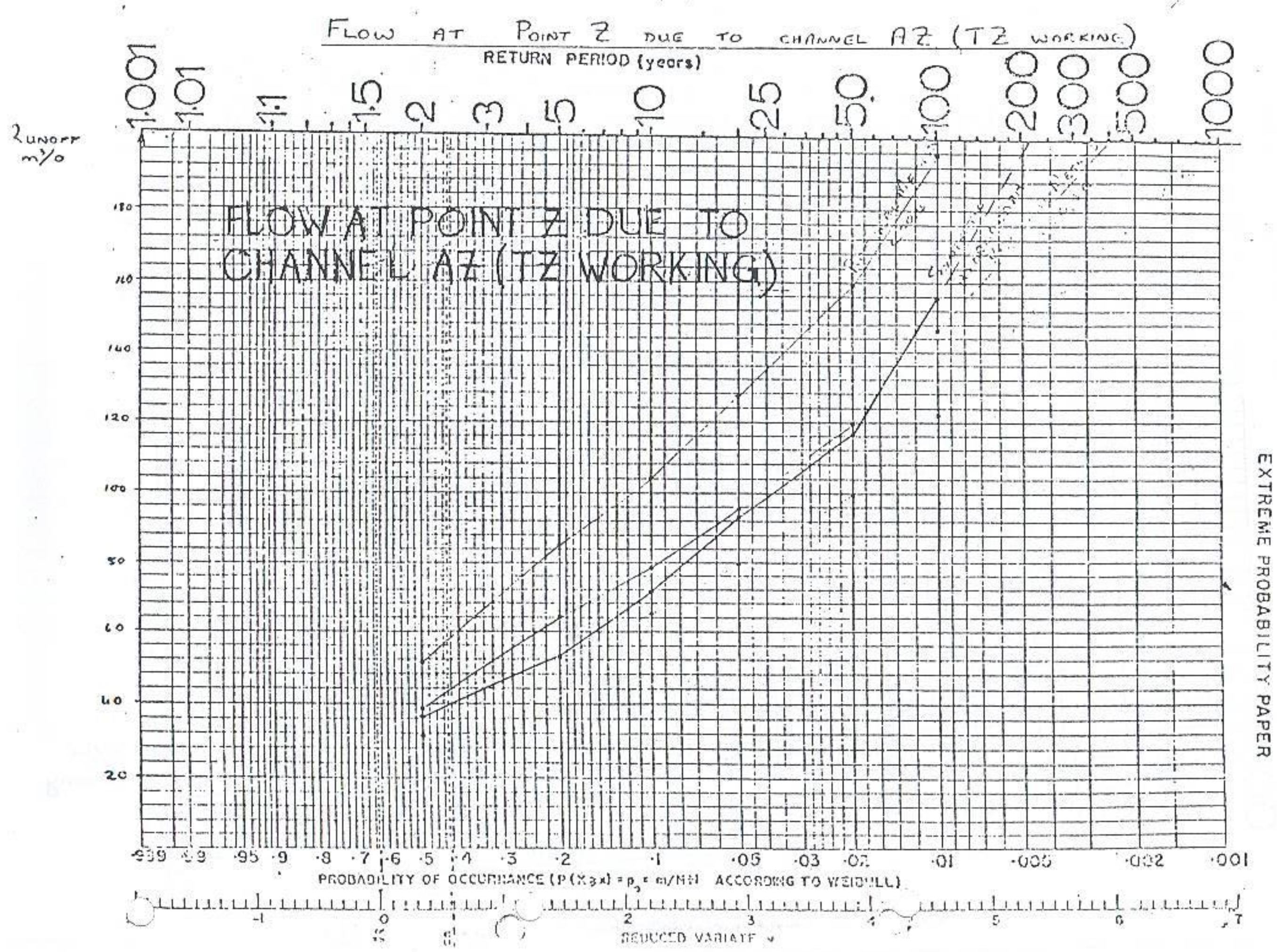


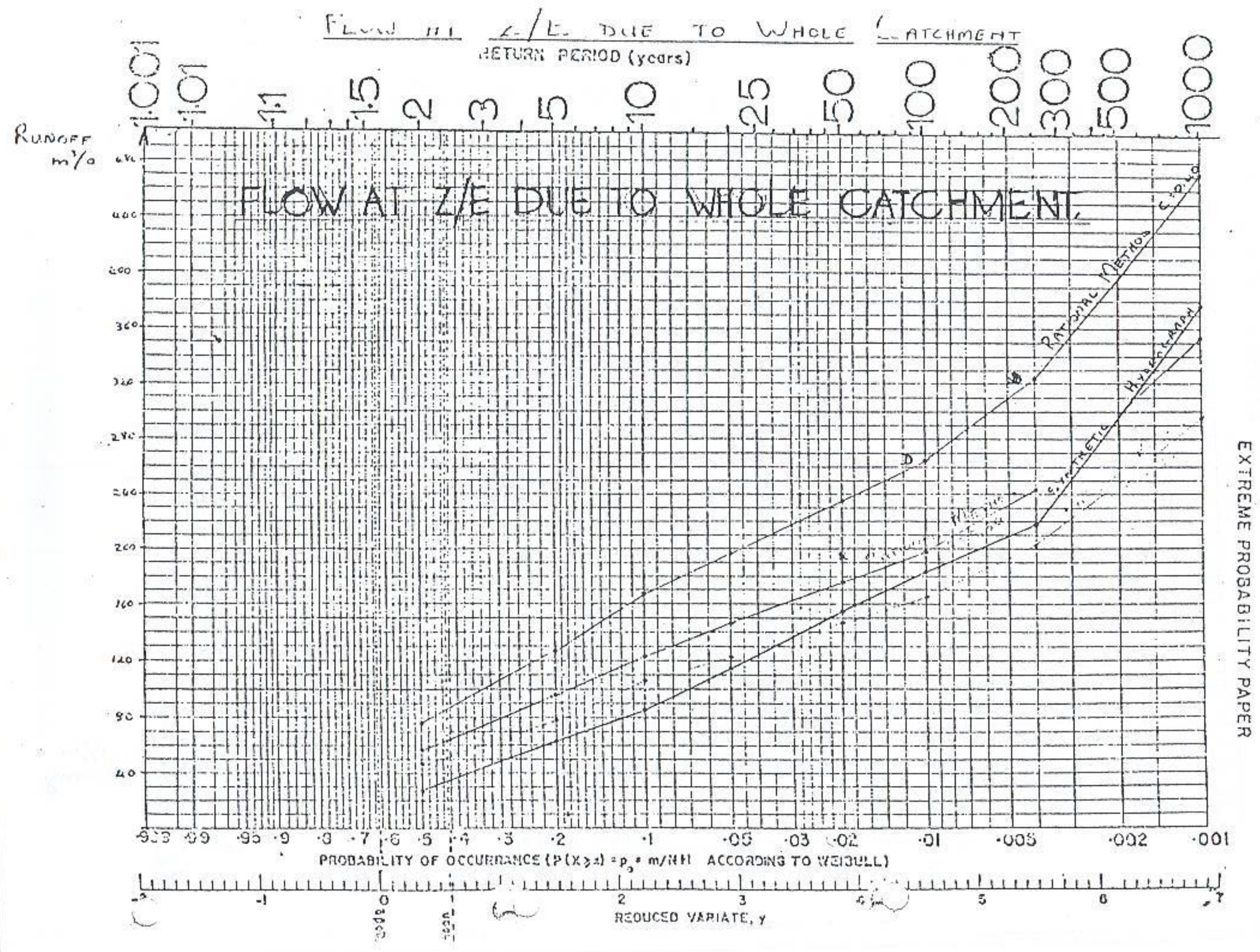
EXTREME PROBABILITY PAPER
RETURN PERIOD (years)
1.001
1.01
1.1
1.5
2
3
5
10
25
50
100
200
300
500
1000
PROBABILITY OF OCCURRANCE (P(X≥x) = p = m/N+1 ACCORDING TO WEIBULL)
FLOW AT POINT T



Flow at Point 'W'
RETURN PERIOD (years)
1.001 1.01 1.1 1.5 2 3 5 10 25 50 100 200 300 500 1000
Runoff Q
FLOW AT POINT 'W'
EXTREME PROBABILITY PAPER
PROBABILITY OF OCCURRANCE (P(X≥x) = p = m/N+1 ACCORDING TO WEIBULL)
REDUCED VARIATE


FLOW AT Z DUE TO TZ
RETURN PERIOD (years)
1.001
1.01
1.1
1.5
2
3
5
10
25
50
100
200
300
500
1000
RUNOFF m³/s
180
160
140
120
100
80
60
40
20
PROBABILITY OF OCCURRANCE (P(X≥x) = Pa = m/N+1 ACCORDING TO WEIBULL)
·999 ·99 ·95 ·9 ·8 ·7 ·6 ·5 ·4 ·3 ·2 ·1 ·05 ·03 ·02 ·01 ·005 ·002 ·001
-2 -1 0 1 2 3
EXTREME PROBABILITY PAPER


FLOW AT POINT Z DUE TO CHANNEL AZ (TZ WORKING)
RETURN PERIOD (years)
1.001 1.01 1.1 1.5 2 3 5 10 25 50 100 200 300 500 1000
Runoff m³/s
180 160 140 120 100 80 60 40 20
FLOW AT POINT Z DUE TO
CHANNEL AZ (TZ WORKING)
·999 ·99 ·95 ·9 ·8 ·7 ·6 ·5 ·4 ·3 ·2 ·1 ·05 ·03 ·02 ·01 ·005 ·002 ·001
PROBABILITY OF OCCURRANCE (P(X≥x) = p = m/N+1 ACCORDING TO WEIBULL)
-1 0 1 2 3 4 5 6 7
REDUCED VARIATE y
EXTREME PROBABILITY PAPER



FLOW AT Z/E DUE TO WHOLE CATCHMENT
RETURN PERIOD (years)
1.001 1.01 1.1 1.5 2 3 5 10 25 50 100 200 300 500 1000
RUNOFF m³/s
400 360 320 280 240 200 160 120 80 40
FLOW AT Z/E DUE TO WHOLE CATCHMENT
RATIONAL METHOD
C.P.L.D
SYNTHETIC
HYDROGRAPH
·999 ·99 ·95 ·9 ·8 ·7 ·6 ·5 ·4 ·3 ·2 ·1 ·05 ·03 ·02 ·01 ·005 ·002 ·001
PROBABILITY OF OCCURRANCE (P(X≥x) = p₀ = m/N+1 ACCORDING TO WEIBULL)
-1 0 1 2 3 4 5 6 7
REDUCED VARIATE, y
EXTREME PROBABILITY PAPER

8. CHOICE OF DESIGN FLOW

Channel ABCDE

It is anticipated that this channel will remain the permanent course of the stream after mining operations are completed. The channel runs adjacent to both pits and is therefore considered more important than channel TUVWXYZ with regard to risk to the mine. The worst possible flood flow for the 100 year recurrence period has been chosen as the design flow from the four alternative methods of calculating runoff. At this flow the design non-scour velocity is not exceeded in the channels. Due to the high freeboard on the channels and the haul road bridge, the channels will however cater for 1 in 1000 year flood although average velocity does increase marginally (from 1.2m/sec. to 1.4m/sec.). It is considered that there is a high margin of safety in the design of this channel provided channel maintenance is carried out while mining operations are in progress.

Channel TUVWXYZ

This channel will not be constructed until mining operations intersect channel AB. For a period of approximately 12 years this channel will serve a useful life and thereafter the stream will no longer be diverted at T but put back approximately on its old course to meet the main channel at B again. It will then be flowing over the mined out area of pit 3. Due to the short life, it is considered sufficient to design the actual channels to take a 1 in 20 year flood. The level on the pit side of channel TZ will however be high enough to protect the workings from a 1 in 1000 year flood although flood waters will rise out of the channel on the opposite side onto farm lands. Only in two short lengths namely chainage 2400,0m - 2700,0m AND 5100,0m - 5800,0m has the channel been widened to cater for a 1 in 50 year flood since the depth of the channel prevented the spread of water onto adjacent farm land.

Cannel Design Flows

	Design velocity flow within channel		Worst flood contained by levee	
	Recurrence years	Flow cu.m./sec.	Recurrence years	Flow cu.m./sec.
Channel AZ point A.	100	185,4	1000	303,0
Channel TZ point T.	20	98,7	1000	204,0
Channel TZ point W	20	112,9	1000	219,9
	50	141,2		
Channel TZ point Z	20	118,2	1000	220,3
	50	141,8		
Ch nnel AZ point Z wi h TZ working	-		-	
Channel AZ point Z whole catchment	100	231,0	1000	313,1
Channel ZE points Z & E whole catchment	100	264,8	1000	470,9

Note:
1. The design flows are indicated by the letter D on the Gumbell plots.
2. The most conservative flow figures with C = 0.4 have been chosen.

9. EFFECT OF BETHAL OGIES ROAD BRIDGE

The diversion channel at E has been designed to carry a flow far in excess of that which can be handled by provincial road bridge situated 1.1 km downstream of point E. During a 100 year storm, it has been calculated that the causeway approaching the bridge and the bridge itself will be submerged to a depth of 0,6m. Water will back up upstream of the road, but it will not inundate the channel at E since channel invert level at E is 1543.968 whilst top flood level at bridge is 1543,8. The surface of the backed up water is shown on drawing 479/0/3710 and does not present a danger to the opencast workings either. The following sketch indicates the relative size of the bridge and channel at point E.

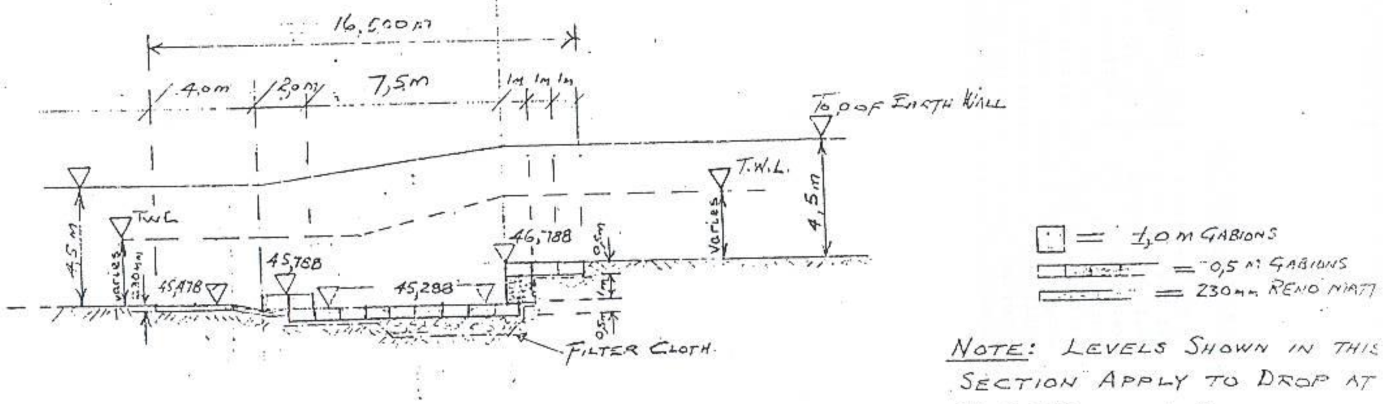
10. EFFECT OF CHANNEL TW ON DELMAS ROAD

The relative size of the existing bridge carring a provincial road over the stream and the channel carrying the corresponding flow are shown on the following sketch. It appears that the road would be inundated during a 1 in 20 year storm at present. The channels T to V_1 will carry a 1 in 1000 year flood if water is allowed to build up on the upper side slope of the channel. The cutting V_1 to V_2 and the bridge under the Delmas road will be designed to carry a 1 in 50 year flood peak. Greater floods will be of short duration and considerable storage effect of the channel from T to V_1 will serve to reduce the magnitude of the flood peak, but increase the flood time. The road opposite chainage 3200m has a top level of 1568,60 i.e. 2,60m above the stream diversion invert. The 50 year storm top water level at chainage 3200m is 2,5m above invert thus the road would be just above water or at worst just under water at the peak of a storm but for a duration of not more than 1 hour. This is considered acceptable by A.A.C.

Further, it is probable that this road will eventually be closed due to mining operations.

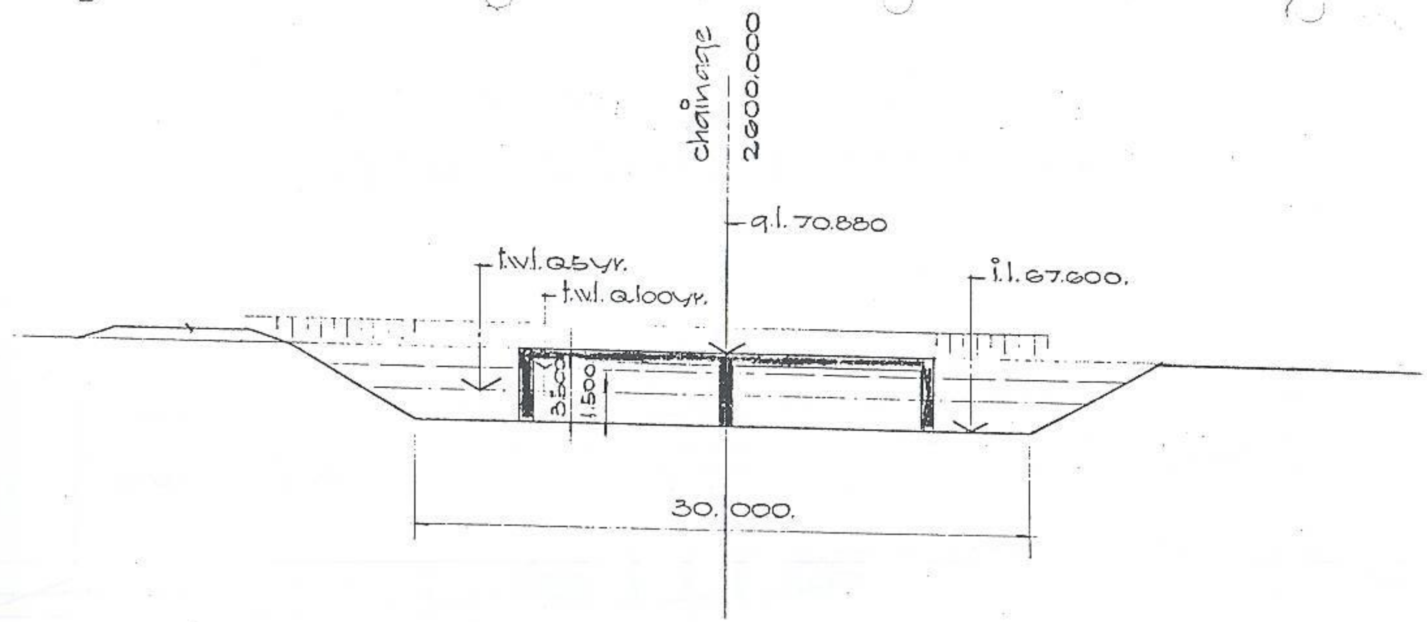
11. EROSION PROTECTION

A typical cross section through the proposed gabion type construction at the 1,3m drops follows. All drops will have this protection which will be continued up the side slopes of the channels to the design top water level. The top surface of all levels and banks is to be accessible by tipper lorry, and should local scouring occur possibly at bends on the intersection of channels, loose rock can quickly be dumped in the dangerous areas. Once water levels have subsided, additional gabion construction can be used at these areas. The most important means of limiting erosion of normal channel sides is by the planting of grass by hydroseeding.

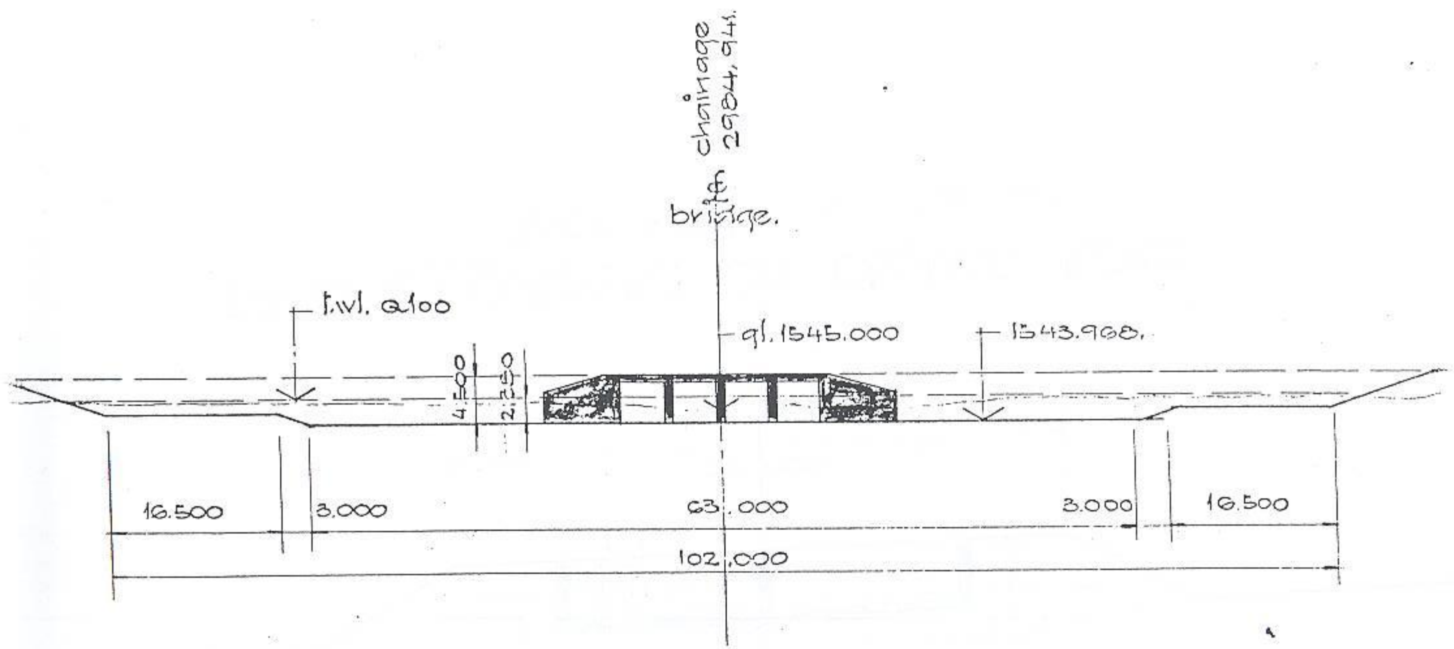


Typical Sectional Detail of Proposed Gabion Protection at all 1,3m. Drop Points on Stream Diversions

Note: Levels shown in this section apply to drop at Ch. 2 633 m on Diversion A-B-C-D-E.



BRIDGE/CULVERT ON DELMAS ROAD
PAST MATLA (superimposed)



BETHAL - OOGIES ROAD BRIDGE.
(superimposed approx)
BRIDGE 1804. BUILT 2.11.61.

Scale:-

12. ANTI POLLUTION MEASURES

It is not intended that water in the stream diversion channels should come into contact with coal or coal wastes at any point. The open pits will be reasonably protected from the channels by the normal channel banks and levels, but the workings will be further protected by the spoil heap formed by the box cut or initial cut of the mining operation. This is marked in green on drawing 479/0/3710.

Rainwater and seepage water which does enter the pits will be pumped out and given special treatment. The final solution to this problem has not yet been decided upon, but alternatives under investigation are listed in order of preference.

1. Form earth walled settling ponds as shown on drawings. (Note evaporation dams would be too big to be practical). Surplus water would be discharged into the stream.

2. Pump silty, polluted water up the hill into ESCOM's ash settling dams, the decanted water being used in the power station.

3. Discharge water into the adjacent pan where silt and coal wastes would settle to the bottom.

13. IDEALISED CHANNEL SHAPE DESIGNS

Ref.: 1. "Open Channel Hydraulics" by Ven Te Chow.
2. "Fluid Mechanics for Engineers" by M.L. Albertson, J.R. Barton and D.B. Simons.

The idealised channel shapes which follow have been used as the basis for the working drawings. The design of these channel shapes is based on the Manning Formula:

$$Q = A \times \frac{1}{n} \times R^{2/3} \times S^{1/2}$$

Q = Designed Runoff

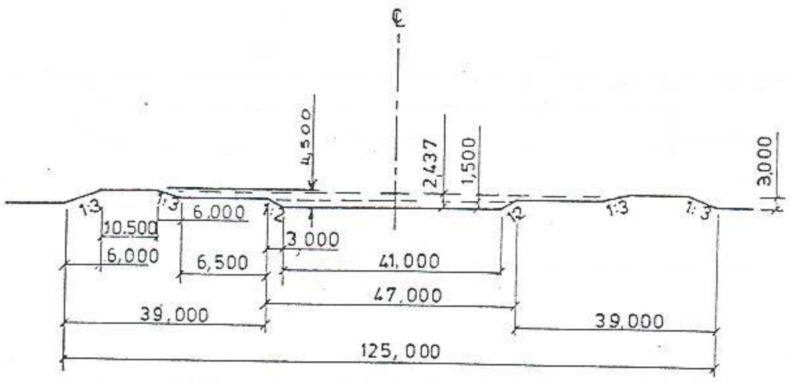
where A = Cross-sectional Area

R = Wetted Perimeter

S = Channel Slope

n = Manning's Coefficient of Roughness.

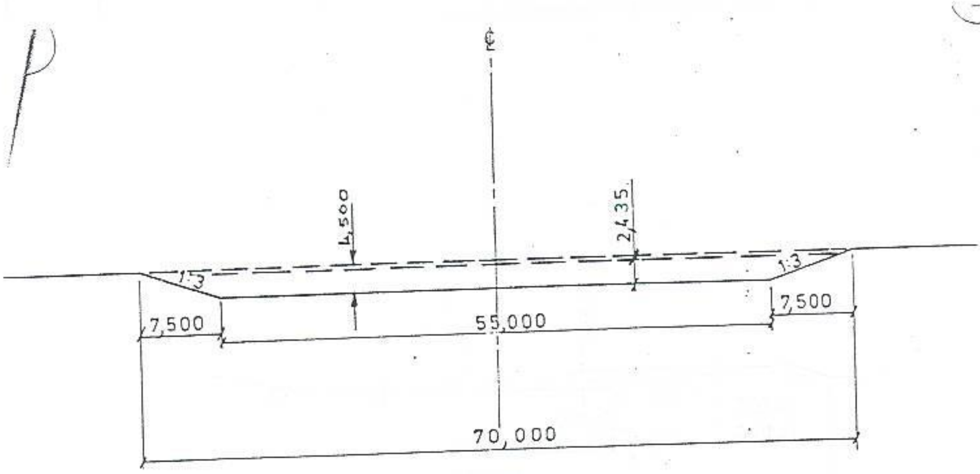
The channel considered in each case was one of earth with reasonable growth in the form of grass and weeds so that roughness coefficient n = 0,030.



TYPICAL SECTION THROUGH CHANNEL A-2

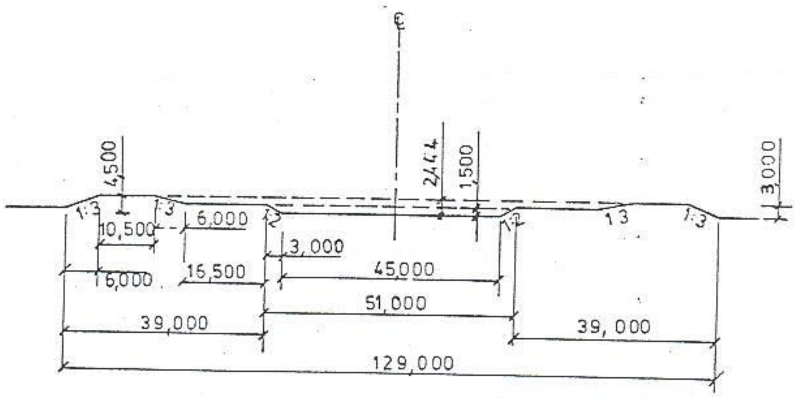
SCALE 1:1000

100 YR RUNOFF	Q = 165,4 Cumecs	
DEPTH OF FLOW	D = 2,437 m	
AREA	A_1 = 110,039 m^2	A_2 = 33,555 m^2
WETTED PERIMETER	P_1 = 47,708 m	P_2 = 38,926 m
COEFFICIENT OF ROUGHNESS (MANNING'S n) = 0,030		
SLOPE	S = 1:1600	
HYDRAULIC RADIUS	R_2 = 2,307	R_2 = 0,862
VELOCITY	V_1 = 1,455 m/s	V_2 = 0,755 m/s



TYPICAL SECTION THROUGH CHANNEL A-2

100 YR RUNOFF	Q	= 1923 Cumecs
DEPTH OF FLOW	D	= 2,435 m
AREA A		= 156,250 m^2
WETTED PERIMETER	P	= 70,811 m
COEFFICIENT OF ROUGHNESS (MANNING'S n)		= 0,030
SLOPE	S	= 1:2250
HYDRAULIC RADIUS	R = A/P	= 2,207 m
VELOCITY (V)		= 1,268 m/s

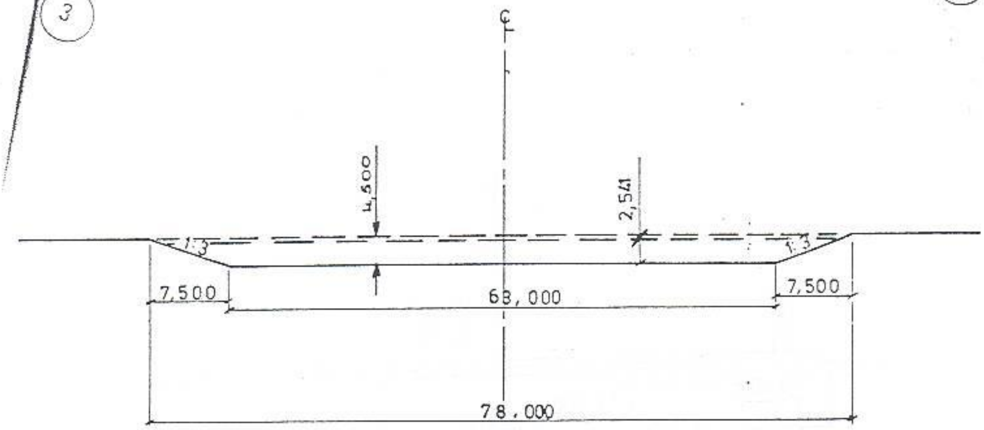


TYPICAL SECTION THROUGH CHANNEL A – 2

100 YR RUNOFF	Q	=	201,2 Cumecs	
DEPTH OF FLOW	D	=	2,444 m	
AREA	A_1	=	120,144 m^2	A_2 = 33,825 m^2
WETTED PERIMETER	P_1	=	51,708 m	P_2 = 38,970 m
COEFFICIENT OF ROUGHNESS	(MANNING'S n)	=	0,030	
SLOPE S		=	1:1600	
HYDRAULIC RADIUS R_1		=	2,324 m	R_2 = 0,868 m
VELOCITY	V_1	=	1,462 m/s	V_2 = 0,758 m/s

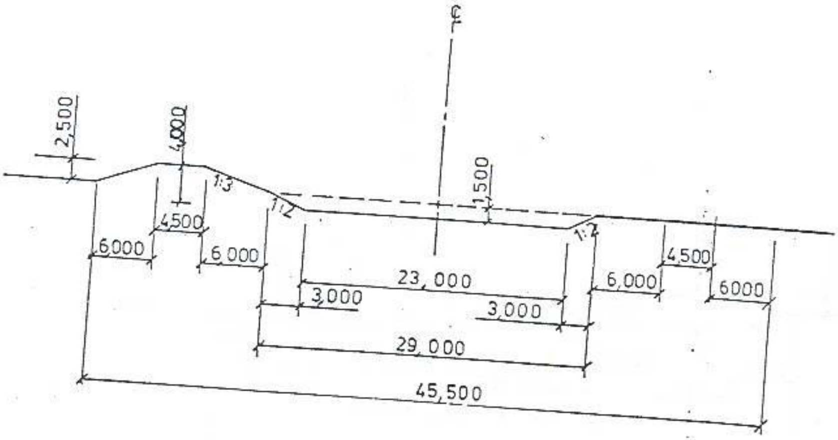
3

4



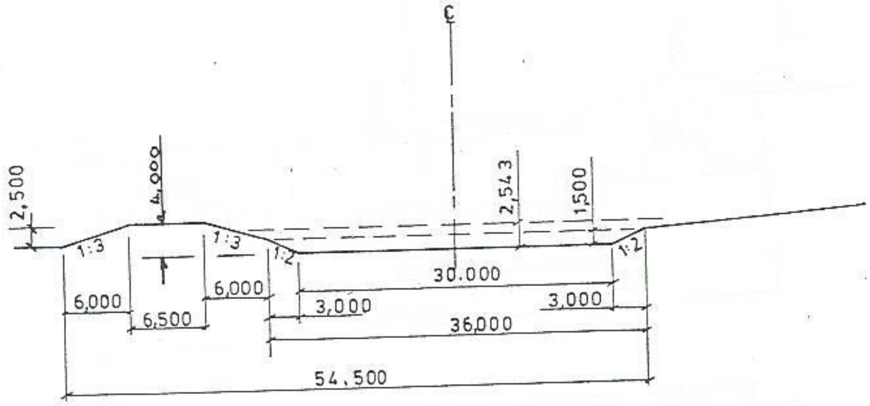
TYPICAL SECTION THROUGH CHANNEL A-2

100 YR RUNOFF	Q	=	217,7 Cumecs
DEPTH OF FLOW	D	=	2,541 m
AREA	A	=	179,141 m^2
WETTED PERIMETER	P	=	78,838 m
COEFFICIENT OF ROUGHNESS	(MANNINGS n)	=	0,030
SLOPE	S		1:2250
HYDRAULIC RADIUS	$R = A/P$		2,272 m
VELOCITY	V		1,214 m/s



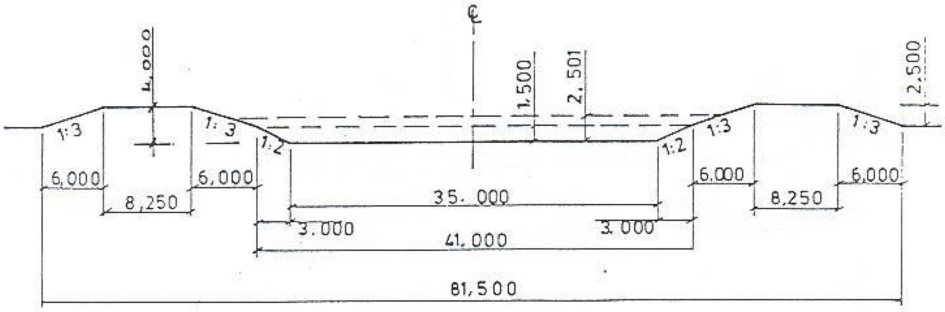
TYPICAL SECTION THROUGH CHANNEL T.U.V.

20 YR RUNOFF	Q	= 98,7 Cumecs
DEPTH OF FLOW	D	= 2,436 m
AREA	A	= 71,138 m²
WETTED PERIMETER	P	= 40,586 m
COEFFICIENT OF ROUGHNESS (MANNINGS n)		= 0,030
SLOPE	S	= 1:2000
HYDRAULIC RADIUS	R = A/P	= 1,753 m
VELOCITY	V	= 1,271 m/s



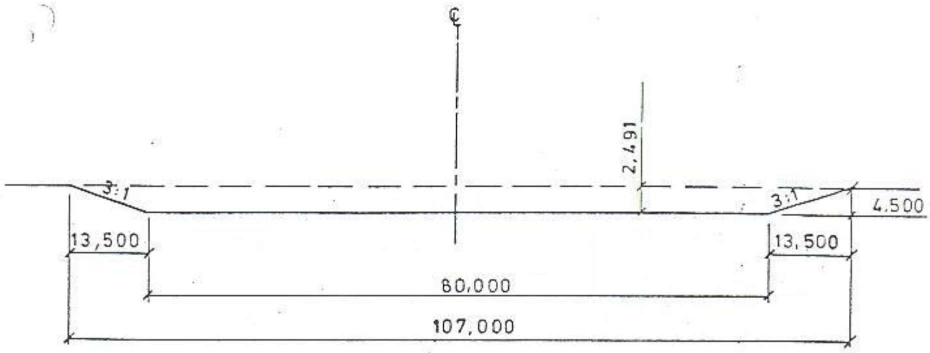
TYPICAL SECTION THROUGH CHANNEL T-2

20 YR RUNOFF	Q	= 112,9 Cumecs
DEPTH OF FLOW	D	= 2,543 m
AREA	A	= 95,140 m^2
WETTED PERIMETER	P	= 50,330 m
COEFFICIENT OF ROUGHNESS	(MANNINGS n)	= 0,030
SLOPE	S	= 1:2 000
HYDRAULIC RADIUS	R = A/P	= 1,890 m
VELOCITY	V	= 1,257 m/s



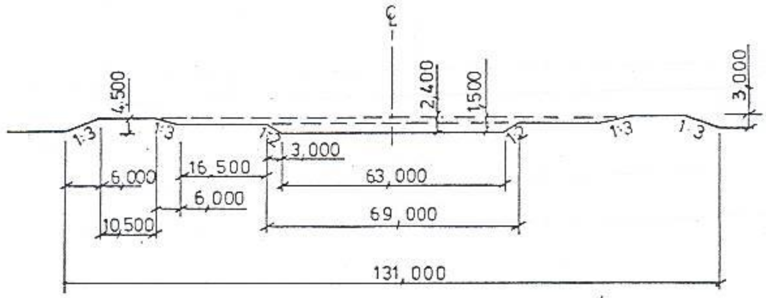
TYPICAL SECTION THROUGH CHANNEL T-2

20 YR RUNOFF	Q	= 118,2 Cumecs
DEPTH OF FLOW	D	= 2,501m
AREA	A	= 101,047m^2
WETTED PERIMETER	P	= 48,039 m
COEFFICIENT OF ROUGHNESS (MANNINGS n)		= 0,030
SLOPE	S	= 1:2 000
HYDRAULIC RADIUS	R A/P	= 2,103 m
VELOCITY	V	= 1,245m/s



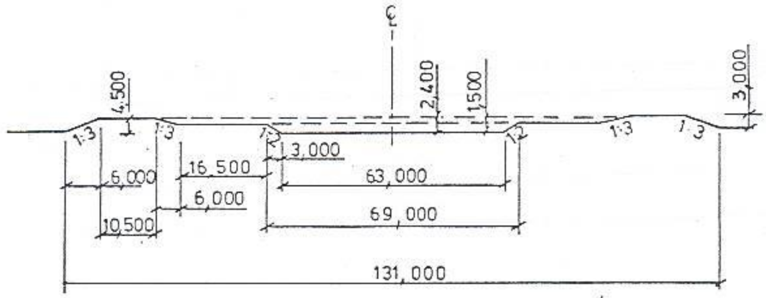
TYPICAL SECTION THROUGH CHANNEL Z- E

100 YR RUNOFF	Q	= 264,9 Cumecs
DEPTH OF FLOW	D	= 2,491 m
AREA	A	= 217,895 m^2
WETTED PERIMETER	P	= 95,754 m
COEFFICIENT OF ROUGHNESS		(MANNING'S n) = 0,030
SLOPE	S	= 1:2250
HYDRAULIC RADIUS	R=A/P	= 2,276m
VELOCITY	V	= 1,216 m/s



TYPICAL SECTION THROUGH CHANNEL 2-E

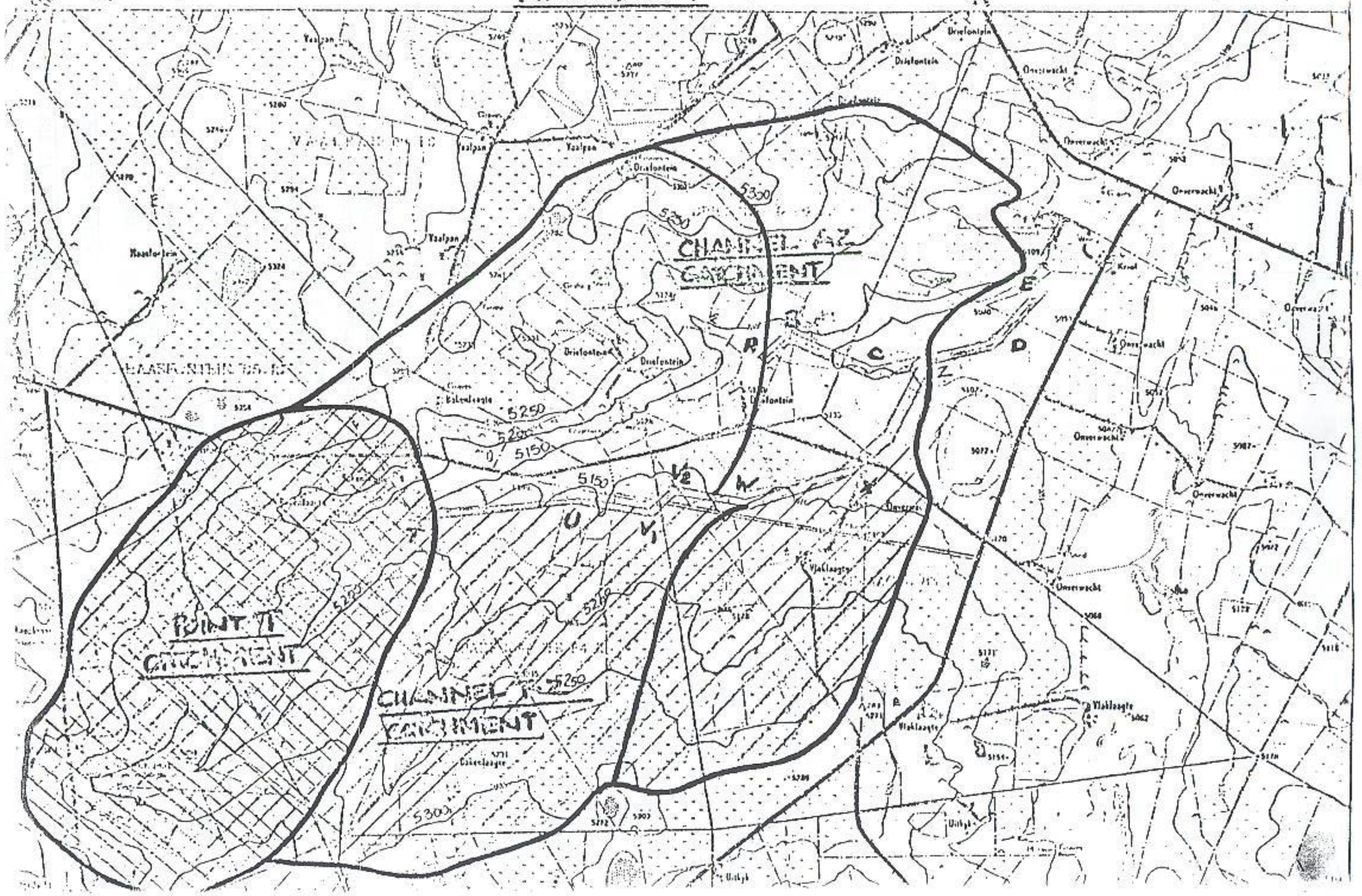
100 YR RUNOFF	Q	= 264,9 Cumecs	
DEPTH OF FLOW	D	= 2,400 m	
AREA	A_1	= 161,100 m^2	A_2 = 32,130 m
WETTED PERIMETER	P_1	= 69,708 m	P_2 = 38,692 m
COEFFICIENT OF ROUGHNESS	(MANNING'S n)	= 0,030	
SLOPE	S	= 1: 1600	
HYDRAULIC RADIUS	$R = A/P$	= 2,311 m	R_2 = 0,830 m
VELOCITY V_1		= 1,457 m/s	V_2 = 0,735 m/s



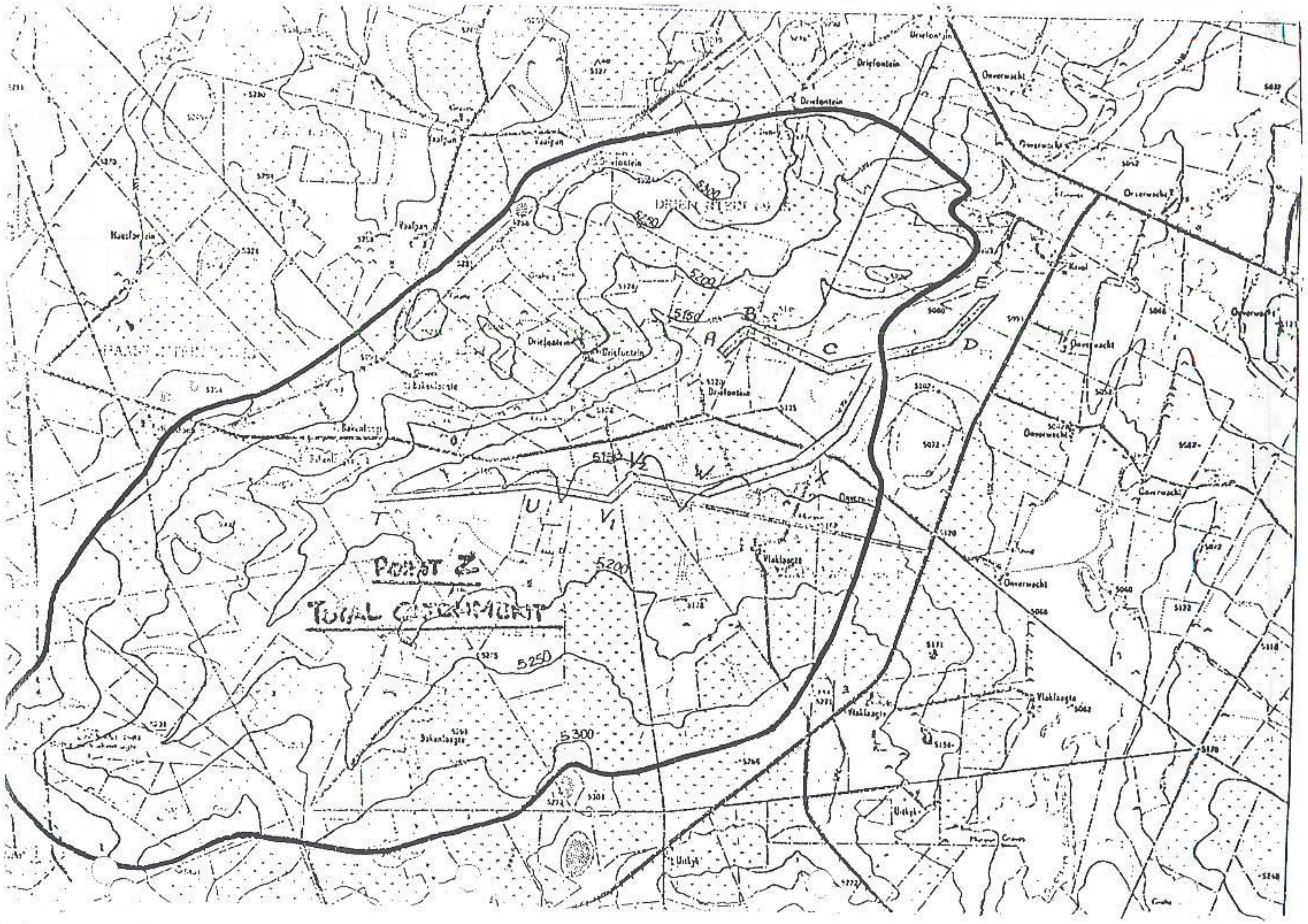
TYPICAL SECTION THROUGH CHANNEL 2-E

100 YR RUNOFF	Q	= 264,9 Cumecs	
DEPTH OF FLOW	D	= 2,400 m	
AREA	A_1	= 161,100 m^2	A_2 = 32,130 m
WETTED PERIMETER	P_1	= 69,708 m	P_2 = 38,692 m
COEFFICIENT OF ROUGHNESS	(MANNING'S n)	= 0,030	
SLOPE	S	= 1: 1600	
HYDRAULIC RADIUS	R=A/P	= 2,311 m	R_2 = 0,830 m
VELOCITY V_1		= 1,457 m/s	V_2 = 0,735 m/s

APPENDIX 1



CHANNEL AZ CATCHMENT
CHANNEL T CATCHMENT
POINT T CATCHMENT
5300
5250
5200
5150
Driefontein
Vaalpan
Onverwacht
Vlaklaagte


5300
5250
5200
5150
A
B
C
D
E
Driefontein
Onverwacht
Vlaklaagte

CIVIL ENGINEERING

DWG. REF. .... DATE .... INITIALS ....

CODE NO
MINE OR COST CENTR

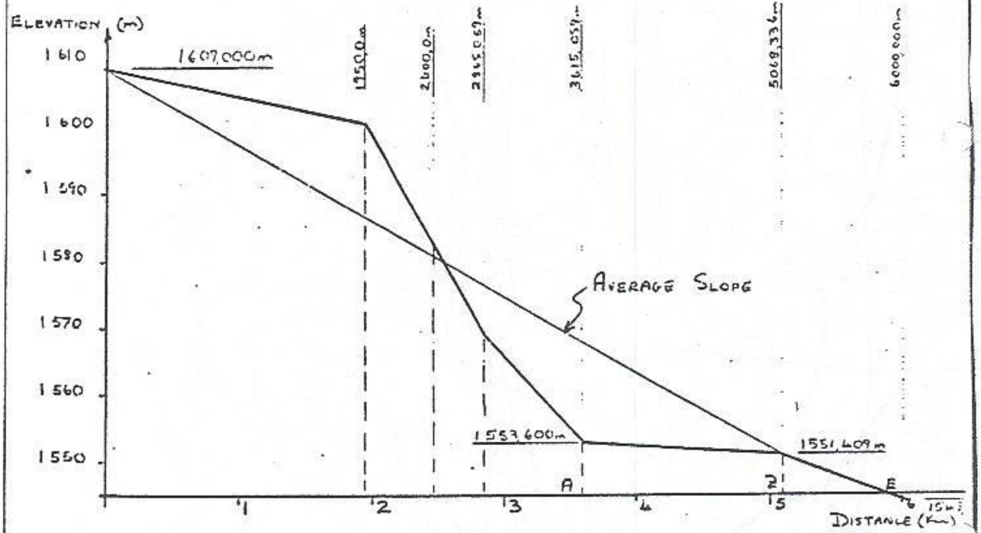
FILING REFERENCE

SHEET OF

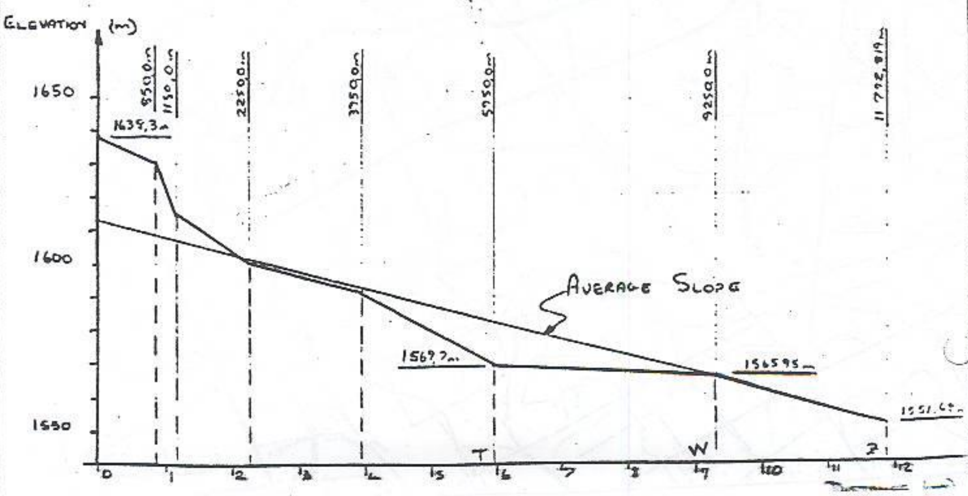
APPENDIX 1(a)

LONGITUDINAL PROFILES OF MAIN WATERCOURSES

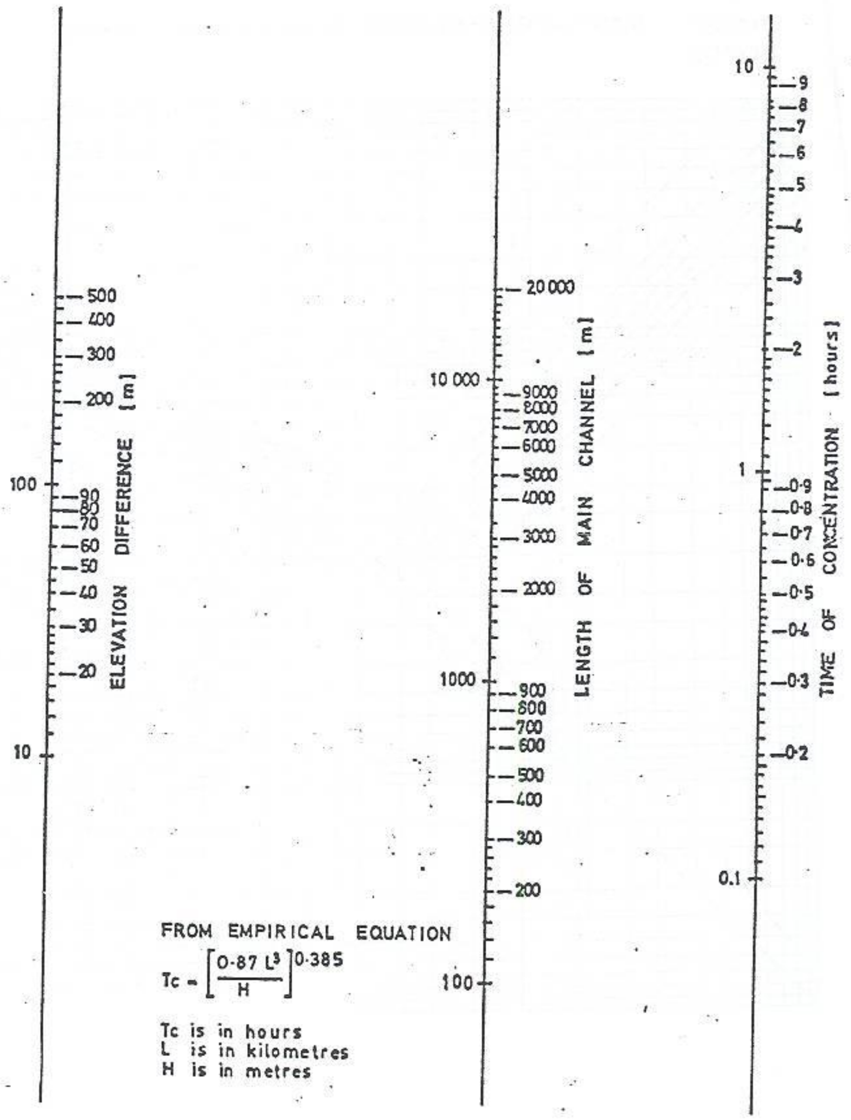
1. MAIN STREAM DIVERSION A-B-C-Z-D-E



2. AUXILIARY STREAM DIVERSION T-U-V-W-X-Y-Z



NOMOGRAPHIC SOLUTION OF THE TIME OF CONCENTRATION EQUATION



FROM EMPIRICAL EQUATION

$$T_c = \left[\frac{0{\cdot}87\,L^3}{H}\right]^{0{\cdot}385}$$

T_c is in hours
L is in kilometres
H is in metres

APPENDIX 3.

FIGURE C.2

FIG C2: DEPTH–DURATION–FREQUENCY DIAGRAM FOR POINT RAINFALL
(REVISED)

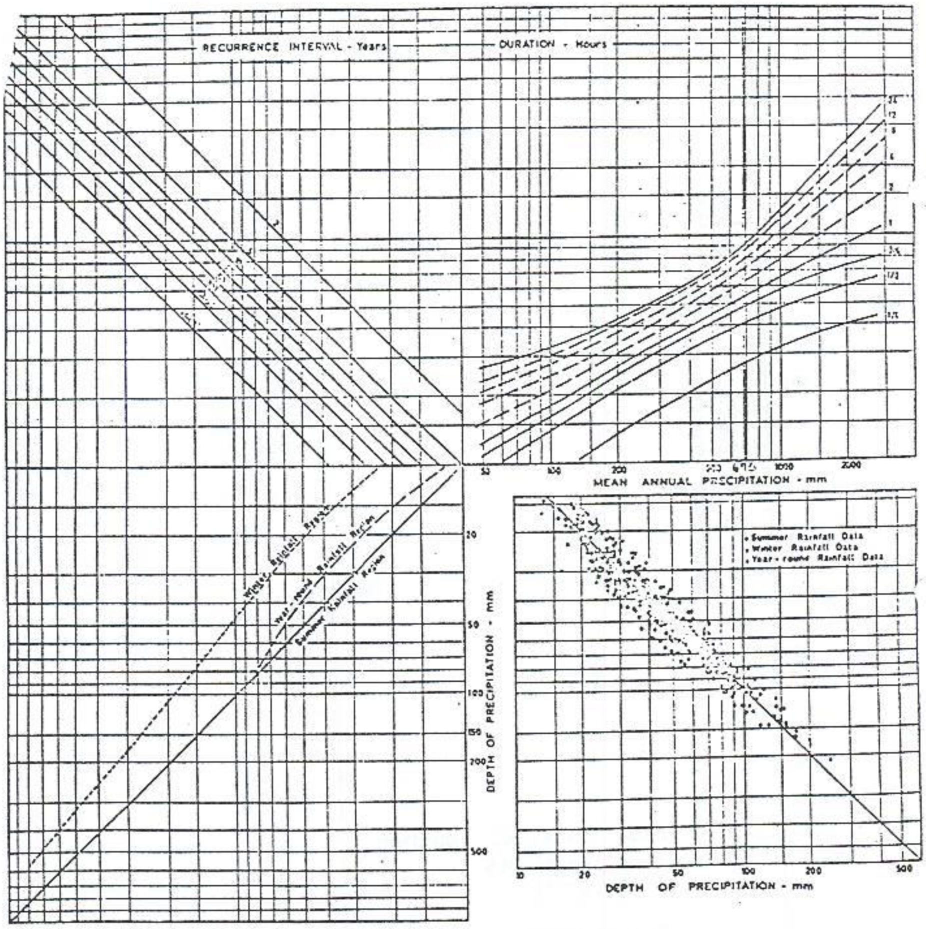


Table E.1 : Recommended runoff coefficients, C, in the Rational Formula : Q = CIA

A. OPEN AREAS - less than 5 km²

Cover	Slope		
	Flat < 5%	Undulating 5% to 10%	Steep > 10%
Lawn, sandy soil	0,08	0,13	0,17
Lawn, heavy soil	0,15	0,20	0,30
Cultivated land	0,50	0,60	0,70
Grassland (veld)	0,30	0,35	0,45
Timber	0,15	0,18	0,20

B. AREAS over 5 km²

Size range km²	Coefficient
5 - 13	0,3 - 0,2
13 - 130	0,2 - 0,1

C. BUILT-UP AREAS

Cover	Coefficient
Streets, pavements	0,80
Playgrounds	0,30
Parks (see A)	0,1 - 0,30
Railway yards	0,30
Roofs	0,90
Industrial areas:	
Open development - up to 50% covered	0,70
Dense development - more than 50% covered	0,80
Residential areas:	
Special residential - (one dwelling per plot)	0,40
High density townships	0,60
Neighbourhood shopping centres	0,60
Central business district	0,85

Refs:

1) Ven te Chow. Handbook of Hydrology 1964, p.14-8.

2) Horner & Flynt. Relation between rainfall and runoff from small urban areas. Trans. ASCE, Vol. 101,1936.

3) Vorster, J.A. The Rational Method for determining maximum runoff. Farming in South Africa. Vol. 15, Aug. 1940.

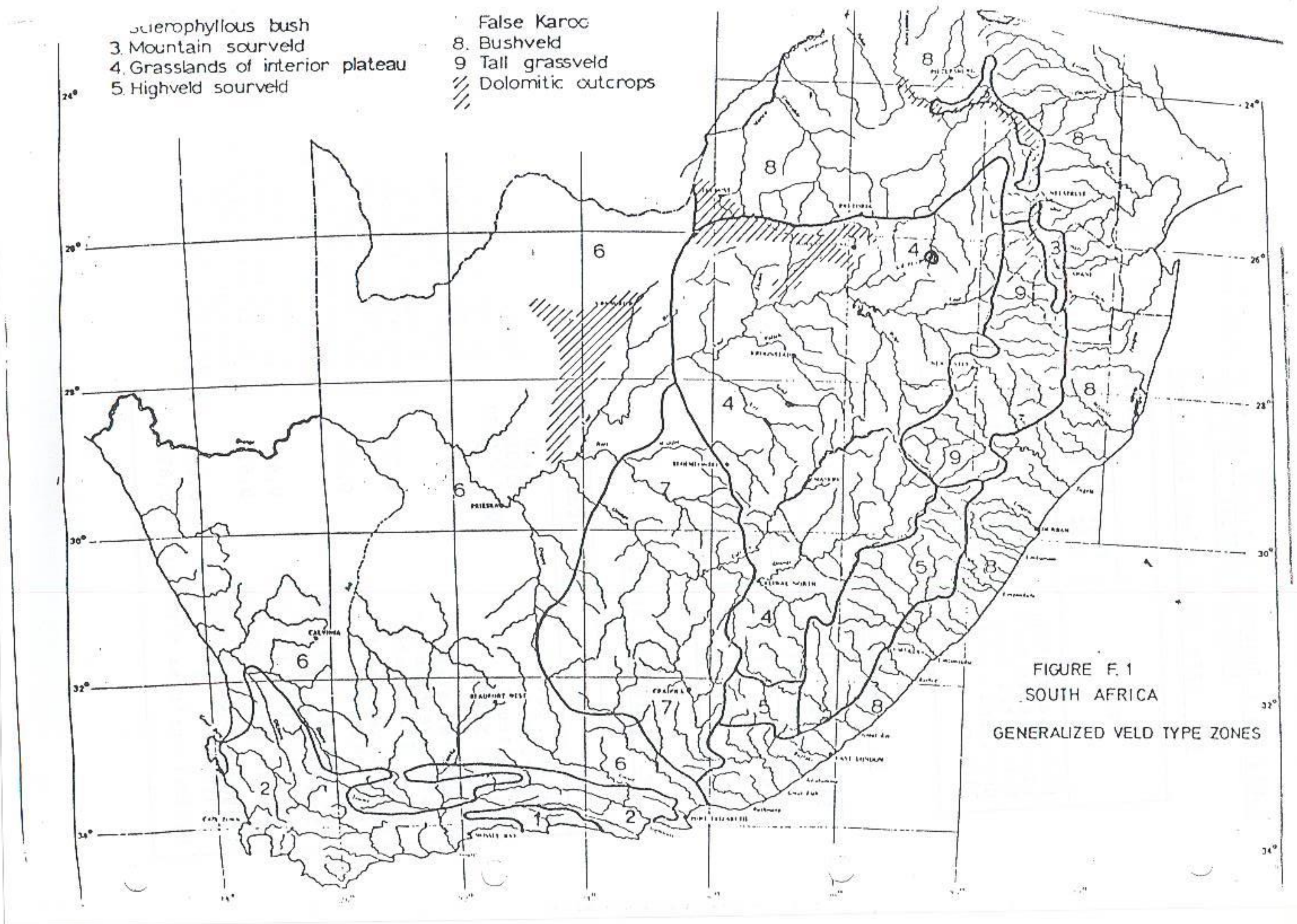


FIGURE F.1
SOUTH AFRICA
GENERALIZED VELD TYPE ZONES

FIGURE F.2

LAG/PHYSIOGRAPHY RELATIONSHIPS

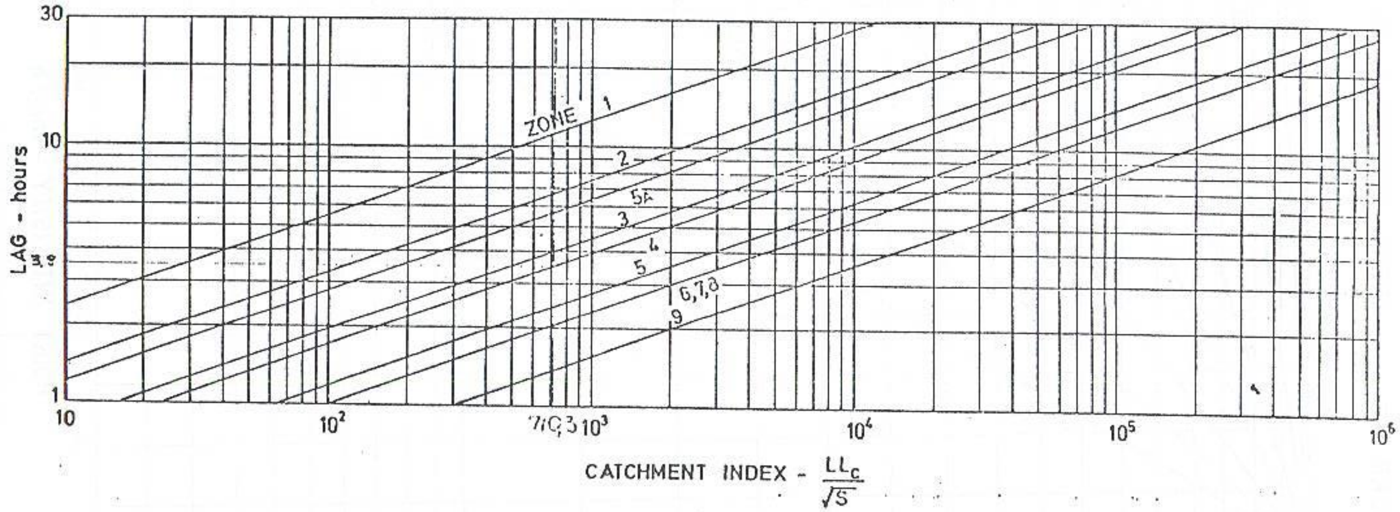


FIGURE C.6 AREAL REDUCTION CURVES

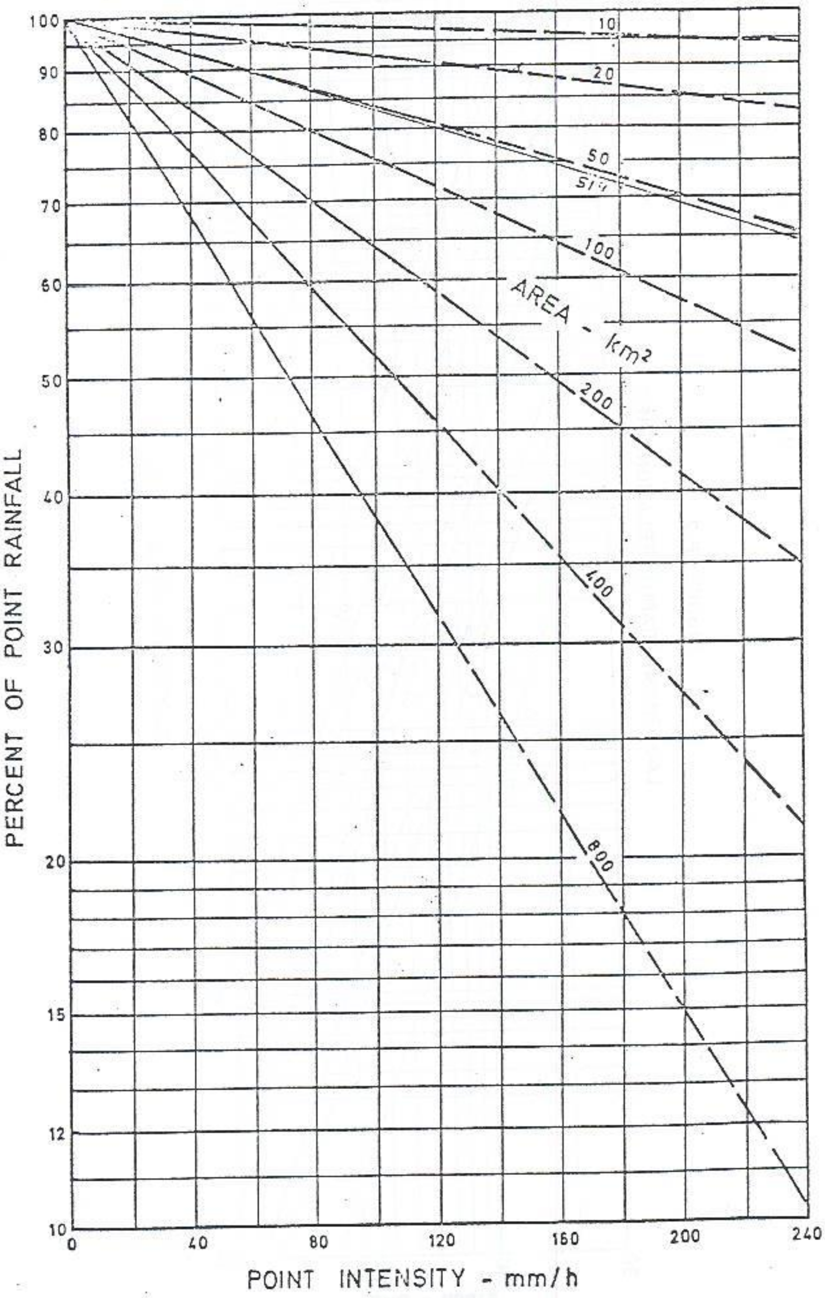
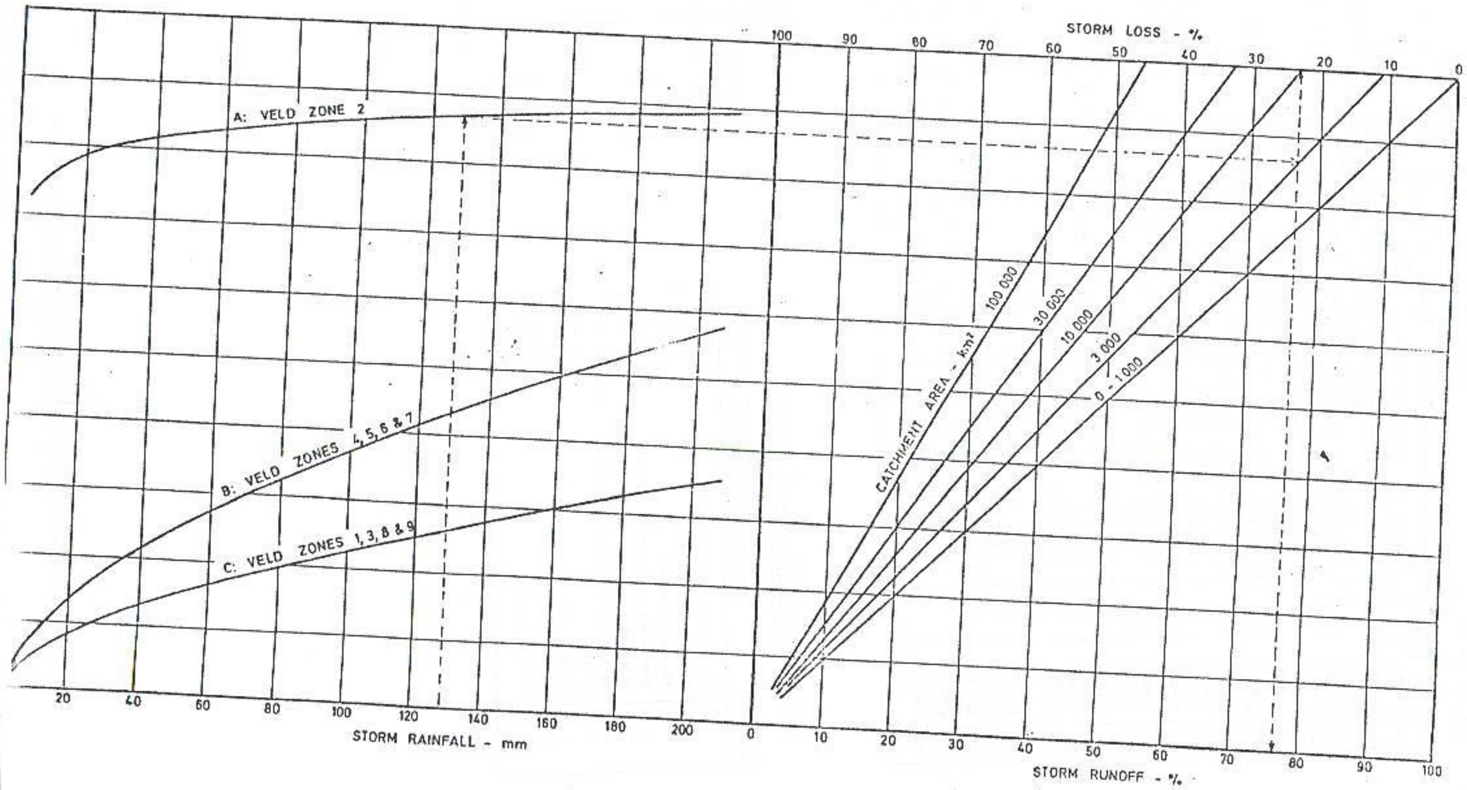


FIGURE G. 2 MEAN STORM LOSSES



APPENDIX 9.

Table F.1 contd/.....

No.	Code	Std. duration (h)	Time to peak (h)	Peak (m^3/s)	Time as proportion of time-to-peak 0,5	1,0	1,5	2,0	3,0	4,0	5,0	6,0	7,0	8,0	9,0	10,0
					Ordinates of dimensionless unitgraph - per cent of peak											
67	S2M01	6	11	37,092	20,15	100,0	34,07	7,09	1,91	0,56	0,13					
68	S3M02	4	6	40,820	25,64	100,0	39,05	11,71	2,64	1,15	0,56	0,23	0,00	0,03	0,01	
69	S6M02	6	13	8,407	18,75	100,0	54,90	30,77	9,41	4,65	2,64	1,35	0,53	0,09		
70	T3M02	6	12	60,861	16,12	100,0	32,80	7,82	0,15							
71	T3M04	5	7	30,005	17,37	100,0	47,46	27,44	7,04	1,19	0,12					
72	T3M05	6	6	47,987	52,69	100,0	64,04	45,89	29,77	22,20	16,25	12,10	8,06	6,16	3,59	1,21
73	T4M01	4	9	17,468	11,50	100,0	57,31	32,79	12,29	5,67	2,03	0,64	0,45	0,29	0,15	0,01
74	T5M01	8	17	56,267	24,03	100,0	44,67	19,42	6,27	1,29	0,05					
75	T5M04	4	6	17,775	42,34	100,0	46,10	28,64	15,50	7,27	3,67	1,56	0,63	0,01		
76	U2M12	3	5	22,346	22,22	100,0	32,17	18,44	7,23	3,38	1,66	1,11	0,75	0,50	0,40	0,29
77	U2M13	4	6	6,088	34,65	100,0	60,24	36,88	23,79	19,18	14,35	11,46	9,55	7,57	6,10	4,15
78	Y1M04	4	5	20,915	57,58	100,0	33,26	17,75	8,41	4,73	2,74	1,72	1,03	0,56	0,24	0,08
79	Y1M09	2	2	11,825	50,0	100,0	40,37	25,43	8,22	3,56	1,68	0,87	0,42	0,19	0,08	0,04
80	Y2M01	8	16	42,745	8,66	100,0	28,24	15,67	3,38	0,29						
81	Y2M02	8	9	34,887	54,03	100,0	57,26	31,11	5,71	0,46						
82	W2M02	10	10	68,717	64,05	100,0	61,30	23,64	9,25	4,01	1,69	0,75	0,33	0,14	0,03	
83	W3M01	7	9	42,992	55,47	100,0	35,55	14,26	4,67	1,39	0,37	0,02				
84	W4M02	8	21	100,510	10,53	100,0	12,59	0,89								
85	W4M04	4	6	31,058	83,56	100,0	46,67	28,80	15,77	9,20	5,24	2,97	1,58	0,56	0,16	0,06
86	W5M05	6	6	21,861	33,70	100,0	60,71	24,32	11,57	8,62	5,58	3,89	2,52	1,33	0,63	0,37
87	W5M07	9	10	7,252	58,59	100,0	62,53	46,66	30,00	19,80	10,08	4,38	2,49	1,04	0,22	
88	X1M01	8	10	129,510	58,15	100,0	43,92	22,05	5,35	0,88	0,10					
89	X2M08	2	3	12,934	25,70	100,0	45,74	22,09	11,94	8,91	6,86	5,41	4,28	3,37	2,56	1,97
90	X2M09	2	8	16,054	5,81	100,0	21,62	6,43	2,22	1,14	0,49	0,11				
91	X2M11	4	5	17,743	56,25	100,0	31,33	14,31	5,39	3,05	1,76	1,06	0,61	0,34	0,14	
92	X2M15	4	6	63,475	30,90	100,0	43,74	23,96	9,42	3,57	1,13	0,27				
93	X2M18	3	3	21,379	50,0	100,0	70,2	65,6	33,5	21,00	13,92	9,68	7,24	5,28	4,05	3,02
94	X2M22	9	11	27,523	52,61	100,0	57,72	35,84	15,05	6,63	2,20	0,48				
95	X3M03	2	4	3,295	6,24	100,0	38,43	19,89	9,43	6,53	4,33	2,33	0,77			
96	X3M06	6	8	16,238	48,14	100,0	49,31	30,36	15,86	10,86	7,35	4,73	3,60	2,85	2,22	0,97

Table F.2 : Generalized veld type zones with corresponding lag coefficients

Zone No.	Generalized veld type	C_t
1	Coastal tropical forest	0,99
2	Schlerophyllous bush	0,62
3	Mountain sourveld	0,35
4	Grasslands of interior plateau	0,32
5	Highland sourveld and Dohne-sourveld	0,21
5A	As for Zone 5 - but soils weakly developed	0,53
6	Karoo	0,19
7	False Karoo	0,19
8	Bushveld	0,19
9	Tall sourveld	0,13

Table F.4 : Values of K_u in the expression $Q_p = K_u \cdot \frac{A}{T_L}$

Zone No. on Fig. F.1	Factor K_u (cumec-hour/km^2)
1	0,261
2	0,306
3	0,277
4	0,386
5	0,351
5A	0,488
6	0,265
7	0,315
8	0,367
9	0,321

FIGURE F5. ZONE 3

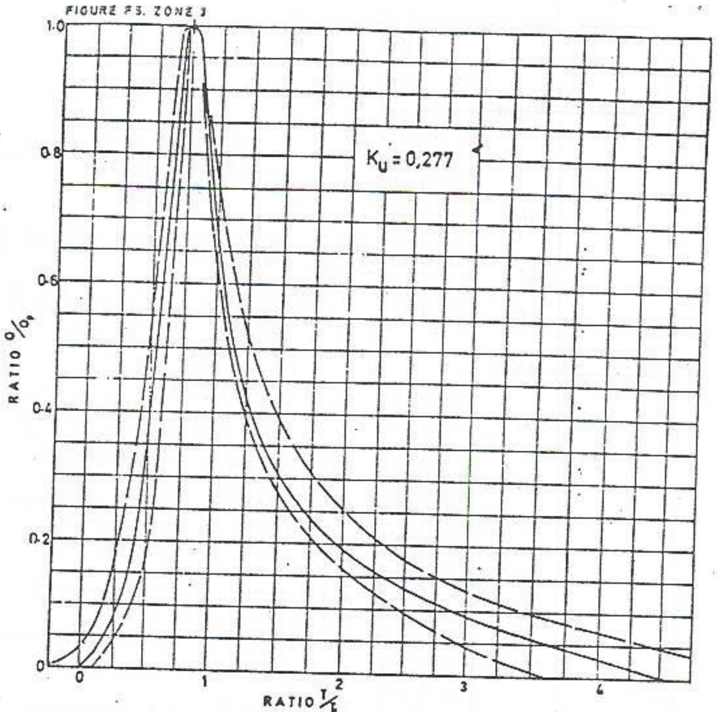
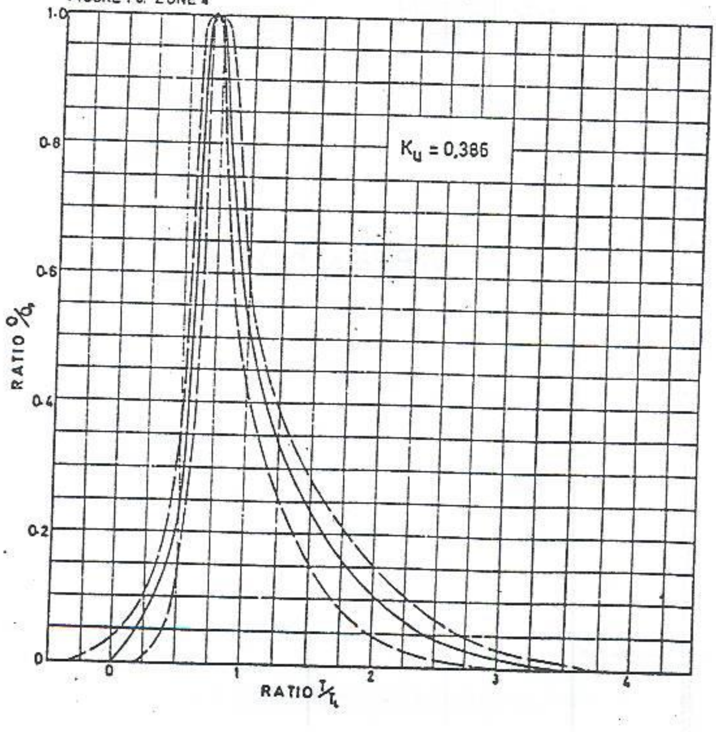
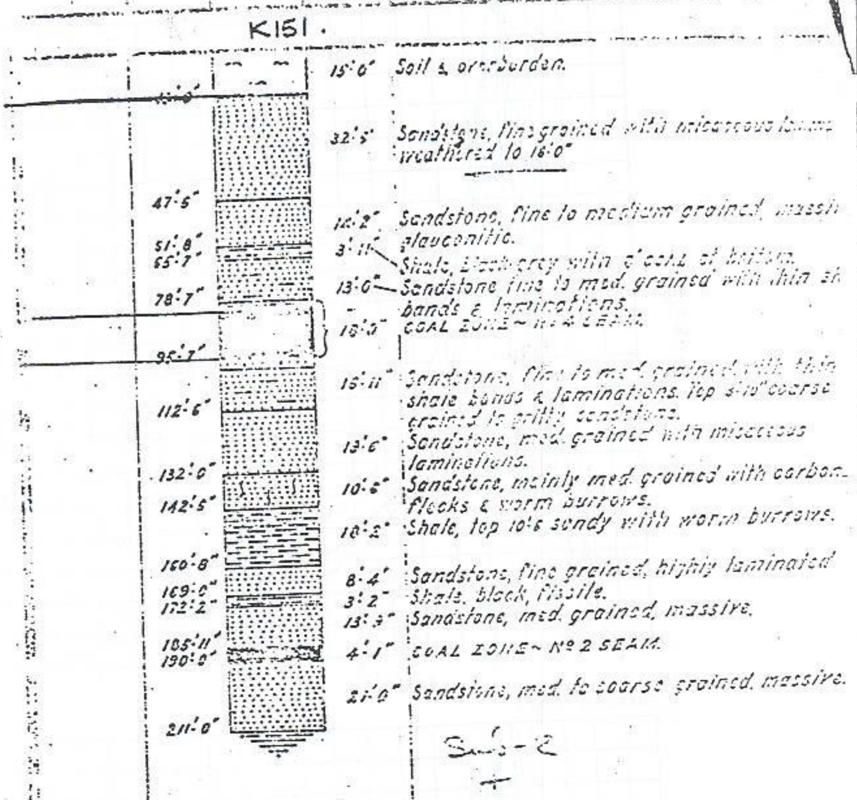


FIGURE F6. ZONE 4




K151.
15'0" Soil & overburden.
32'5" Sandstone, fine grained with micaceous lam... weathered to 16'0"
47'5"
14'2" Sandstone, fine to medium grained, massi... glauconitic.
51'8"
65'7"
3'11" Shale, black-grey with ... at bottom.
13'0" Sandstone fine to med. grained with thin sh... bands & laminations.
78'7"
16'0" COAL ZONE ~ No 4 SEAM.
95'7"
16'11" Sandstone, fine to med. grained with thin shale bands & laminations. Top ... coarse grained to gritty sandstone.
112'6"
13'6" Sandstone, med. grained with micaceous laminations.
132'0"
10'5" Sandstone, mainly med. grained with carbon. flecks & worm burrows.
142'5"
18'2" Shale, top 10'6 sandy with worm burrows.
160'8"
8'4" Sandstone, fine grained, highly laminated
169'0"
3'2" Shale, black, fissile.
172'2"
13'9" Sandstone, med. grained, massive.
185'11"
4'1" COAL ZONE ~ No 2 SEAM.
190'0"
21'0" Sandstone, med. to coarse grained, massive.
211'0"

APPENDIX II

Seasonal variations related to dilution by rainfall or concentration by draught can affect contaminent levels, thus rainfall monitoring data should be evaluated as a time series along with a reliable indicator element. Monitoring frequency should also be planned taking such seasonal variations into account.

2.9.3. Drainage density of area

The catchment area figures are quoted in kilometres of drainage path per square kilometre of area as in Table 2.9.3.

Table 2.9.3 Drainage density of the area

Bakenlaagte/Onverwacht Spruit		Tributary stream	
Surface area	34,28km^2	Surface area	3,66km^2
Drainage path per length	24,30km	Drainage path per length	3,70km
Drainage density	0,71/km	Drainage density	1,01/km

2.9.4 Surface Water Use

2.9.4.1 Water Use: Steenkool Spruit

The Usutu-Vaal Government Water Scheme (See Plan no 16a) transfers water by canal from the Grootdraai Dam at Standerton to the Trichardtsfontein Dam. Water is released from Trichardsfontein Dam to Rietfontein Dam from where Matla Power Station abstracts water.

Water released from Rietfontein Dam flows into the Trichardt Spruit and Dwars-in-die-Weg Spruit and eventually into the Steenkool Spruit and the Olifants River. These releases from Rietfontein Dam are abstracted further downstream by farmers, collieries, local authorities and Duvha Power Station. Dwars-in-die Weg Spruit and Steenkool Spruit therefore act as conduits for the transfer of high quality Usutu-Vaal water.

Water is abstracted for potable use by a number of collieries along the Steenkool Spruit, downstream of Kriel Colliery. These include the Tavistock Collieries and Kleinkopje Colliery. The Steenkool Spruit flows into the Witbank Dam where potable water is abstracted by Witbank Municipality and Wolwekrans Colliery and cooling water make-up is abstracted by Duvha Power Station. Other downstream users include local farmers.

2.9.4.2 Water Use: Onverwacht and Bakenlaagte Spruits

There are no legitimate users of water from the Onverwacht Spruit or Bakenlaagte Spruit.

2.9.4.3 Water Use: Final Cut / Ramp 3 and 4 of Pit 3N

Final Cut

Since the ashing process started in Pit 3N the Final Cut is being used as an ash water return dam.

Ramp 3 and Ramp 4

These 2 cuts are filled with slurry and as the ash settles the water drains to the Final Cut for re-use.

Ramps 3 and 4 form part of the ash dam basis and are also used to assist in evaporation for water management purposes.

2.9.5 Water Authority

The Olifants River basin, upstream of Loskop Dam, is a Government Water Controlled Catchment. A riparian owner may not abstract more than 110 000m^3 / annum from any stream in this catchment, without authorization from the Department of Water Affairs and Forestry.

2.9.6 Wetlands

From pre-mining topocadastral maps, it appears that there were no wetlands on the Pit 3N Mine area except for the vlei area formed by the Onverwacht Spruit and Bakenlaagte Spruit. These were subsequently diverted.

When Matla Power Station acquired the Pit 3N area, the following "wetlands" occurred on the Matla Power Station property in the area of Pit 3N:

Onverwacht Spruit and Bakenlaagte Spruit

NB

A diverted portion of the Onverwacht Spruit and the diverted section of the Bakenlaagte Spruit occur on the Matla Power Station Property. The diversions have an "engineered" appearance - straight lines and regular angles. The entire diverted portion is covered in reeds - Typha sp and Phragmites sp.

This reeded area forms a nesting and breeding habitat for bird species such as red bishops.

"Waterbodies"

Ramps 3 and 4, and the final cut which remained after mining activities had been completed, had filled with mine seepage by the time Eskom took over the property, as well as a depression situated on the eastern portion of Pit 3N. A small wetland filled with reeds had formed in a depression north of Ramp 3.