ASSESSMENT OF THE AQUATIC ECOSYSTEMS ON THE PROPERTIES PORTION 6 AND 7 OF THE FARM GAMS No 367 IN NORTHERN CAPE PROVINCE

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SYNOPSIS

Inspection of sites where prospecting bore holes may be drilled was undertaken and impacts on aquatic systems are considered. Expected impacts are minor but management recommendations are put forward.

KEY WORDS: Wetlands, Pans, Prospecting, Boreholes, Northern Cape Province

QUALITY VERIFICATION

This report has been prepared under the controls established by a quality management system that meets the requirements of ISO 9001: 2015 which has been independently certified by DEKRA Certification.

Verification	Capacity	Name	Signature	Date
	Wetland Ecologist	Jake Alletson	DG Allet	July 2023
	Section Manager	M. Summerton	MArk Summerton	July 2023
	Director	J. Norris	MArk Summerton pp	July 2023

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ASSESSMENT OF THE AQUATIC ECOSYSTEMS ON THE PROPERTIES PORTION 6 AND 7 OF THE FARM GAMS No 367 IN NORTHERN CAPE PROVINCE

1. INTRODUCTION AND BACKGROUND

1.1 Document Background

JG Afrika (Pty) Ltd has been appointed by the Greenmined (Pty) Ltd to undertake specialist studies in regard to aquatic ecosystems and the terrestrial biodiversity on the property Portion 6 And 7 of the Farm Gams No 367 in the Northern Cape Province. The studies will form a component of the application for a Prospecting Right by African Exploration Mining and Finance Corporation Soc Ltd. This document presents the findings of a study of the aquatic ecosystems in and around the project footprint. It is also submitted in terms of the National Environmental Management Act (Act No. 107 of 1998): Environmental Impact Assessment Regulations (2014), as amended, as well as in terms of the National Water Act (Act No. 36 of 1998). Therefore, cognisance is taken of Appendix 6 of the EIA Regulations (2014) as amended, and of the requirements for a Wetland Delineation in the Regulations Regarding the Procedural Requirements for Water Use Licence Applications and Appeals (R. 267, 24/03/2017).

1.2 Project Description

The following information has been provided by the project proponent:

"The proposed prospecting activities will include the following:

a) Desktop study
b) Remote sensing
c) Field mapping
d) Geochemical survey
e) Geophysical survey
f) Trenching
g) Drilling
h) Geological modelling and resource estimation

Drilling/Trenching

The implementation of trenching and/or drilling will be determined based on the results from initial exploratory work. Either technique will be implemented at spacing grid capable of providing an Inferred Mineral Resource. This Resource is defined at a low degree of confidence but is sufficient to be used to complete a Scoping Study and to evaluate the economic feasibility of the project to advise the decision to continue to feasibility study work.

Drilling will be to a maximum depth of 500 m.

Drilling/Trenching will be carried out to provide sample material from intersections of the targeted strata or geological features. A small excavator or tractor-loader-backhoe will be used for trenching. On the other hand, the preferred method to employ for drilling is Reverse Circulation (RC) and/or diamond drill techniques. The objective of drilling/trenching programme is to assess the presence of potentially economic mineralisation. The number of drill holes to be dug and their depths to the top will depend on the results of Phase 1 and initial act2. Once favourable geological or geomorphological features such as channel lag gravel is encountered, then a detailed drilling grid will be prepared to focus on establishing the extent (and/or potential available volume) of the gravel deposit.

At this stage of the project, it is impossible to define the exact locations of drill sites or number of drillholes to be dug. However, the detailed drilling spacing will be planned to allow the defining of an Inferred Mineral Resources as per the SAMREC code."

2. TERMS OF REFERENCE

The terms of reference for this assessment are based on the requirements for a wetland delineation as defined in Regulation 267 (Regulations Regarding the Procedural Requirements for Water Use Licence Applications and Appeals) under the National Water Act (Act No. 36 of 1998).

The reports listed below contain the standardised and accepted methods that must be used for determining the various aspects of assessments during the WUA process related to wetlands:

1) Wetland and riparian habitat delineation document (DWS report on DWS website);
2) Wetland Buffer Guideline (SANBI WRC project and Report, on DWS website)
3) Wetland Offset (WRC report TT660116; on DWS website)
4) High Risk Wetland Atlas (WRC Report TT659116, on DWS website)
5) Wetland Rehabilitation in mining landscapes (WRC Report TT658116, on DWS website)
6) Risk Assessment Protocol and associated Matrix (DWS document on DWS Website)

However, since this is an initial report, based partly on desktop studies certain of the above will be excluded to await implementation in a final report should it be decided that the proposed prospecting may be considered further.

3. KNOWLEDGE GAPS

The study reports on here presents a preliminary investigation of conditions at the project site and is based partly on desktop investigations since not all of the borehole sites could be accessed due to property restrictions. It is recognised that a further field study may have to be undertaken in order to develop a thorough understanding of the area and possible consequences of the prospecting activities.

4. STUDY AREA

The project site which makes up the study area is located in the Northern Cape Province and lies on either side of road R 360 approximately 41 Km north of the town of Upington. See Figure 1 and Figure 2. It is situated within the Local Municipality NCDMA08 of the Siyanda District Municipality. The Water Management Area is the Lower Orange WMA and it is in Quaternary Catchments D42D, D42E and D73E.

5. EXPERTISE OF THE SPECIALISTS

The *curriculum vitae* of the specialist, Mr J. Alletson is attached in Annexure A.

Mr Alletson is a SACNASP (No.125697) registered Ecological Scientist and is a member of IAIASA (No. 035). He holds a BSc Honours degree in Zoology from Rhodes University and a BSc degree in Biological Sciences from the University of Natal. He joined the (then) Natal Parks Board in 1975 and served as the aquatic ecologist before leaving to become an environmental consultant in1997. Mr Alletson has in excess of 45 years' experience in the fields of aquatic and terrestrial ecological studies in Southern Africa.

In this study Mr Alletson was assisted by Ms M. Holder who undertook the terrestrial plant survey as well as participating in the wetland study. She has received training at the Bews Herbarium (University of KwaZulu-Natal) and is a member of CREW[1] (Custodians of Rare and Endangered Wild Flowers). She has more than 20 years of experience in undertaking such surveys.

[1] CREW: The Custodians of Rare and Endangered Wildflowers (CREW) programme is a citizen science initiative that involves members of the South African public in the surveying, monitoring and conservation of plants.

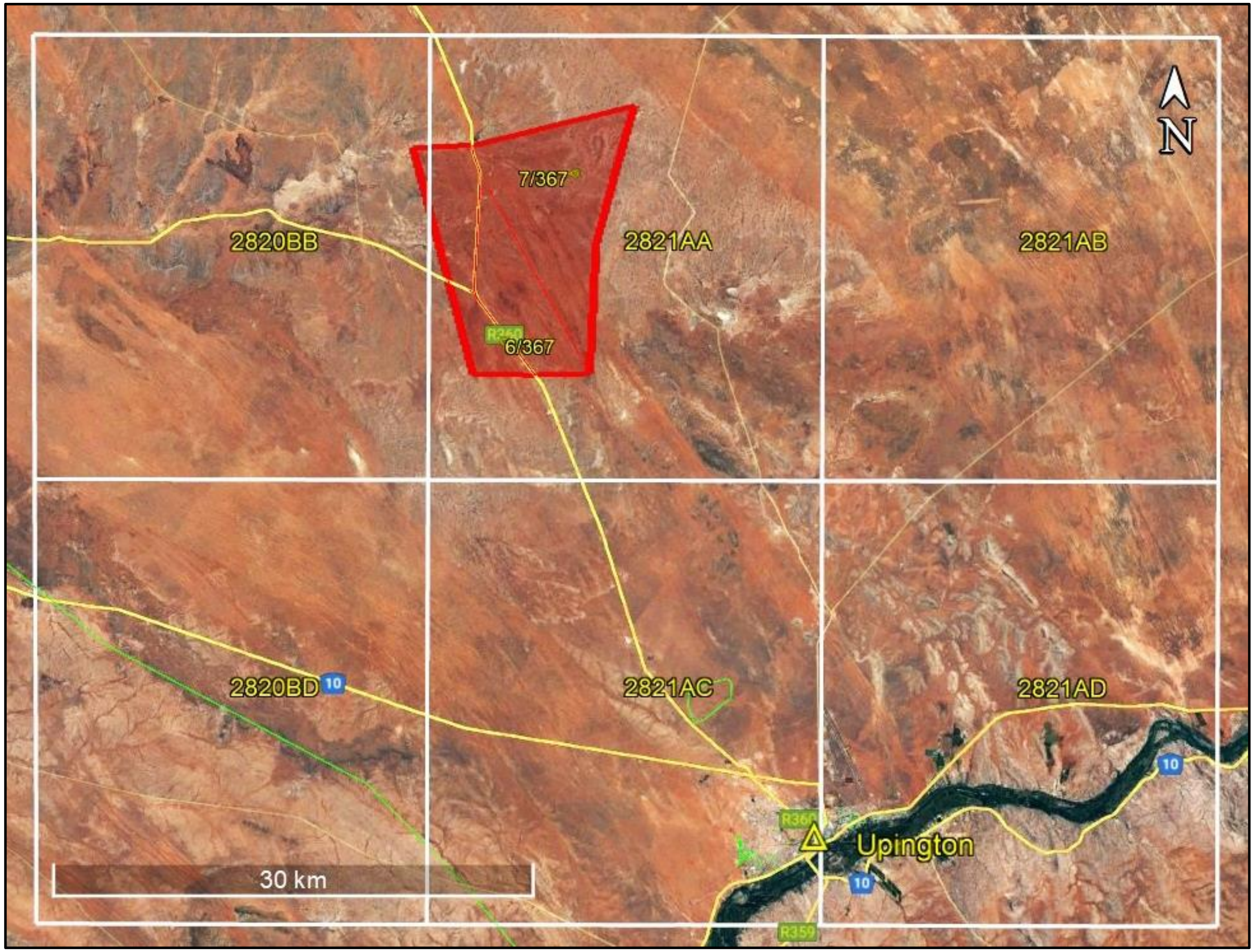


Figure 1: Location of the Gams project area

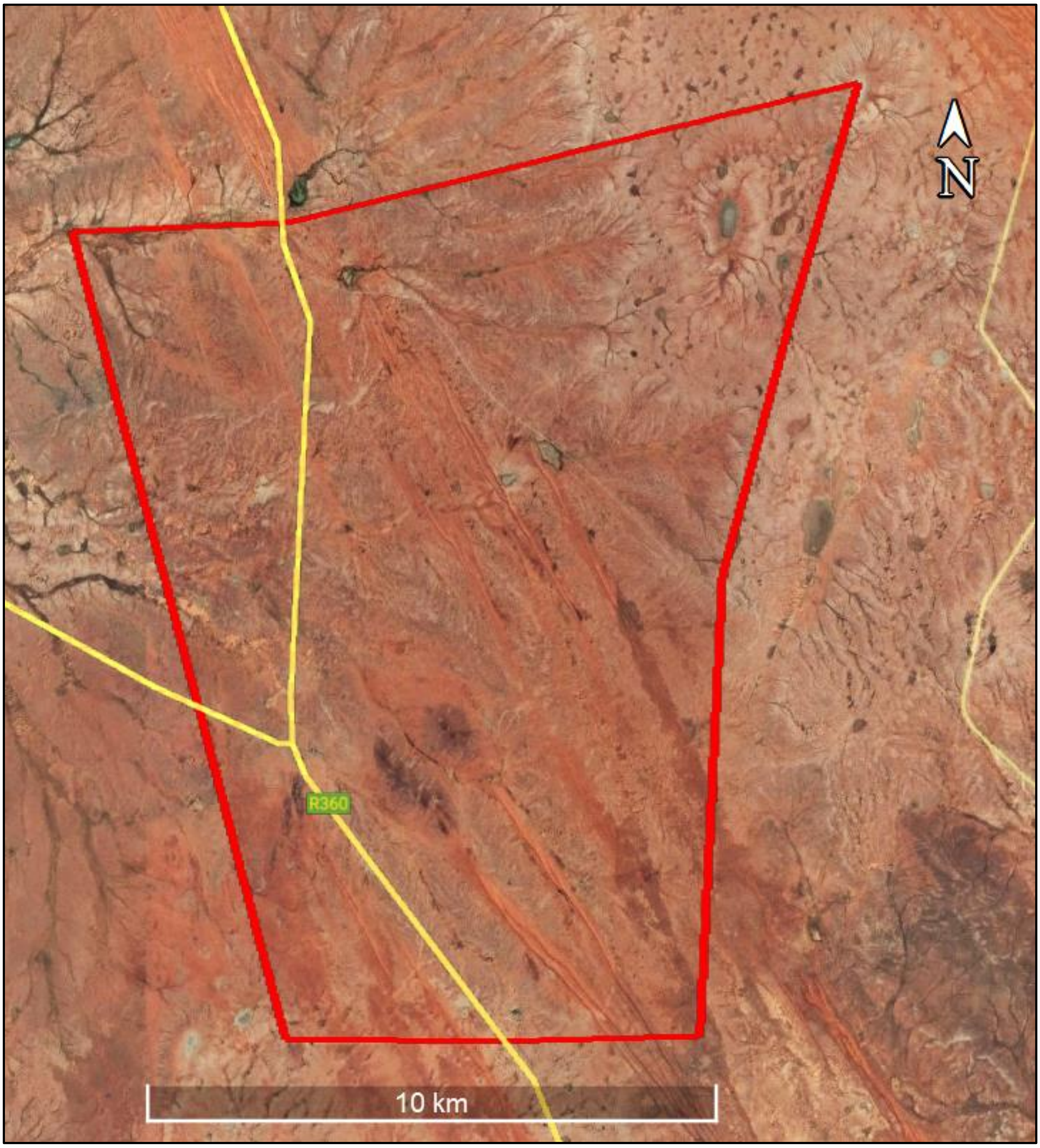


Figure 2: View of the Gams project area land surface

6. AIMS AND OBJECTIVES

The aims and objectives of this preliminary study may be summarised as follows:

- Statement of the methods to be used and the techniques used to assess the site;
- Collection of background information by means of database searches;
- Assessment, based on professional opinion of the environmental risks posed by the project and an assessment of the potential impacts that could arise out of the project;

- Assessment of the specific sensitivity of the site related to the proposed activity or activities;
- An identification of any areas that are to be avoided, including consideration of buffers;
- A description of any assumptions made and any uncertainties or gaps in knowledge;
- Any mitigation measures, including possible offsetting, for inclusion in the Environmental Management Programme Report (EMPr); and
- Recommendations for the way forward.

7. METHODOLOGY USED AND DATA SOURCES

The methodology that was followed in completing this study was to obtain information from a number of data sources and then to consider the probable impacts and risks based on professional opinion. The first phase consisted of a desktop study.

The following wetland data sets were referred to:

- The NFEPA Wetland Map 4.
- The South African Inventory of Inland Aquatic Ecosystems (SAIIAE) Wetland Map 5.
- The NFEPA rivers database was checked to ascertain the listed status of the river systems which were included in the project area.
- The Freshwater Biodiversity Information System (FBIS) was consulted for records and species data from the vicinity of the dam site.
- The SANBI Screening Report for the project EIA was interrogated for any features of aquatic relevance.
- Google Earth images dating from 2008 to the present time were examined for visual information relating to wetlands and watercourses.
- Historic aerial survey images were examined to give a further perspective on the project area.
- Vegetation types in the area based on Mucina and Rutherford (2006) and SANBI (2018) Vegetation Types of South Africa.

7.1 Wetland Delineation

To the greatest possible extent, the wetland delineation procedure of DWAF (2005) was to be followed. The procedure calls for recognition of four indicators as listed below:

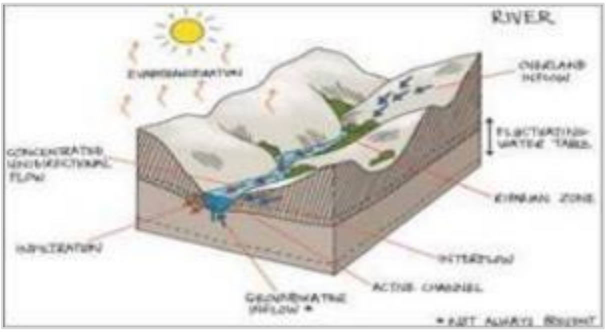
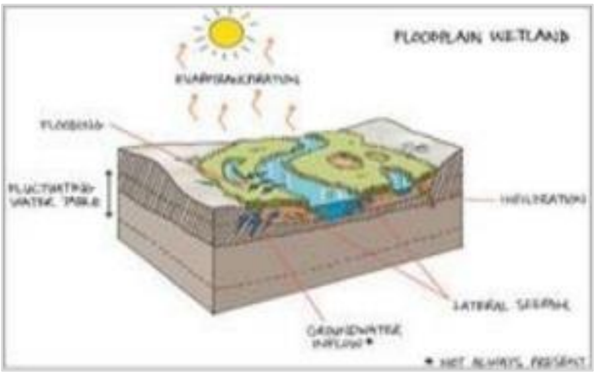
- ***Terrain Unit Indicator*** – Identification of the part of the landscape where wetlands are more likely to occur;
- ***Soil Form Indicator*** – Identification of the soil types which are associated with prolonged and frequent saturation;
- ***Soil Wetness Indicator*** – Identification of the morphological signatures that develop in soil profiles as a result of prolonged and frequent saturation; and

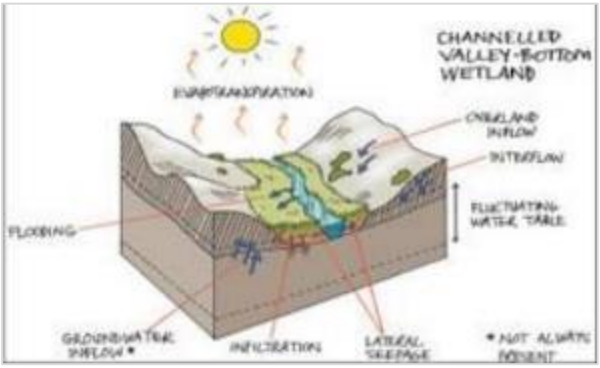
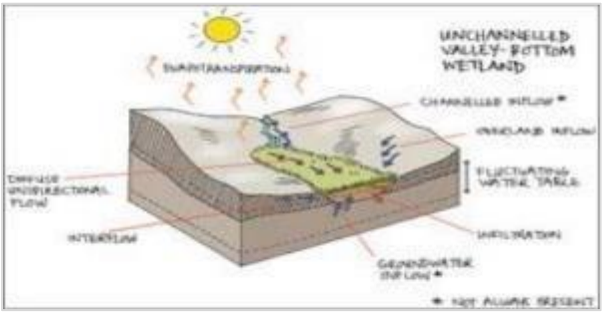
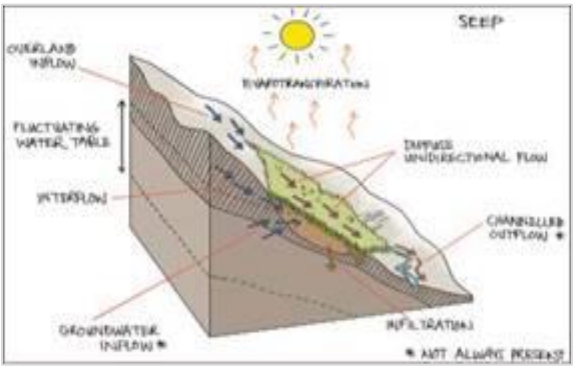
- ***Vegetation Indicator*** – Identification of the hydrophilic vegetation associated with frequently saturated soil.

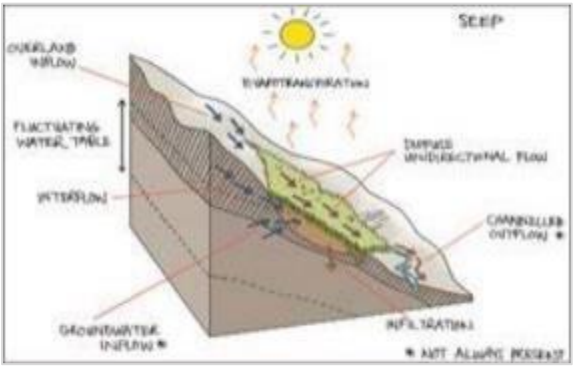
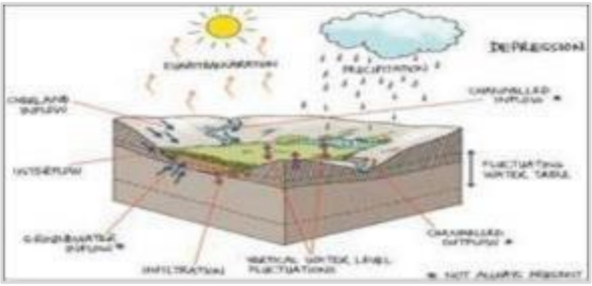
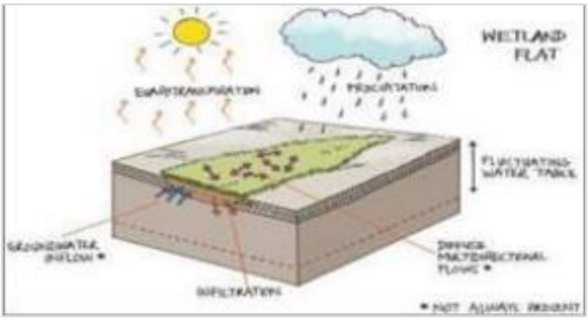
However, it is recognised that, due to the aridity of the region, as well as the very flat terrain, certain of the indicators are not of relevance. In the field it was found that the Vegetation Indicator, including bare areas, will be of the most use. However, reliance will also to be placed on the content of Wetland Map 5 to indicate sites

Further refinement of the wetland delineation was then to be undertaken by possibly dividing the wetlands into one or more hydrogeomorphic units as defined by Ollis *et al* (2013) and shown in Table 1.

Table 1: Wetland hydrogeomorphic (HGM) types as defined by Ollis et al, 2013.

Hydrogeomorphic Types		Description
River		Rivers are linear landforms with clearly discernible banks and a channel, which permanently or periodically, carries a contained and defined flow of water. A river is taken to include both the active channel and the riparian zone.
Floodplain		Valley bottom areas with a well-defined stream channel, gently sloped and characterised by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.

<table>
<tr><th colspan="2">Hydrogeomorphic Types</th><th>Description</th></tr>
<tr><td>Valley bottom with channel</td><td>
</td><td>Valley bottom areas with a well-defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterised by the net accumulation of alluvial deposits or may have steeper slopes and be characterised by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.</td></tr>
<tr><td>Valley bottom without a channel</td><td>
</td><td>Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterised by alluvial sediment deposition generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.</td></tr>
<tr><td>Hillslope seepage linked to a stream channel</td><td>
</td><td>Slopes on hillsides, which are characterised by the colluvial (transported by gravity) movement of materials. Water inputs are mainly sub-surface flow and outflow is usually via a well-defined stream channel connecting the area directly to a stream channel.</td></tr>
</table>

Hydrogeomorphic Types		Description
Isolated Hillslope seepage		Similar to other hillslope seeps but with no direct surface water connection to a stream channel. Slopes on hillsides, which are characterised by the colluvial (transported by gravity) movement of materials. Water inputs mainly from sub-surface flow and outflow primarily by diffuse sub-surface and/or limited surface flow.
Depression (includes Pans)		A basin shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent, and therefore this type is usually isolated from the stream channel network.
Wetland Flat		A flat wetland with no apparent inlet or outlet points. Water is obtained from surface or near surface flows and is lost either by downward percolation or evapotranspiration. May be only seasonal in terms of its wetness and hydromorphic soils may be only weakly developed or else be absent. Vegetation may be the strongest indicator.

7.2 Wetland Modelling

Because the area is so arid, all of the wetlands and watercourses are dry for long periods of time. For this reason, the commonly used models (WET-Health and WET-Ecoservices) are unable to produce meaningful results.

7.3 Watercourse Classification

Riverine units were to be classified locally according to channel width and duration of low flows (Table 2), and regionally according to slope and geomorphic setting (longitudinal zones) as per the Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis *et al*., 2013).

Table 2: Watercourse classification criteria

Channel Type	Channel Width
Major River	>10 m
River	2 m – 10 m
Minor River - Stream	< 2 m
Flow Pattern	**Description**
Perennial	Flows throughout the year or most of the year (>95% of the time). The water table is situated above the streambed for most of the year.
Seasonal	Flows intermittently through the year (>50% of the time), usually during the wet season.
Ephemeral	Flows only occur during, and shortly after precipitation events in a typical year. Stream bed is situated above the water table year-round.

8. RESULTS OF THE DESKTOP STUDY

The results presented below are based on the findings of the desktop assessment as well as the field investigations conducted for the study.

8.1 History of the Site

The history of the site was investigated since the information gained can contribute to an understanding of observations made and so contribute to setting out guidelines for future observations and management interventions. The oldest aerial survey photographs that could be found for the study area are dated 2017 but, although relatively modern, and in colour, the resolution is so poor that they are virtually unusable. Therefore, greater dependence was placed on Google Earth imagery dating back to 2004. It appears that the area has changed very little in the time period for which images are available. This is to be expected as no industrial or agricultural development has taken place since the aridity of the climate tends to make conditions inhospitable. Rough grazing of livestock is practiced but stocking densities are low.

8.2 Site Characteristics

8.2.1 Climatic Data

Modelled meteorological data was obtained from Meteoblue for the Kurees area which is situated some eight kilometres to the east of the project area. The climate in the area is classified as BSh (Hot semi-arid climate) by the Koppen Climate System. Summer rainfall events are usually derived from south-westerly frontal systems or from locally generated convectional thunderstorms. See Figure 3. However, the frequency and extent of rainfall events varies greatly between years. The winters are dry with the rare precipitation events being due to frontal systems. The temperate range is from hot summers (>40°C) through to cold winters when sub-freezing conditions are experienced on many nights.

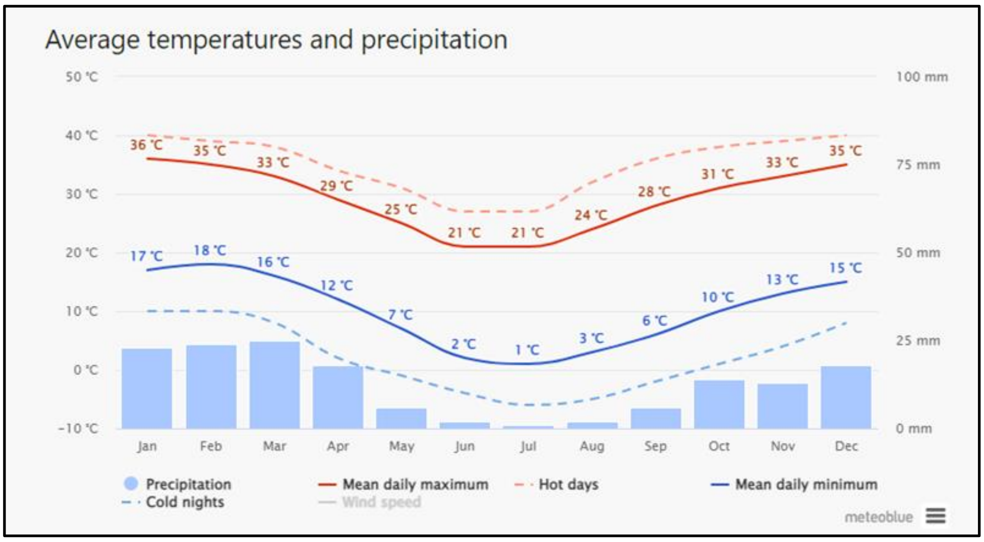


Figure 3: Modelled climatic data from the Kurees area.

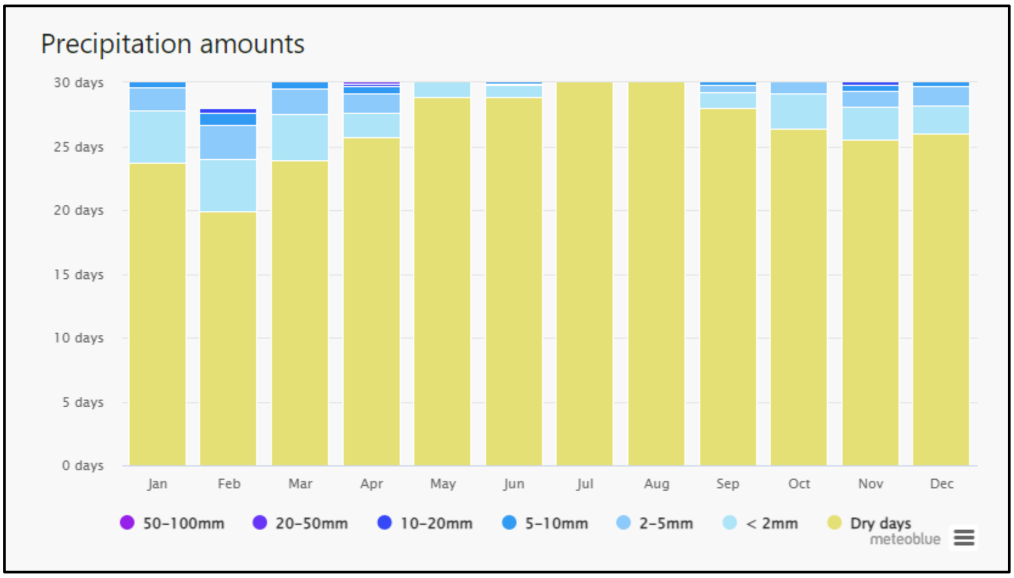


Figure 4: Precipitation pattern in the Kurees area

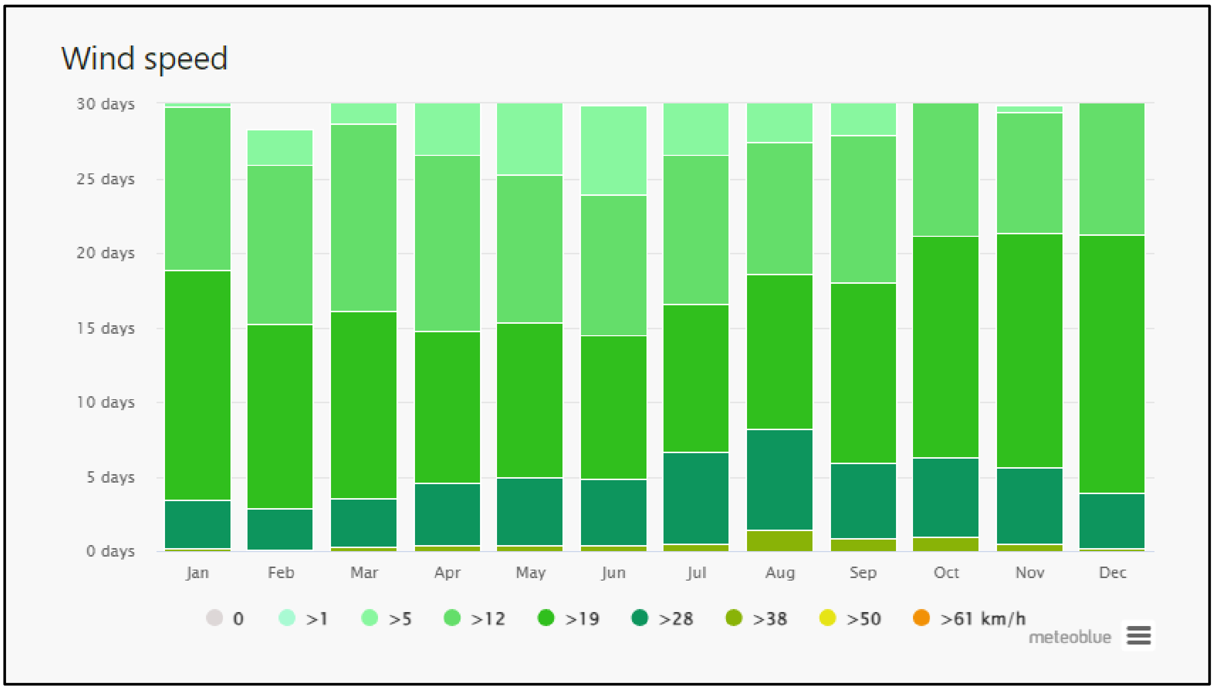


Figure 5: Monthly wind patterns in the Kurees area

8.2.2 Vegetation

The study area includes three vegetation types after Mucina and Rutherford, (2006).

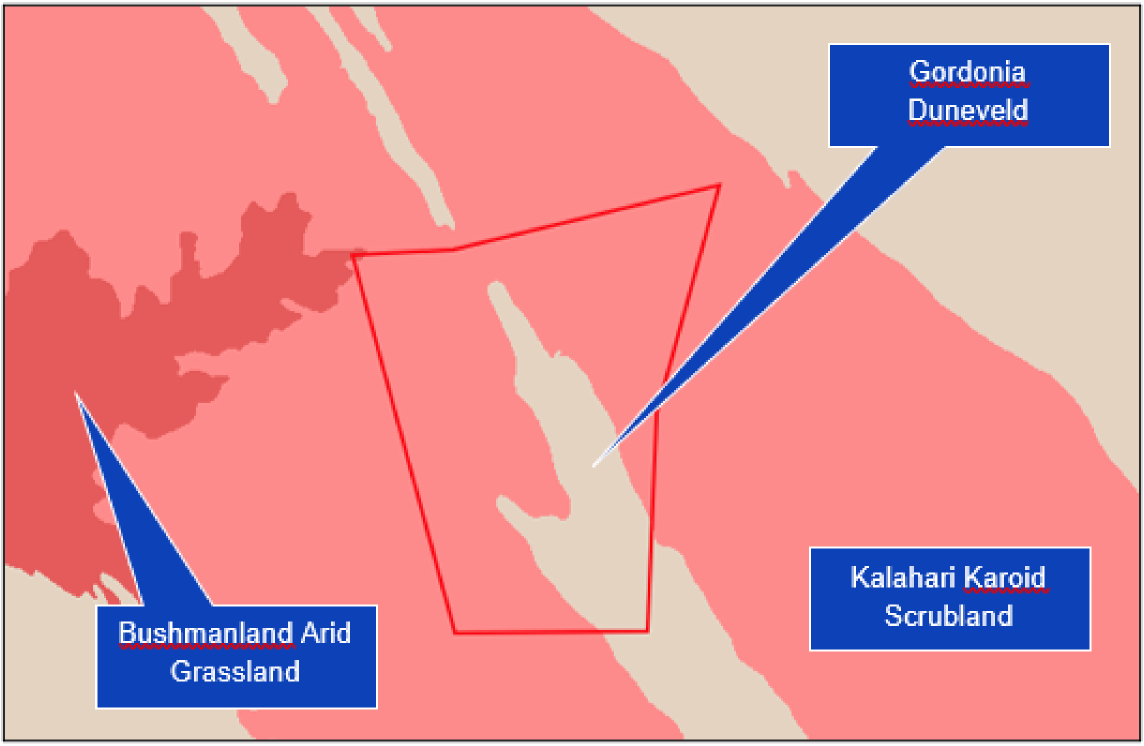


Figure 6: Vegetation types in the study area

Bushmanland Arid Grassland (Type NKb 3)

This grassland type occurs on extensive plains in the Northern Cape Province in the area between Aggenys, Prieska, and Pofadder. It extends slightly north of Upington where it intermingles with areas of Lower Gariep Broken Veld, Kalahari Karroid Shrubland, and Gordonia Duneveld. Sparsely vegetated grassland dominated by white grasses such as *Stipagrostis* species and low shubs including *Salsola* species.

Kalahari Karroid Shrubland (Type NKb 5)

Occurs in the Northern Cape Province especially north-west of Upington. Low karroid shrubland on flat gravel plains. Karroo-related shrubs merging with species characteristic of the Kalahari Region and sandy soils. Transitional between the Savanna Biome and the Nama-Karroo Biome.

Gordonia Duneveld (Type SVkd1)

Typical of sand dunes in the Northern Cape Province as either dune fields or loose dune cordons. Aeolian sand dunes underlain by silcretes and calcretes. Parallel dunes 3 – 8 m high with open shrubland dominated by *Stipagrostis* Grasses on the crests and *Acacia haematoxylon* and *A. mellifera* on the slopes. *Rhigozum trichotomum* in the interdune spaces.

8.2.3 Wetlands

The extents of the study area wetlands mapped in the NFEPA Map 4 and SAIIAE Wetland Map 5 datasets are shown in Figure 7 and Figure 8. It is apparent that there is a high degree of commonality between the two systems. There is a strong correlation between the various wetlands and watercourses in terms of the features identified and the descriptors used by each are shown in Table 3.

Table 3: Wetland database descriptions

System Type	NFEPA Wetland Map 4	SAIIAE Wetland Map 5
Fluvial Systems	River	River
River PES Category	C. Moderately Modified	Unspecified
Lentic[2] Systems	Depression	Depression
Region	Nama Karoo Bushmanland	Bushmanland Bioregion

From Table 2, on account of their width and flow patterns, the fluvial systems would be classified as being Ephemeral Rivers.

[2] Lentic: Lentic ecosystems are those whose water is still, and are made up of ponds, marshes, ditches, lakes and swamps. These ecosystems range in size from very small ponds or pools that may be temporary, to large lakes.

The study area is included within three Quaternary Catchments. See Figure 9.

The greater part of the study area lies within Catchment D42E which includes the Doringdam Spruit. This spruit has a part of its source area in the project area and then passes on down to the Molopo River. It is NFEPA listed as being an Orange River tributary.

In the south-eastern corner of the study area is Catchment D73E. This area includes the headwaters of an unnamed watercourse which flows southwards to enter the Orange River near Upington. The catchment is small and is probably of very low significance. Finally, the north-eastern corner of the study area just reaches into Catchment D42D. This catchment flows around the northern side of Catchment D42E and enters the Molopo River.

While Catchments D42E and D73E have clear evidence of channels with erosion features, Catchment D42D appears to have no clear drainage line. Its surface topography tends to have very low gradients and it consists primarily of dune fields and plains with numerous depressions (pans). See Figure 10. Therefore, any rainfall into its area is likely to be held and then to either evaporate away, or else to percolate down into the soil. An implication of this is that it may contribute some ground water to the other two catchments.

The origin of the pans and their development processes is not clear. Such formations occur in arid areas elsewhere in the world such as in South America, the United States of America, Australia, China, Russia, and elsewhere in Africa. A variety of developmental processes have been described with both biological and geological factors being involved. The biological processes relate to alteration (depletion) of vegetation in the vicinity of termitaria and to removal of soil by large herbivores wallowing in mud holes and then carrying away material embedded in their coats. While both of these may play some role, the greater number of authors suggest that the pans develop by means of physical and geological processes (Tooth and McCarthy, 2007; De Klerk *et al*, 2016; Goudie *et al*, 2016; Goudie and Wells, 2000: Le Roux, 1978). In this scenario, a soil surface is altered by weathering processes, and fine residual material is removed by the wind. This results in deflation of the soil surface level and then acceleration of the weathering in the newly exposed bare area, with the process being repeated.

As the project area is subject to strong winds at times it is probable that this process could explain the origin of the pans. Figure 4 and Figure 5 show that the windiest conditions in the area coincide with the driest months of July to September. Thus the substrate would be at its most dusty and so be susceptible to wind-blown erosion.

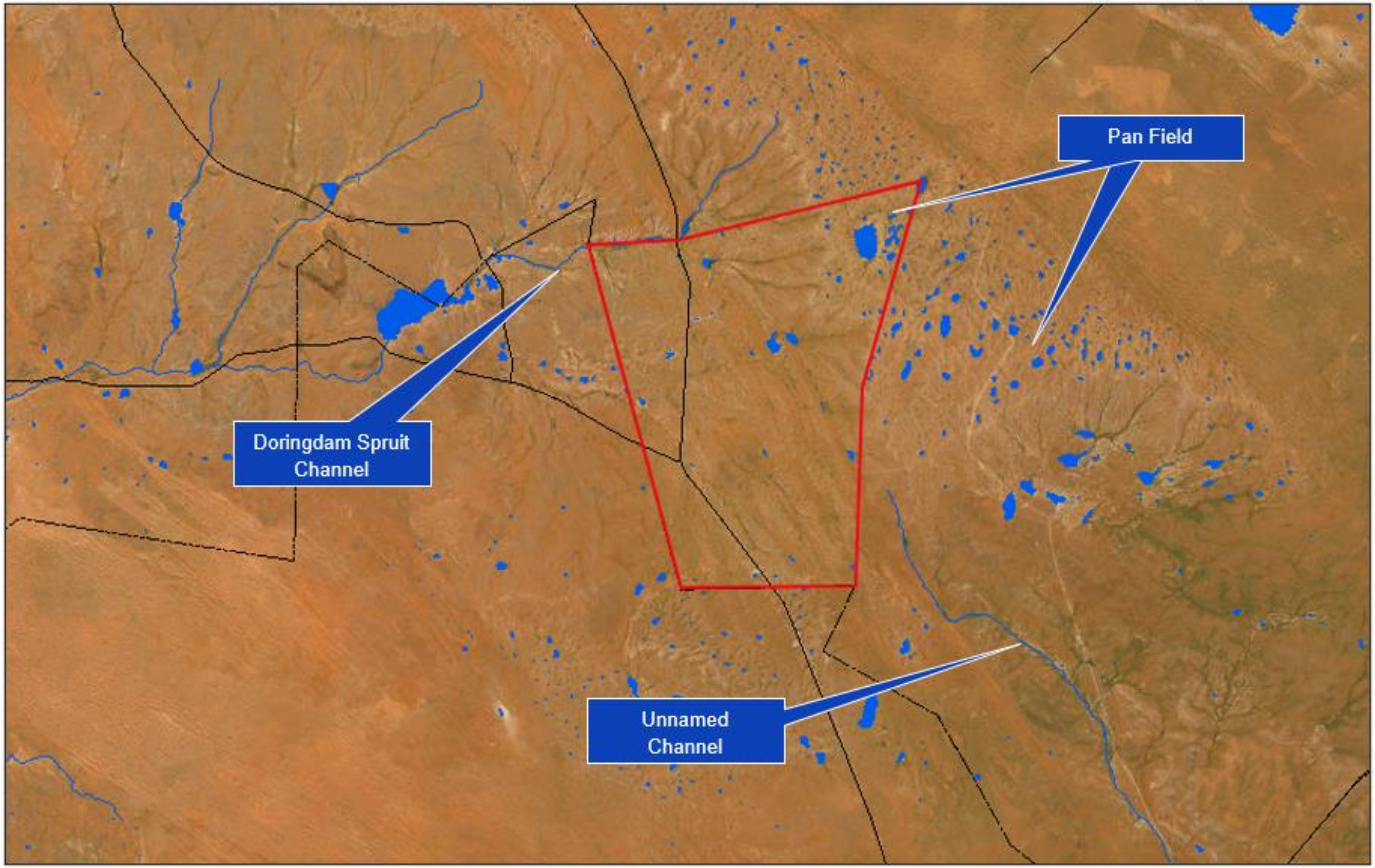


Figure 7: NFEPA Wetland Map 4 sites around the project area

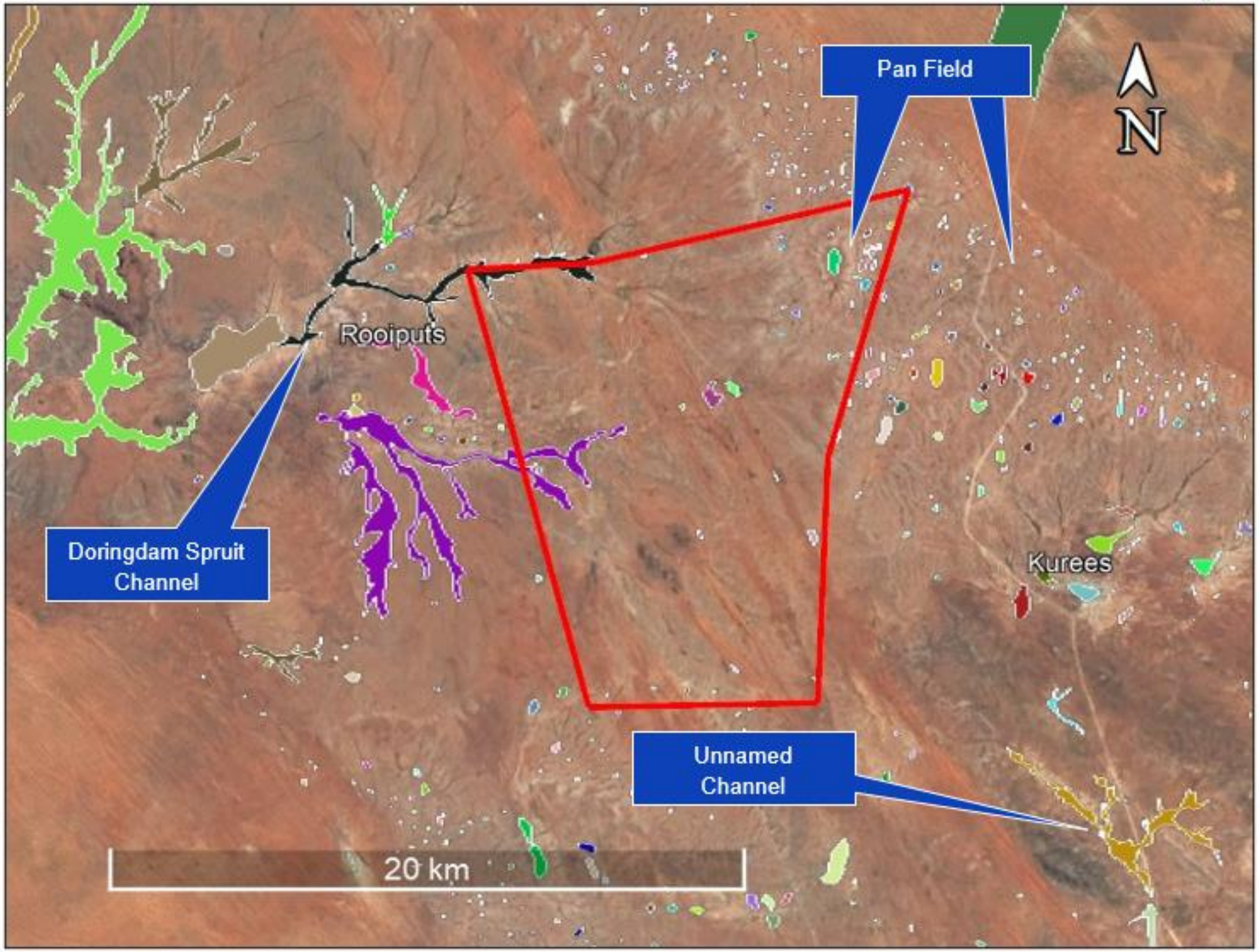


Figure 8: Wetland Map 5 sites around the project area

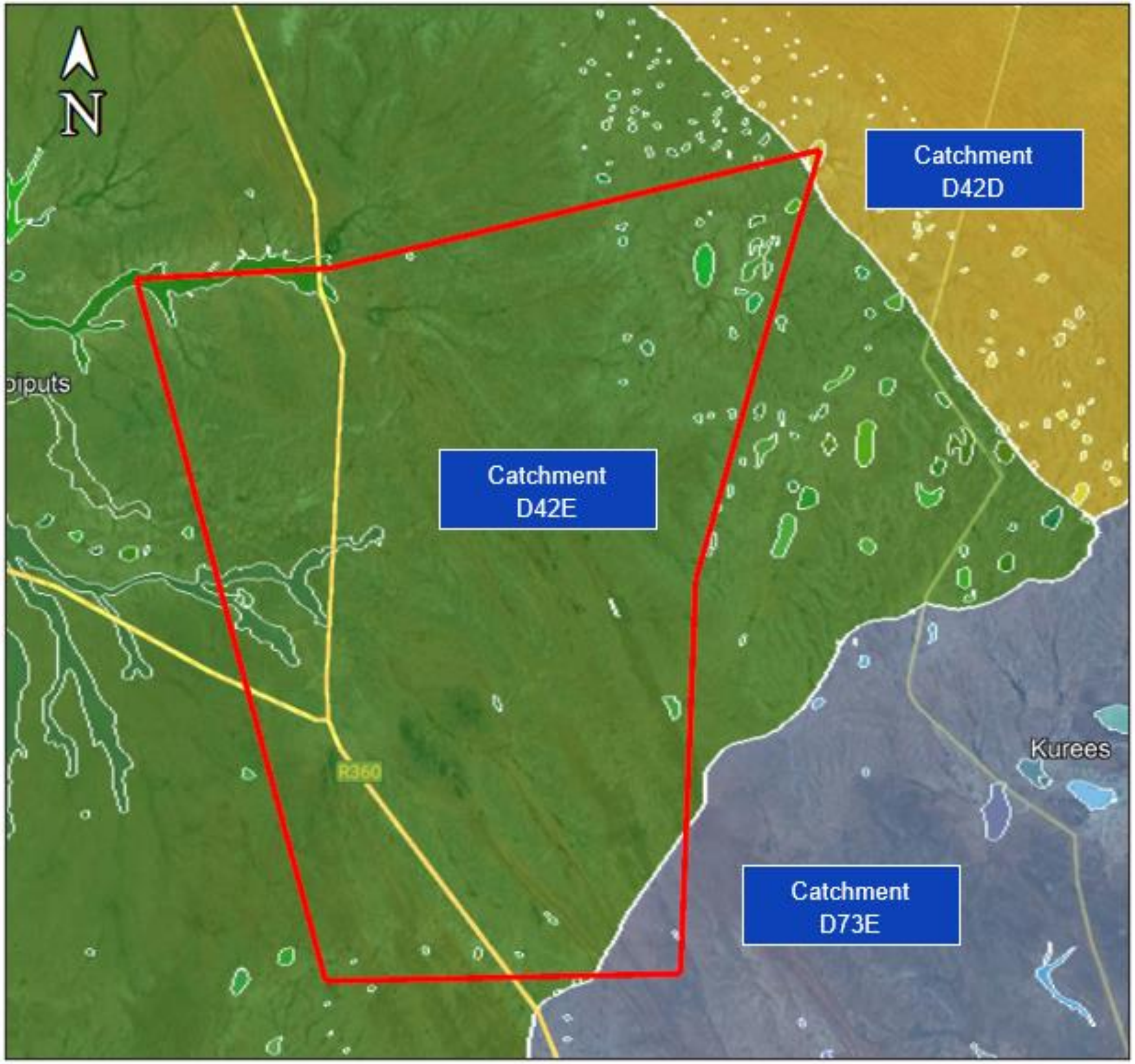
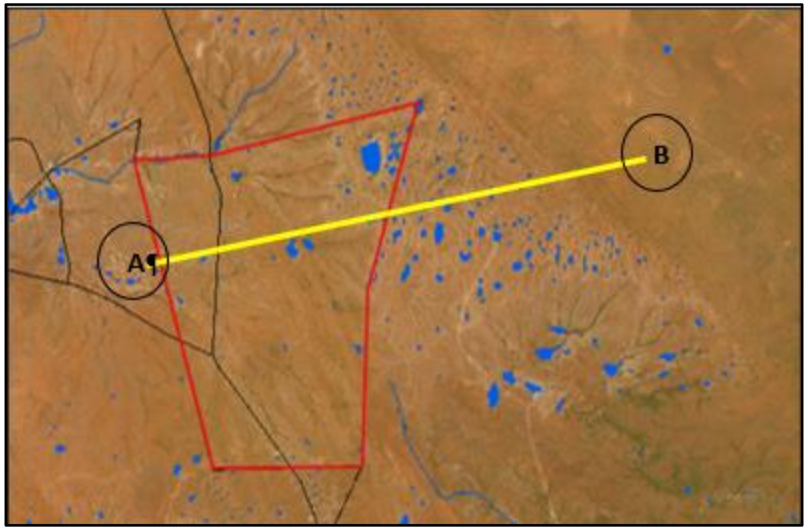


Figure 9: Quaternary Catchments in the project area



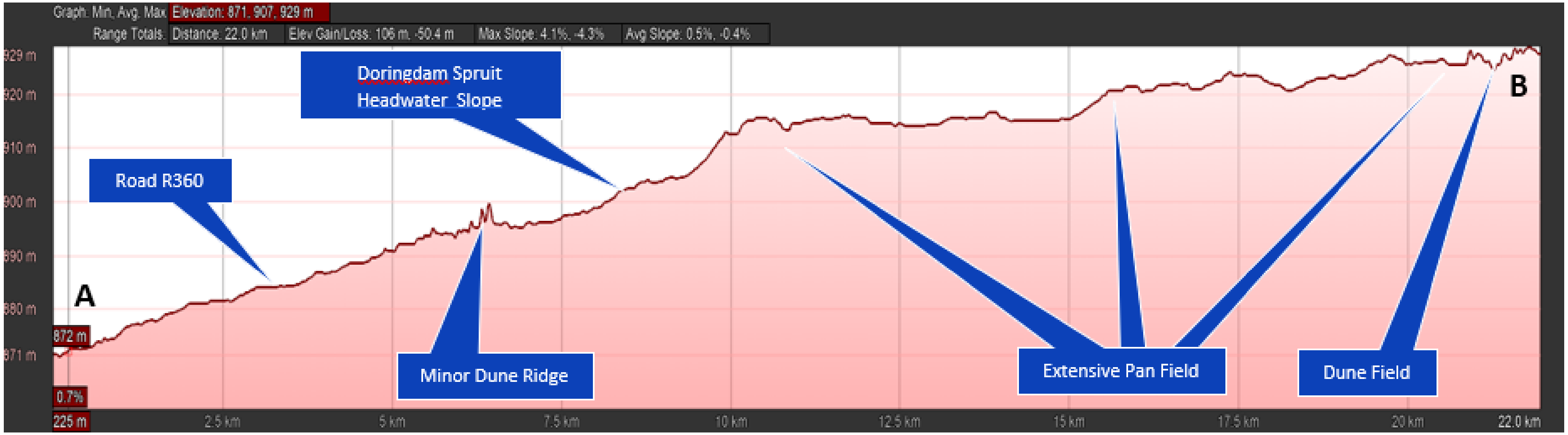


Figure 10: Cross section through the study area along Line A - B

9. CONSIDERATION OF WETLAND CONDITION AND FUNCTIONALITY

As was stated in Section 3 above, this report is based partially on a desktop study and so data for full assessment of wetland functionality and condition are not available. However, since the wetlands in the study area are not amenable to modelling with the conventional tools, the omission is less significant than it might otherwise be. The NFEPA mapping of the Doringdam Spruit indicates a PES category of C (Moderately Modified). This is applied for the full length of the spruit from its source down to the confluence with the Molopo River. However, the headwater area in the vicinity of the project area may be somewhat less affected by human activities and so be in PES Category B (Near Natural). There are a number of farm dams in the study area which are supplied almost entirely by surface water when it is available. Irrespective of the water source, their scarcity and small size suggest that they will have little effect on the condition of the spruit. The generally flat gradients in the area indicate that soil erosion will not be extensive despite the large areas of bare ground.

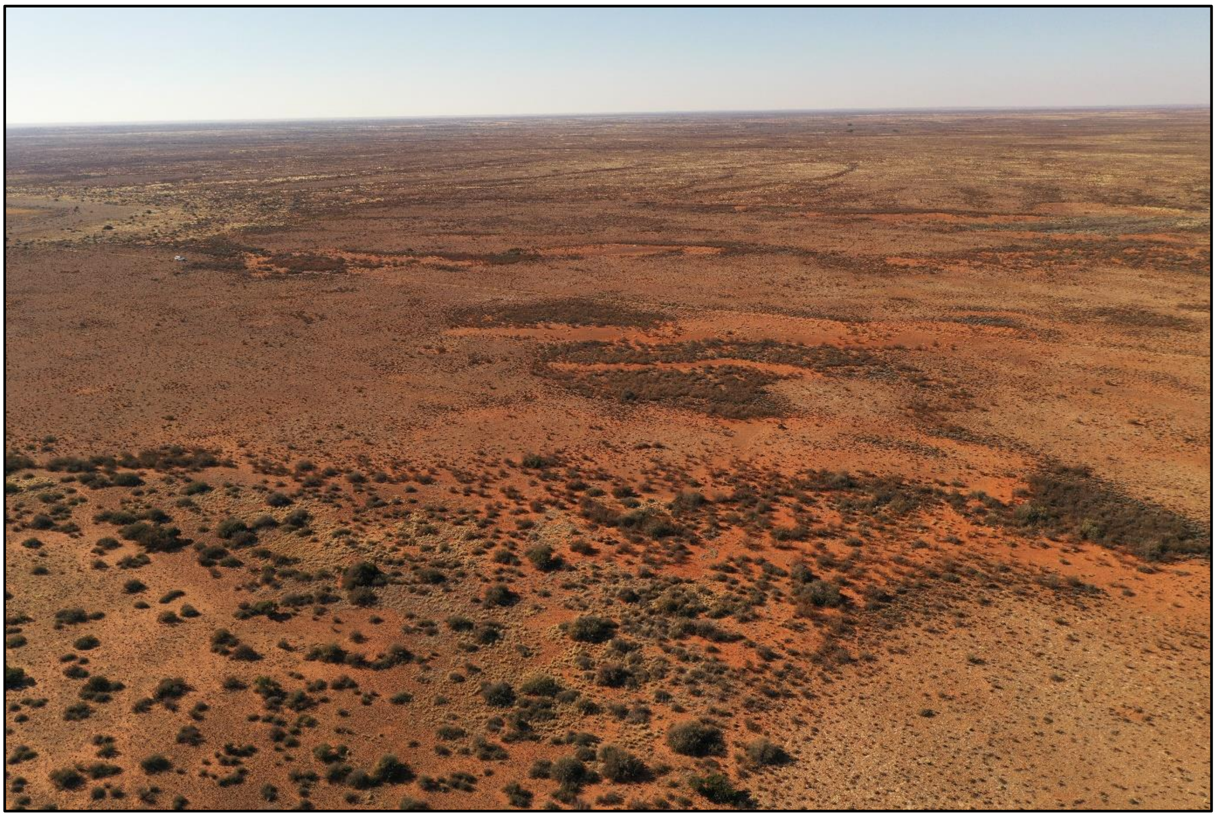


Plate 1: Flat landscape in the study area

A functionality (ecosystem services) assessment of the wetland systems is not supplied by any of the wetland databases. The aridity of the region implies that such assessment is difficult and so consideration is taken here of only biological factors. It is to be noted that the SANBI Screening Report lists the wetlands as being of “Very High Sensitivity” in relation to the Aquatic Biodiversity Theme. No reason is provided although it is recognised that they do form part of the Orange River system. No aquatic species are listed. However, since there are some pans and dams which do sometimes hold water for a while, the possible biodiversity implications of the water were considered. The 2820BB, 2820BD, 2821AA, and 2821BB, 1:50,000 topocadastral map sheets were interrogated in the Animal Demography Unit faunal databases and for the SABAP2 bird data which came from Pentads 2800-2100, 2800-2105, 2805-2055, and 2805-2105. Only the bird lists revealed any species which have some dependence on water, with a total count of 29 such species being present and with large numbers being present at timesof high rainfall. However, birds are highly mobile and will enter and leave the area as conditions dictate.

No frog species were found to be listed but it is possible that the Bullfrog (*Pyxiecephalus adspersus*) could be present as it is known from the Kalagadi Transfrontier Park. Some six Odonata (dragonflies and damselflies) species were also noted but these species are able to survive around livestock, drinking troughs, water reservoirs and the like and so are not counted as being dependent on natural conditions. All of the species with some dependence on water were listed as being of "Least Concern". It is not known whether or not the pans in the area in and around the study area contain invertebrate faunas which are adapted to periods of desiccation. Nkabeng *et al* (2022) report a diversity of macro- invertebrate taxa in ephemeral pans in the Nama-Karoo region south of the project area. Families represented included Branchipodidae, Notonectidae, Chironomidae, Libellulidae and Corixidae. Of these, the Branchipodidae (Fairy Shrimps) are the most specialised and there is a possibility of considerable species diversity and endemism within the group. It is probable that they are a primary food source for the birds.

From the foregoing it is considered that the pans offer and Doringdam Spruit offer little by way of human ecosystem services other than for occasional water for livestock and for ecological services other than for a small assemblage of adapted vertebrate and invertebrate species. It is possible however, that certain species may be endemic and so be of high conservation concern.

10. RESULTS OF THE FIELD STUDIES

The overall study area is large (> 15000 ha) and so the field studies which were undertaken over the period 3rd to 6th July 2023 were largely restricted to the areas around the boreholes which could be accessed i.e. only on Portion 7 of the Farm Gams 367. Farm tracks could be used in places but elsewhere it was necessary to walk. Use was made of a drone for photographic purposes. Delineation of the wetlands was made difficult due to the extremely dryness of the conditions at the time. A local farmer reported as having received only some 30 mm of rain during the course of this year and having experienced dry conditions prior to that.

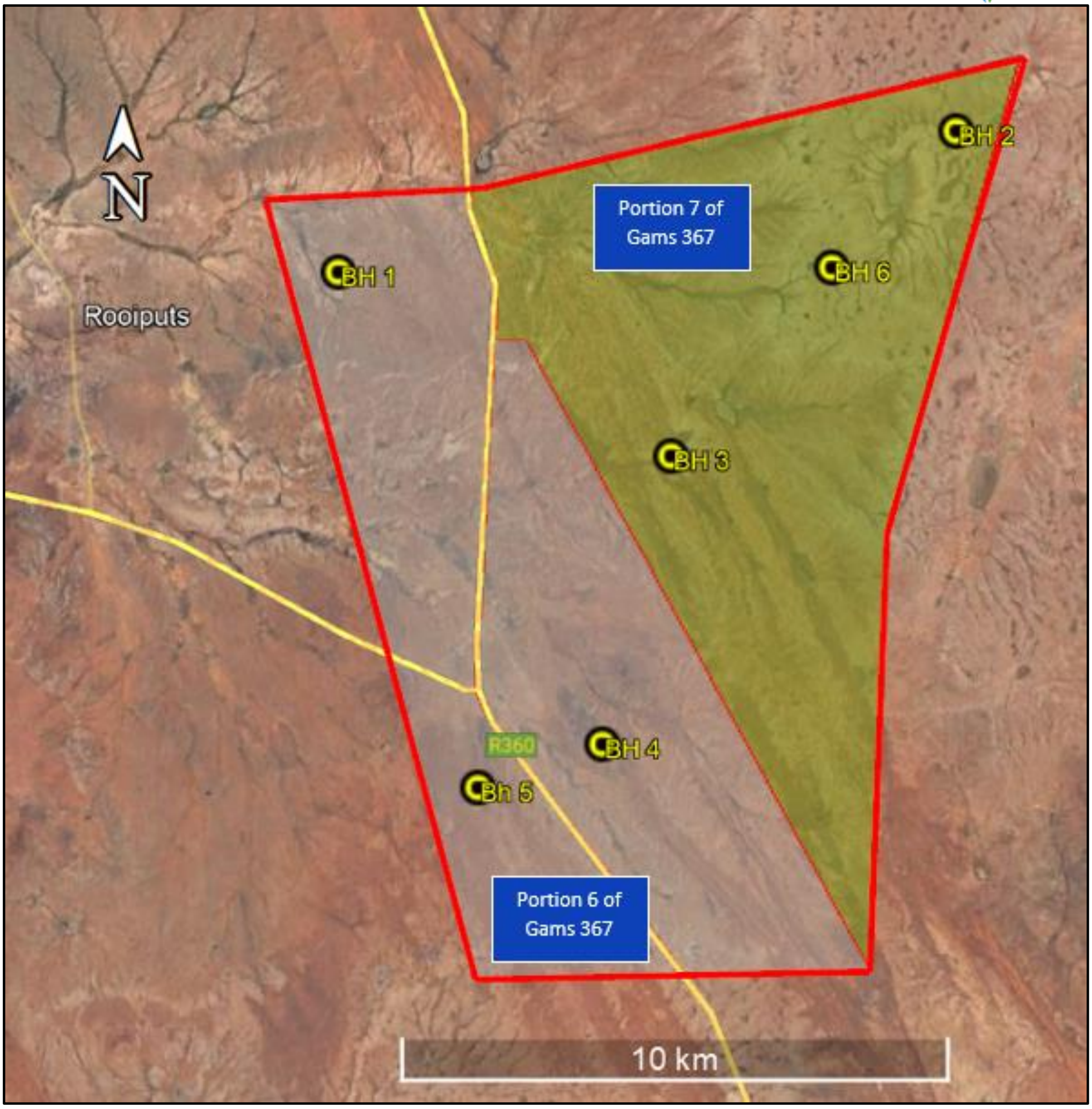


Figure 11: Locations of borehole sites in the project area

Thus any wetland features could only be detected through the presence of depressions or, occasionally of channels. Vegetation was also used as an indicator with the depressions having a greater proportion of grasses although commonly surrounded by woody vegetation. The reason for this differentiation in vegetation patterns is surmised to be based on the woody plants having deeper roots which can reach further down to access moisture which is in the soil near the pans, but being unable to be inundated at times. On the other hand, the grasses benefit from nutrients washed into the pans, which are endorheic, and can survive the inundation or, at least, can recover quickly after it. Also present in the landscape are extensive areas of stony ground but these are not always considered to be in pans. In many places evidence of a mud crust was found in the depressions and so the past presence of water was indicated. It is to be noted that no pans which would be classed as "salt pans" like those found further north in the region were found.


Plate 2: Google Street View of a salt pan alongside Road R360


Plate 3: Grassy vegetation within a pan but surrounded by bushes

Plate 4: Dried mud crust indicating the past presence of water

On the basis of the field observations, it is thought that the very numerous pans indicated in the Wetland Map 5 database may be an overestimation of the real numbers since there are extensive stony or sandy areas which are not necessarily actual pans although they can also be found within pans. The presence of such confusing features, and especially in drought conditions, makes the identification of pans very difficult.

Plate 5: Stony ground does not indicate the presence or absence of a pan.

Plate 6: Flat sandy surface but not in a pan

On the basis of the field observations, it is thought that the very numerous pans indicated in the Wetland Map 5 database may be an overestimation of the real number.

In addition to the pans which are mostly, but not exclusively, located in the pan field indicated in Figure 8 are a number of "watercourses" which lead down the Doringdam Spruit headwater slope. See Figure 10. All are situated in Quaternary Catchment D42E but a large part of the headwater area lies outside of the study area. It is important to note that the "Pan Field" area is also in the same catchment area since it acts as a catchment for the Doringdam Spruit drainage. This is of significant importance to the farmers since they recognise that water trapped in the pans helps to sustain flows in their livestock watering boreholes. They report that, once the pans are dry after a period of rainfall, the water levels below their pumps will start to drop, and that eventually only the deepest boreholes will have water.
The upper watercourses are very shallow and, in their upper reaches, are difficult to discern on the ground. However, in their lower reaches they become deeper and may be wooded with a form of riparian vegetation dominated by trees such as Karree (*Searsia lancea*), Kameeldoring (*Acacia erioloba*), and the alien Mesquite (*Prosopis glandulosa*). No significant soil erosion was noted even though the size and construction of the R360 road crossing suggests that a large quantity of water may flow at times.

The portion of the study area which lies in Catchment D73E lies within a dune field and appears to have no surface runoff into that catchment.

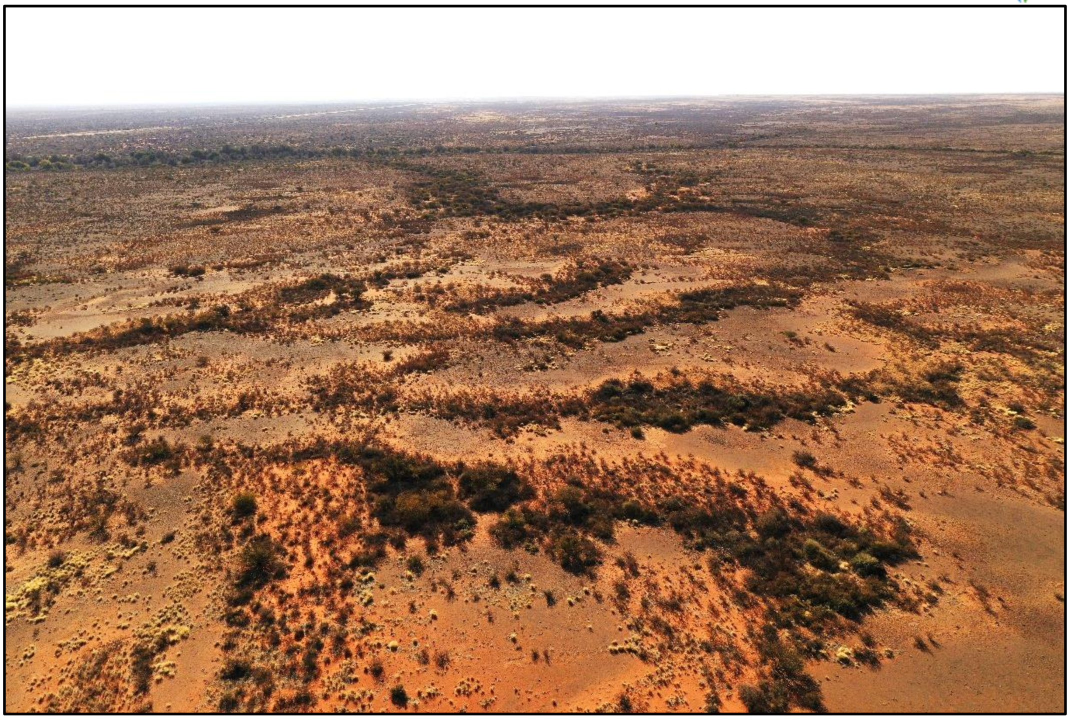


Plate 7: Headwater slopes of the Doringdam Spruit


Plate 8: Doringdam Spruit channel near the Road R360 bridge

Plate 9: Road R360 bridge over the Doringdam Spruit showing the large culverts

11. ASSESSMENT OF IMPACTS

The potential impacts which might arise from the proposed prospecting operations are assessed below. In doing so the process was guided by reference to the Mitigation Hierarchy which, in turn, is supported by the draft National Biodiversity Offset Policy (RSA, 2017). This concept is illustrated in

Figure **12** which indicates the flow of the decision-making process. It entails iterative consideration of the impacts of a proposed development and means of reducing those impacts. It starts at the top level ("Avoid/Prevent") and only when the options in that level are considered and exhausted, does the process move progressively down to the next lower level with the intention of limiting impacts to that extent.

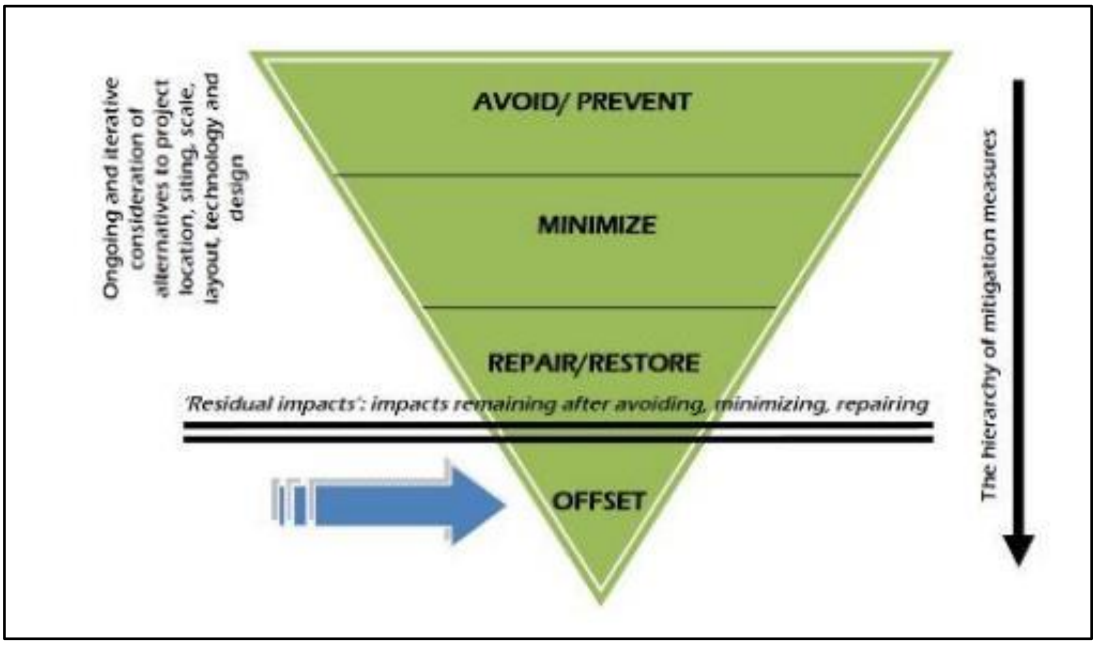


Figure 12: Schematic representation of the Mitigation Hierarchy

Prior to assessment of the potential impacts, the present uses and values of the land are taken into consideration as below.

11.1 Hydrological Conditions

The project area lies in an extremely arid region. Rainfall events are scattered and prolonged periods of drought are experienced. Thus the availability of water generally is very limited and surface water is completely lacking. This was the case at the time of the site visit as is shown below.

Plate 10: Completely dry dam on the Doringdam Spruit.

While a limited quantity of potable water is available from the Kalahari East Water Users Association pipeline which feeds through the area, the supply is strictly for domestic purposes only. Thus water for livestock is derived from boreholes but is still scarce. Groundwater recharge in the study area is from the pan field in the east but the boreholes do run dry at times. The implication of this is that any threat to the pan field area is a threat to the livestock farming to the west and south-west and also to the Doringdam Spruit which is a tributary of the Molopo River.

11.2 Agricultural Conditions

The properties which make up the study area are only used for crop production on a very limited and localised scale but are extensively used for livestock grazing. Most of the stock consists of sheep (Dorpers) and goats (Boerbokke) as these breeds are well adapted to dry conditions, but a few larger animals such as horses, cattle and donkeys are also kept. Water for the animals is obtained from boreholes and it is noted that the use of traditional windmills

Plate 11: Doringdam Spruit downstream of the R360 road bridge.

and open tanks (reservoirs) is being largely replaced by solar driven electric pumps and closed water tanks. This system is more efficient and less wasteful of water. It was observed that, where animals are not restrained in pens, they were invariably seen in pan areas. Presumably the grazing in such places is better than in the more heavily wooded areas.

Plate 12: Dorper sheep held in a pen near a solar powered water supply

11.3 Biodiversity Conditions

Despite the aridity of the area there is considerable indigenous biodiversity present. Apart from a diverse flora, there are game animals such as Springbok and Gemsbok and numerous small mammal species including some of high biodiversity concern. As with the domestic stock, these animals were almost entirely restricted to pans.

Plate 13: Springbok seen in a pan

Also present are several important reptile species and the landowners report that the pans attract large numbers of birds at times when there is water present. This in turn leads to consideration of the invertebrate biodiversity in the pans.

The biodiversity of the area is addressed more fully in a second report.

11.4 Identification of Impacts

The broad activities of the proposed prospecting survey, along with some finer detail and explanation are listed in Table 4 and listing of the impacts follows. Mitigatory measures are provided in Section 14.

Table 4: Preliminary exploration activities

Proposed Prospecting Activities	Implications for Preliminary Phase of Exploration	Site Activities
Desktop study	None	n/a
Remote sensing	None	n/a
Field mapping	None	n/a
Geological modelling and resource estimation	None	n/a
Geochemical survey	None in the early stages of prospecting	n/a
Geophysical survey	None in the early stages of prospecting	n/a
Trenching	None in the early stages of prospecting	n/a
Test Drilling	Size of a drilling site	25 m x 20 m
	Number of drilling sites	Not yet decided. Restricted to six in the initial phase but possibly 20 – 100 at a later stage
	Site camp at each drilling site. The camp will be moved to each drilling site	25 m x 20 m
	Infrastructure to be developed in the area	• Access roads. Use will be made of existing roads but tracks to individual drilling sites will be required. • Drilling rigs • Water supplies
	Nature of infrastructure	• In a greenfield area • Temporary
	Personnel resident on the property	Drill operators will live on the property at the drill sites.
	Hazardous materials or substances on site	• No explosives • Petrol, diesel, and oils

The following potential impacts on aquatic systems arising from the preliminary prospecting activities have been identified:

- *Construction of access roads and/or tracks to service the drilling sites.* In order to reach and operate the various drilling sites it will be necessary to establish a series of roads or tracks which may be used by vehicles and machines. These will originate from existing farm roads or tracks but will then enter areas of original (greenfields) veld in order to reach the identified drilling sites. It is possible that the routes could pass through watercourse or wetland sites and so be potentially damaging to aquatic systems. The principal concern will be that of establishing unnatural bare areas which could become prone to erosion of the soil at times of rainfall.
- *Establishment and operation of the drilling sites.* Each drilling site will consist of a drilling area which will hold the drilling rig as well as laydown areas for equipment, and stores. Nearby the drilling area will be a site camp which will form the residence for the workers while they are active at that site. The principal concern will be that of establishing bare areas which could lead to erosion of the soil at times of rainfall.
  The activities at the sites will lead to the production of a variety of wastes which may consist of broken drill parts or other scrap iron, rock material from the drill hole, domestic wastes such as food packaging and the like, waste water, and human wastes. All of these wastes could be residual for a long period of time due to the aridity of the area and there is a possibility of certain of them contaminating any nearby aquatic features at times of rainfall.
- *Spillage of hydrocarbon (fuels and oils).* The drilling activities will entail the use of a variety of transport vehicles as well as the actual drilling machinery. Spillage of fuels and oils could happen and, if the quantity is large enough, the spilled materials could percolate into either a pan or watercourse, or the soil where they might enter the groundwater. Hydrocarbons are highly toxic in the aquatic environment and could be transported for a considerable distance. Wild animals or domestic livestock could be affected when drinking from pans, dams, or a watercourse.
- *Damage to the hydrology of the area.* The hydrology of the area is based largely on rain water being collected in the endorheic pans in the east and then percolating into the soil where it can enter subterranean aquifers which transport the water westwards. Discussion with the landowners suggests that such aquifers, which are sufficiently developed to be tapped for agricultural purposes, are very limited in extent. While it is unlikely that only the six boreholes indicated will have any effect on the aquifers, it is possible that a larger number of boreholes, or other survey procedures, could have an impact on the hydrology and hence on agriculture and biodiversity in the area.

- *Damage to the agricultural activities in the area.* The movement of vehicles, as well as the establishment and operation of the borehole sites could pose some threat to the livestock in the area through disturbance, possible soil contamination, pan water quality, and deposition of various wastes.
- *Damage to the faunal biodiversity of the area.* The fauna of the area will be disturbed by the human presence and drilling activity. While this will not be of relevance to the more common species such as Springbok, other species and especially smaller burrowing species which will not move very freely due to specialised habitat requirements, could be affected. Activity near pans during the wet season could have significant impacts on the birds which utilise them.
- *Damage to the specialised vegetation associated with pans, dams, or watercourses.* Although the region has a very arid climate, there are some waterbodies which have a surrounding riparian vegetation. This vegetation provides habitat for a number of animal species but also included plant species which are not found in the surrounding spaces. Although the plant species are unlikely to be listed as being threatened, they are uncommon in the region and so should not be impacted on. It is possible that drilling activities, including establishment of roads or tracks, or the establishment of drill sites could impact on this vegetation type and so cause environmental harm.

11.5 Identification of Impacts

Definitions of the terms used in the impact assessment are provided in Annexure A and the assessments are shown in Table 5.

The potential impacts arising from the construction of roads or tracks, and from the damage to hydrophilic vegetation are rated as being Low Significance prior to any implementation of mitigatory measures and as being Very Low Significance after mitigation. However, the impacts arising from establishment and operation of the drilling sites, and from possible contamination of aquatic features as a result of hydrocarbon spillage are rated as being of Medium Significance prior to mitigation. The reasons for the higher assessments arise from the fact that the impacts could either be spread over a large area, contaminate water supplies, or could persist for a longer time period. However, with mitigation these impacts can also be reduced to being of Low or Very Low Significance.

It is to be noted that the above impacts are assessed in relation to only the preliminary prospecting operation which is to be undertaken through drilling of just six test holes. Therefore, the usual consideration of impacts in the construction, operational, and decommissioning phases of an operation are not considered. In addition, later stages of prospecting, such as trenching or other activities which will have a greater effect on the ground surface, have not been taken into account since their *modus operandi* remains unknown at present.

Table 5: Assessment of possible impacts arising from the prospecting activities

With/ Without Mitigation	Activity/Impact	Consequences of the Impact	Spatial extent	Severity / Magnitude	Duration	Resource Loss	Reversibility	Probability	Significance
Pre-mitigation	Construction of access roads and/or tracks to service the drilling sites.	In regard to aquatic systems in the area the activity could lead to gullies or other erosion and to soil deposition which could cause sedimentation and also infilling of dams.	2	3	3	2	3	0.4	5.2 Negative Low
Post-mitigation			1	2	1	1	1	0.2	1.2 Negative Very Low
Pre-mitigation	Establishment and operation of the drilling sites.	The establishment and operation of the drilling sites will require clearance of vegetation and so could lead to sedimentation of aquatic features. In addition, there will be production of a variety of wastes including rock from the drill hole, broken machinery, and domestic and human wastes.	2	4	3	3	1	0.8	10.4 Negative Medium
Post-mitigation			1	2	1	1	1	0.3	1.8 Negative Very Low

With/ Without Mitigation	Activity/Impact	Consequences of the Impact	Spatial extent	Severity / Magnitude	Duration	Resource Loss	Reversibility	Probability	Significance
Pre-mitigation	Contamination of the aquatic features by the spillage or leakage of hydrocarbons originating from the activities around the drilling rig, or from the site camp.	It is not known where the drilling sites will be established, but the associated site camp will be storing potentially hazardous goods such as fuel and oils. Such goods, if spilled could pose a contamination risk to the aquatic features in the wetland area. Livestock drinking points could be affected	2	5	3	3	3	0.7	11.2 Negative Medium
Post-mitigation			2	4	3	2	3	0.3	4.2 Negative Low
Pre-mitigation	Damage to the specialised vegetation associated with pans, dams, or watercourses.	Some drilling sites may need to be placed in areas which are close to aquatic features. In such places there is a risk that the specialised hydrophilic vegetation could be damaged. Although the plant species are unlikely to be threatened, they are relatively uncommon in the region and so should not be impacted on.	2	3	3	4	3	0.3	4.5 Negative Low
Post-mitigation			2	2	3	3	1	0.2	2.2 Negative Very Low

With/ Without Mitigation	Activity/Impact	Consequences of the Impact	Spatial extent	Severity / Magnitude	Duration	Resource Loss	Reversibility	Probability	Significance
Pre-mitigation	Damage to the hydrology of the area	Disturbance in the pan field could affect the water resources to the west.	2	3	3	4	1	0.2	2.6 Negative Very Low
Post-mitigation			2	2	1	3	1	0.1	0.9 Negative Very Low
Pre-mitigation	Damage to the agricultural activities in the area	Disturbance of livestock, deposition of wastes which could be edible or toxic, contamination of water in the pans.	1	3	3	3	1	0.2	2.2 Negative Very Low
Post-mitigation			1	2	1	1	1	0.1	0.6 Negative Very Low
Pre-mitigation	Damage to the faunal biodiversity of the area	Disturbance due to human presence and noise and vehicles. Destruction of habitat of burrowing animals and prevention of birds using the pans when water is present.	2	5	1	4	3	0.5	7.5 Negative Medium
Post-mitigation			1	3	1	3	1	0.3	2.7 Negative Very Low

12. RISK ASSESSMENT

In order to assess the risks posed to the wetland systems by the proposed drilling of prospecting boreholes the DWS Risk Assessment Matrix (DWS, 2014) was used. The tool makes provision for the assessment of the risks linked to the impacts which have been identified in relation to the prospecting operation. See Section 11 for listing of the impacts. Consideration was taken of the history of the area and of its present condition and likely future state under the present landuse.

The potential risks associated with the construction of roads or tracks, and from the establishment and operation of the drilling sites, are rated as being Low Significance prior to any implementation of mitigatory measures and therefore as being of Low Significance after mitigation. However, the impacts arising from possible contamination of aquatic features as a result of hydrocarbon or chemical spillage, and from the damage to hydrophilic (riparian) vegetation, are rated as being of Moderate Significance prior to mitigation. The reasons for the higher assessments arise from the fact that the impacts could either be spread over a large area or could persist for a longer time period. However, with mitigation the risks can also be reduced to being of Low Significance. In addition, the potential risks on the hydrology, agriculture, and biodiversity are also rated as being of Moderate Significance prior to mitigation. These risks arise out of the perceived link between the pan field and the water in the farmers' boreholes, and from disturbance of the indigenous fauna some of which includes species of very high conservation concern. However, careful placement of the drill sites and management of the associated activities can reduce the risks to the level of Low.

13. CONSIDERATION OF BUFFERS

While it is usual to consider buffer areas around wetlands or watercourses which may be impacted upon by a proposed development, that is not taken to be the case in regard to the proposed preliminary prospecting operation. The reason for this is that the operation will consist of very short term operations at only six sites. Further, the sites are to be widely scattered and it is probable that their impact footprints will not overlap. This does not imply that there is no need for environmental caution, and so a number of mitigatory measures to reduce the impact and risk levels are put forward.

Table 6: Assessment of risks arising from the preliminary prospecting activities

With/ Without Mitigation	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk rating	Confidence Level
Pre-mitigation	Construction of access roads and/or tracks to service the drilling sites.	In regard to aquatic systems in the area the activity could lead to gullies or other erosion and to soil deposition which could cause sedimentation and also infilling of dams or other livestock watering points.	Damage to the soil surface and runoff of soil material into aquatic systems.	2	6	9	54	LOW RISK	80
Post-mitigation				1	5	9	45	LOW RISK	80
Pre-mitigation	Establishment and operation of the drilling sites.	The establishment and operation of the drilling sites will require clearance of vegetation and so could lead to sedimentation of aquatic features.	Contamination of the drilling sites by wastes which could remain in place for years.	2	6	9	54	LOW RISK	80
Post-mitigation				1.25	4.25	9	38.25	LOW RISK	80
Pre-mitigation	Contamination of the aquatic features by the spillage or leakage of hydrocarbons originating from the activities around the drilling	It is not known where the drilling sites will be established, but the associated site camp will be storing potentially hazardous goods. Such goods, if spilled could pose a	Hydrocarbons are easily transported through the system and could be a threat to humans and livestock.	2.25	6.25	12	75	MODERATE RISK	80

With/ Without Mitigation	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk rating	Confidence Level
Post-mitigation	rig, or from the site camp.	contamination risk to the aquatic features in the wetland area. Livestock drinking points could be affected.		1.5	4.5	10	45	LOW RISK	70
Pre-mitigation	Damage to the specialised vegetation associated with pans, dams, or watercourses.	Some drilling sites may need to be placed in areas which are close to aquatic features. In such places there is a risk that the specialised hydrophilic vegetation could be damaged. Although the plant species are unlikely to be threatened, they are uncommon in the region and so should not be impacted on.	Hydrophilic (riparian) vegetation is relatively rare in the area and especial care is necessary to conserve it.	1.75	6.75	10	67.5	MODERATE RISK	70
Post-mitigation				1	4	8	32	LOW RISK	70
Pre-mitigation	Drilling survey for prospecting purposes.	Damage to the hydrology of the area	Disturbance in the pan field could affect the water resources to the west.	2	6	12	72	MODERATE RISK	50
Post-mitigation				1	3	11	33	LOW RISK	60

With/ Without Mitigation	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk rating	Confidence Level
Pre-mitigation	Drilling survey for prospecting purposes.	Damage to the agricultural activities in the area.	Disturbance of livestock, deposition of wastes which could be edible or toxic, contamination of water in the pans.	**2.25**	**5.25**	**11**	**57.75**	**MODERATE RISK**	**50**
Post-mitigation				**1.25**	**4.25**	**10**	**42.5**	**LOW RISK**	**60**
Pre-mitigation	Drilling survey for prospecting purposes.	Damage to the faunal biodiversity of the area.	Disturbance due to human presence and noise and vehicles. Destruction of habitat of burrowing animals and prevention of birds using the pans when water is present.	**2.5**	**7.5**	**11**	**82.5**	**MODERATE RISK**	**70**
Post-mitigation				**1.25**	**5.25**	**10**	**52.5**	**LOW RISK**	**70**

14. DISCUSSION OF MITIGATORY AND MANAGEMENT MEASURES

Although the prospecting operation which is currently planned is very limited in its scope and duration, it will still be necessary for some mitigatory measures to be set in place in order to reduce the impacts and risks which have been foreseen. These measures are divided into two categories which are:

- Measures to be applied in relation to all six borehole sites
- Measures which are site specific to particular boreholes

It is essential that the drilling contractor(s) be made aware of these measures prior to the start of any work and a copy of the measures must be kept on each site at all times.

14.1 Measures to Applied in Relation to all Boreholes

The following are to be applied at all sites:

i. Ideally no drilling should be undertaken at times when rain has fallen and the pans are holding water. This measure is recommended to both minimise the possibility of contamination of the surface and ground water, and to minimise disturbance of the important bird populations around the pans.
ii. The access to the site must be planned together with the relevant land owner and be approved by the land owner.
iii. The land owner may stop operations at any site if the conditions of the approval are ignored or otherwise bypassed.
iv. Access roads and tracks must make use as far as is possible of existing farm roads and tracks. Ideally, the routes will be approved and documented by an Environmental Control Officer (ECO).
v. To the greatest possible extent, the access roads and tracks must avoid passing through watercourses or pans or other environmentally sensitive areas. Such areas could include known home ranges of species of especial biodiversity conservation concern.
vi. Preparation of the drilling site must avoid damage to the vegetation as far as is possible.
vii. The size of the drilling sites must be restricted to a practical minimum and must be approved by the land owner and ECO. An extent of 20 m x 25 m is suggested but may be changed after discussion between the drilling contractor and the land owner. Once decided, the boundary of the site must be demarcated with a temporary fence which may consist of poles and hazard tape, plastic mesh, or shadecloth.
viii. If needed, a lay-down area for pipes may be established close by the drilling site but its boundary must also be demarcated.

ix. Since the drill operators may live on the site while working there, provision must be made for ablution and toilet facilities. Grey water may be disposed of on site but chemical toilets must be provided and be properly serviced. Pit latrines may not be used.

x. Provision must be made for proper retention of all garbage, domestic wastes, and drilling wastes. Bins with lids or skips must be provided and these must be emptied at an approved disposal site. No refuse of any sort may be buried or burned at the site.

xi. Fuels and oils must be held in leak-free containers and must be kept on drip trays when not in use.

xii. Waste oils and the like, including items such as used oil filters and oil-soaked paper or rags, must be retained in sealed containers and be kept on drip trays.

xiii. Vehicles and machines must be refuelled or serviced over drip trays. Any soil contaminated by fuel or oil spills must be collected and be held in a suitable sealed contained prior to removal to an approved disposal site. A hazmat kit of appropriate capacity must be kept on the site at all times.

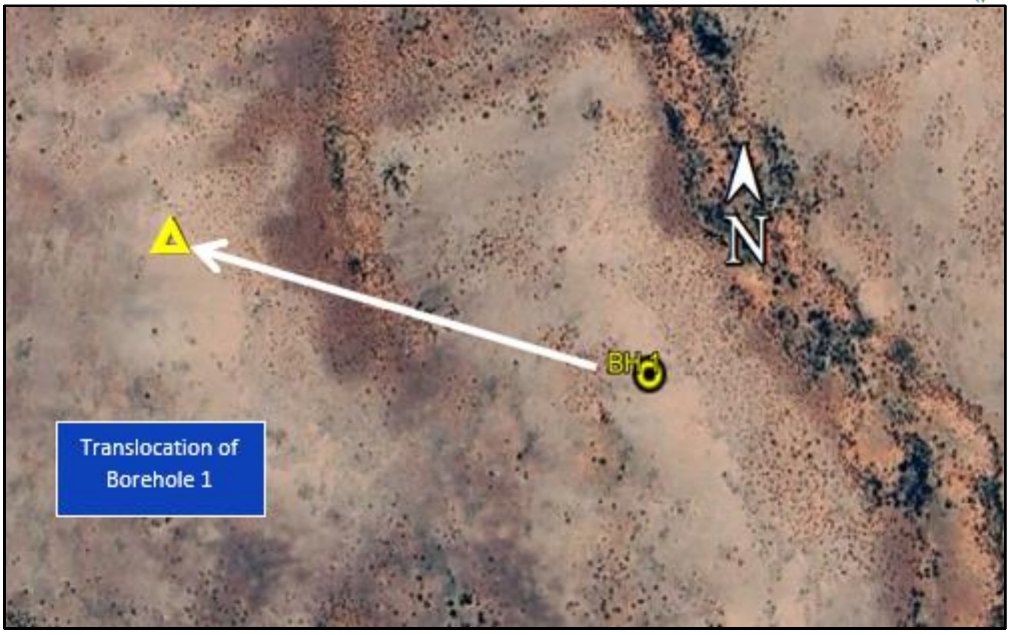
xiv. On completion of drilling operations at each site, all materials, including wastes or litter, must be removed for re-use at another site or for disposal as may be relevant. The site must be cleaned and tidied and its condition must be approved by the land owner before the contractor may leave the site.

xv. Any roads or tracks that were prepared or used for access to the site must be returned to their prior state and their condition must be approved by the land owner.

14.2 Measures to Applied at Particular Borehole Sites

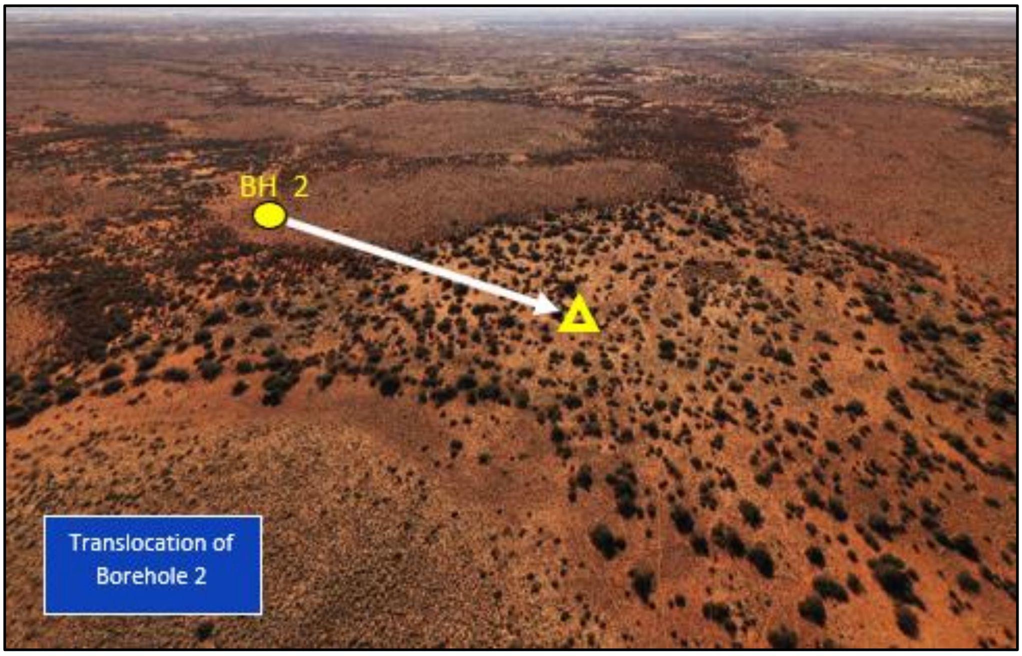
Reference is made to Figure 11 for the borehole site numbers. It is to be noted that the sites of Boreholes 1, 4, and 5 have not been visited and checked on the ground, and so the recommendations put forward are made on the basis of only Google Earth imagery and Google Earth ground elevation profiles.

- Borehole 1. This site appears to be on a dividing ridge between two watercourses. The closest such channel is approximately 45 m away from the site. It is therefore suggested that the site be moved to a location approximately 175 m north-westward to a point where it will be at least 60m from any watercourse. The new site remains within the same lithological unit.



- Boreholes 4 and 5. These boreholes may remain in their present locations unless an actual site visit and inspection suggests otherwise

- Borehole 2. Bore hole 2 is located at the site indicated below. Since it is in a pan area it is recommended that it be moved approximately 100 m south-eastwards to where it will be away from any pan as shown below. The new site remains within the same lithological unit.



- Borehole 3. Borehole 3 is located in a flat stony plain area to the west of two small dune cordons. It is away from any pan or watercourse and so may remain where its position has been indicated.

- Borehole 6. Borehole 6 is located on a low ridge in a grassy area which forms the divide between two pans. It is located more than 100 m away from either pan and so may remain in the position which has been indicated.

15. MONITORING

It is not known for how long the drilling rig will remain at each site but it is recommended that an ECO should visit each at least twice during its operation. Ideally this visit will be done when the site is first being established since that will also allow opportunity for the person to check on the site which has just been left.

16. CONCLUSION

16.1 Background

African Exploration Mining and Finance Corporation Soc Ltd is proposing to undertake exploratory prospecting on Portions 6 and 7 of the property Gams 367 located in Local Municipality NCDMA08 of the Siyanda District Municipality in Northern Cape Province. See Figures 1 and 2. As a part of the application for prospecting rights, the company intends to drill six exploratory boreholes, one of which will be located in each of the major geological formations on the properties. However, prior to doing so, it is necessary to undertake certain environmental studies. Amongst these studies are an assessment of any wetlands and watercourses in the area and an assessment of the biodiversity. This document reports on the aquatic systems and a second report covers the biodiversity.

16.2 Study Procedures and Findings

The project area was visited over the period 3 to 6 July 2023. Only the three sites on Portion 7 were accessible and could be visited. However, a detailed desktop study was undertaken to get information on the area and, during the course of the site visit, it was possible to meet with some land owners and to get further information from them.

It was found that the primary landuse in the area is stock farming with sheep and goats. The animals are either grazed on open veld or are held in feedlot pens. Water for the animals is a very scarce resource and is usually obtained from boreholes except for the rare occasions when there is some rainfall which can temporarily fill pans or dams. Farming may be supplemented with a limited amount of tourism which is usually in the form of hunting.

In regard to aquatic systems, the project area is heavily dependent on a pan field in the east. The pans trap rain water and feed it to the ground water system from where it may be extracted by boreholes located further west. Surface flows are very rare but there is drainage into the Doringdam Spruit. The flows can be substantial for short periods.

16.3 Impacts and Risks

Borehole sites 2, 3, and 6 are all located in the vicinity of pans and so have the possibility of being able to contaminate the ground water should there be any spillage of hydrocarbons (fuels and oils) or use of drilling chemicals, although the use of such chemicals is not planned at present.

The foreseen possible impacts from the borehole drilling are mostly Medium or Low and can be easily mitigated through careful measures taken at the time. See Table 5. Leakage of hydrocarbons in the form of fuels and oils was the possible impact and risk with the highest score but is one that can easily be avoided through careful management procedures which are common in the construction industry. Mitigatory measures are provided for this and all other impacts. See Section 14.

16.4 Summation

The proposed drilling of six test boreholes will probably have little long-term effect on the aquatic systems in the project area provided that the recommended mitigatory measures are adhered to. However, this statement is made subject to the following conditions:

- The area around the three borehole sites on Portion 6 of Gams 367 has not been visited and so comment is made only on the basis of Google Earth imagery, and on an assumption that conditions at the sites are likely to be similar to those on Portion 7 of Gams 367.
- The assessments are made with reference to only the six indicated boreholes. Should more boreholes be proposed, or further forms of prospecting be planned, then further environmental assessment must be undertaken. The extent of such assessment will be determined by the new activities proposed.

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ANNEXURE A - DEFINITION OF THE IMPACT ASSESSMENT TERMS

The terms used in the impact assessment process are defined below.

The Environmental Impact Assessment (EIA) Methodology assists in evaluating the overall effect of a proposed activity on the environment. Determining of the significance of an environmental impact on an environmental parameter is determined through a systematic analysis.

Determination of Significance of Impacts

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale (i.e. site, local, national or global), whereas intensity is defined by the severity of the impact e.g. the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated as shown in Table 1 below.

Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

Impact Rating System

The impact assessment must take account of the nature, scale and duration of effects on the environment and whether such effects are positive (beneficial) or negative (detrimental). Each issue / impact is also assessed according to the various project stages, as follows:

Planning;
Construction;
Operation; and
Decommissioning.

Rating System Used to Classify Impacts

The rating system is applied to the potential impact on the receiving environment and includes an objective evaluation of the possible mitigation of the impact. Impacts have been consolidated into one (1) rating. In assessing the significance of each issue the following formula is used:

((Spatial Extent + Severity + Duration + Resource Lost + Reversibility) * Probability) = Significance.

The interpretation of the overall significance of impact is presented in Table 1 below.

Table 1: interpretation of the significance scoring of a negative impact / effect

Score	Significance
>35	**Very High - The impact is total / consuming / eliminating** - In the case of adverse impacts, there is no possible mitigation that could offset the impact, or mitigation is difficult, expensive, time-consuming or some combination of these. Social, cultural and economic activities of communities are disrupted to such an extent that these come to a halt. Mitigation may not be possible / practical.
25 - 35	**High - The impact is profound** - In the case of adverse impacts, there are few opportunities for mitigation that could offset the impact, or mitigation has a limited effect on the impact. Social, cultural and economic activities of communities are disrupted to such an extent that their operation is severely impeded. Mitigation may not be possible / practical.
20 – 25	**Medium - The impact is considerable / substantial** - The impact is of great importance. Failure to mitigate with the objective of reducing the impact to acceptable levels could render the entire project option or entire project unacceptable. Mitigation is therefore essential.
7 – 20	**Medium - The impact is material / important to investigate** - The impact is of importance and is therefore considered to have a substantial impact. Mitigation is required to reduce the negative impacts and such impacts need to be evaluated carefully.
4 – 7	**Low - The impact is marginal / slight / minor** - The impact is of little importance, but may require limited mitigation; or it may be rendered acceptable in light of proposed mitigation.
0 – 4	**Very Low - The impact is unimportant / inconsequential / indiscernible** – No mitigation required, or it may be rendered acceptable in light of proposed mitigation.

Scores are allocated as below.

Spatial Extent

This addresses the physical and spatial scale of the impact. A series of standard terms and ratings used in this assessment relating to the spatial extent of an impact / effect are outlined in Table 2.

Table 2: Rating scale for the assessment of the spatial extent of a predicted effect / impact

Rating	Spatial Descriptor
7	**International** - The impacted area extends beyond national boundaries.
6	**National** - The impacted area extends beyond provincial boundaries.
5	**Ecosystem** - The impact could affect areas essentially linked to the site in terms of significantly impacting ecosystem functioning.
4	**Regional** - The impact could affect the site including the neighbouring areas, transport routes and surrounding towns etc.

Rating	Spatial Descriptor
3	**Landscape** - The impact could affect all areas generally visible to the naked eye, as well as those areas essentially linked to the site in terms of ecosystem functioning.
2	**Local** - The impacted area extends slightly further than the actual physical disturbance footprint and could affect the whole, or a measurable portion of adjacent areas.
1	**Site Related** - The impacted area extends only as far as the activity e.g. the footprint; the loss is considered inconsequential in terms of the spatial context of the relevant environmental or social aspect.

Severity / Intensity / Magnitude

This provides a qualitative assessment of the severity of a predicted impact / effect. A series of standard terms and ratings used in this assessment which relate to the magnitude of an impact / effect are outlined in Table 3.

Table 3: Rating scale for the assessment of the severity / magnitude of a predicted effect / impact

Rating	Magnitude Descriptor
7	**Total / consuming / eliminating** - Function or process of the affected environment is altered to the extent that it is permanently changed.
6	**Profound / considerable / substantial** - Function or process of the affected environment is altered to the extent where it is permanently modified to a sub-optimal state.
5	**Material / important** - The affected environment is altered, but function and process continue, albeit in a modified way.
4	**Discernible / noticeable** - Function or process of the affected environment is altered to the extent where it is temporarily altered, be it in a positive or negative manner.
3	**Marginal / slight / minor** - The affected environment is altered, but natural function and process continue.
2	**Unimportant / inconsequential / indiscernible** - The impact temporarily alters the affected environment in such a way that the natural processes or functions are negligibly affected.
1	**No effect / not applicable**

Duration

This describes the predicted lifetime / temporal scale of the predicted impact. A series of standard terms and ratings used in this assessment are included in Table 4.

Table 4: Rating scale for the assessment of the temporal scale of a predicted effect / impact

Rating	Temporal Descriptor
7	**Long term** – Permanent or more than 15 years post decommissioning. The impact remains beyond decommissioning and cannot be negated.
3	**Medium term** – Lifespan of the project. Reversible between 5 to 15 years post decommissioning.

Rating	Temporal Descriptor
1	**Short term** – Quickly reversible. Less than the project lifespan. The impact will either disappear with mitigation or will be mitigated through natural process in a span shorter than any of the project phases or within 0 -5 years.

Irreplaceable Loss of Resources

Environmental resources cannot always be replaced; once destroyed, some may be lost forever. It may be possible to replace, compensate for or reconstruct a lost resource in some cases, but substitutions are rarely ideal. The loss of a resource may become more serious later, and the assessment must take this into account. A series of standard terms and ratings used in this assessment are included in Table 5.

Table 5: Rating scale for the assessment of loss of resources due to a predicted effect / impact

Rating	Resource Loss Descriptor
7	**Permanent Loss** – The loss of a non-renewable / threatened resource which cannot be renewed / recovered with, or through, natural process in a time span of over 15 years, or by artificial means.
5	**Long Term Loss** – The loss of a non-renewable / threatened resource which cannot be renewed / recovered with, or through, natural process in a time span of over 15 years, but can be mitigated by other means.
4	**Loss of an 'at risk' resource** - one that is not deemed critical for biodiversity targets, planning goals, community welfare, agricultural production, or other criteria, but cumulative effects may render such loss as significant.
3	**Recoverable Loss** – The resource can be recovered within the lifespan of the project. The resource can be renewed / recovered with mitigation or will be mitigated through natural process in a span between 5 and 15 years.
2	**Loss of an 'expendable' resource** - one that is not deemed critical for biodiversity targets, planning goals, community welfare, agricultural production, or other criteria.
1	**Minimal Loss** – Quickly recoverable. Less than the project lifespan. The resource can be renewed / recovered with mitigation or will be mitigated through natural process in a span shorter than any of the project phases, or in a time span of 0 to 5 years.

Reversibility / potential for rehabilitation

The distinction between reversible and irreversible impacts is a very important one and the irreversible impacts not susceptible to mitigation can constitute significant impacts in an EIA (Glasson *et al*, 1999). The potential for rehabilitation is the major determinant factor when considering the temporal scale of most predicted impacts. A series of standard terms and ratings used in this assessment are included in Table 6.

Table 6: Rating scale for the assessment of reversibility of a predicted effect / impact

Rating	Reversibility Descriptor
7	**Not Reversible** – The impact / effect will never be returned to its benchmark state.
3	**Medium Term Reversibility** – The impact / effect will be returned to its benchmark state through mitigation or natural processes in a span shorter than the lifetime of the project, or in a time span between 5 and 15 years.
1	**Short Term Reversibility** – The impact / effect will be returned to its benchmark state through mitigation or natural processes in a span shorter than any of the phases of the project, or in a time span of 0 to 5 years.

Probability

The assessment of the probability / likelihood of an impact / effect has been undertaken in accordance with ratings and descriptors provided in Table 7.

Table 7: Rating scale for the assessment of the probability of a predicted effect / impact

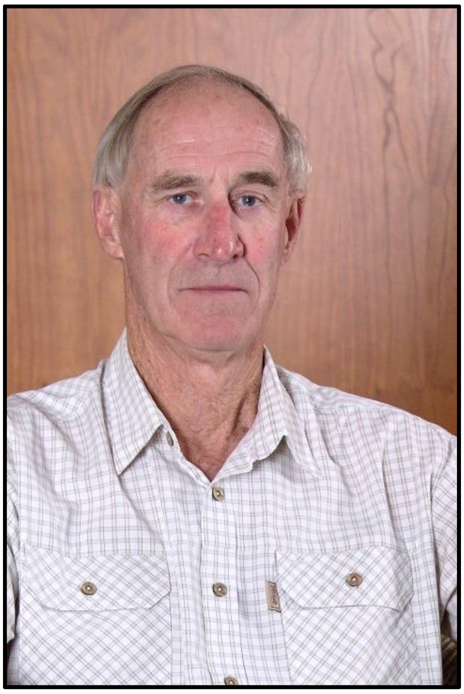
Rating	Probability descriptor
1.0	Absolute certainty / will occur
0.9	Near certainty / very high probability
0.7 – 0.8	High probability / to be expected
0.4 - 0.6	Medium probability / strongly anticipated
0.3	Low probability / anticipated
0.2	Possibility
0.0 - 0.1	Remote possibility / unlikely

Mitigation

In terms of the assessment process the potential to mitigate the negative impacts is determined and rated for each identified impact and mitigation objectives that would result in a measurable reduction or enhancement of the impact are taken into account. The significance of environmental impacts has therefore been assessed taking into account any proposed mitigation measures. The significance of the impact "without mitigation" is therefore the prime determinant of the nature and degree of mitigation required.

ANNEXURE B – CURRICULUM VITAE: D.J. ALLETSON

DACRE JAMES ALLETSON



Profession	*ENVIRONMENTAL SCIENTIST*
Position in Firm	*Wetland and Biodiversity Specialist*
Area of Specialisation	*PRELIMINARY ENVIRONMENTAL ASSESSMENT, TERRESTRIAL FAUNA AND FLORA SURVEYS, AQUATIC BIODIVERSITY SURVEYS, WETLAND DELINEATION AND ASSESSMENT, ENVIRONMENTAL CONTROL OFFICER DUTIES; ENVIRONMENTAL MANAGEMENT PROGRAMMES, ENVIRONMENTAL IMPACT ASSESSMENTS, SCOPING REPORTS*
Qualifications	*BSc, BSc (Hons)*
Years of Experience	*50*
Years with Firm	*11*

SUMMARY OF EXPERIENCE

Mr Alletson has long experience in the fields of conservation and management of the natural environment and has specialised in aquatic species and systems. After graduating he was employed at the Oceanographic Research Institute in Durban where he worked on a number of projects in both the estuarine and marine environments. In 1975 he joined to the Natal Parks Board where he served for 21 years in a number of positions. His activities in this time included research and management of certain fish species, management of a trout hatchery, provision of an extension service relating to wetlands and rivers, and participation in management of game and nature reserves, including drafting of management plans. From 1984 onwards he served as the Board's River and wetland specialist ecologist and was involved in wetland-related research and management activities.

In 1997 he formed Alletson Ecologicals, an environmental consultancy and has undertaken a wide variety of environmental investigation and monitoring programmes. Amongst these are some 100 Environmental Impact Assessments which ranged from developments such as timber planting permits, gravel pits, and irrigation dams, through to coal mines, large state dams, housing schemes, private property developments, and pipelines.

Mr Alletson has also taken part in regional planning studies for the Town and Regional Planning Commission and has contributed toward integrated management plans for conservation areas and projects.

Since 2012 Mr Alletson has worked with JG Afrika (previously Jeffares & Green (Pty) Ltd) and has, amongst other activities undertaken numerous wetland delineations and assessments, and also aquatic surveys for river health assessments and Water Use Licence applications. He also undertakes terrestrial biodiversity surveys as components of impact assessments, planning projects, and monitoring programmes.

EDUCATION

Date (from – to):	1966-1969
Degree/Institution:	BSc – Biological Sciences (University of Natal – now University of KwaZulu-Natal)
Date (from – to):	1972
Degree/Institution:	B.Sc Honours – Zoology (Rhodes University)
Other Training:	**1974:** Basic Business Management - Durban Technical College
	1983: Public Speaking and Visual Aid Preparation - Natal Parks Board.
	1985: Grassland Management and Assessment - Natal Parks Board.
	1998: SASS Biomonitoring Procedure for Assessment of River Health - Umgeni Water.
	1970: Small Craft Skipper's Certificate, and Port of Durban Operators Certificate.
	2015: Wetland Buffer Determination Course – Water Research Commission.
	2018: Biodiversity Offset Training Course – South African National Biodiversity Institute.
	2020 – 2023: Webinars from IAIAsa, SACNASP, and various scientific specialists

EMPLOYMENT RECORD

Date (from – to)	1966 - 1968
Location	Durban, South Africa
Employer	Oceanographic Research Institute
Position(s)	Student Assistant/Intern during university vacations
Description	Assistant on marine and estuarine research programmes.

Date (from – to)	1969 - 1971
Location	Durban, South Africa
Employer	Oceanographic Research Institute
Position(s)	Research Technician

Description	Provision of technical assistance on marine and estuarine research programmes. Also took part in collection of live specimens for display in the Durban Oceanarium.
Date (from – to)	1972
Location	Rhodes University, Grahamstown, South Africa
Position(s)	Student
Description	BSc Honours
Date (from – to)	1973 - 1975
Location	Durban, South Africa
Employer	Oceanographic Research Institute
Position(s)	Research Officer
Description	Conducted research on commercially exploited deep sea crustaceans and assisted with other marine research programmes.
Date (from – to)	1975 – 1996
Location	KwaZulu-Natal, South Africa
Employer	Natal Parks Board
Position(s)	Research Officer
Description	Research and management relating to conservation of rivers, wetlands, and aquatic species. Contribution relevant inputs to an extension programme for landowners, and to management of aquatic systems in game and nature reserves. Also undertook conservation planning and developed the KwaZulu-Natal Environmental Atlas.
Date (from – to)	1997 – present
Location	Pietermaritzburg, KwaZulu-Natal, South Africa
Employer	Alletson Ecologicals
Position(s)	Environmental Scientist
Description	The consultancy has undertaken many environmental consulting projects for various clients, and provides almost full time biodiversity and wetland related service to JG Afrika (Pty) Ltd

SPECIFIC EXPERIENCE

Name of Project:	**Assessment of the Terrestrial Biodiversity at the site of the proposed Umzimkhulu Bulk Water Supply Scheme near Underberg, Kwazulu-Natal**
Client:	(Final Client) Umgeni Water, Pietermaritzburg
Project duration/date:	2022 - 2023
Job Title and Duties:	Terrestrial Biodiversity Specialist.

	Undertook terrestrial faunal and floral surveys in relation to the construction of a dam on the Umzimkhulu River, and the associated water treatment works and bulk potable water pipeline. Study included impact assessments and management/mitigation recommendations.
Name of Project:	**Assessment of the aquatic ecosystems at the site of the proposed Umzimkhulu Bulk Water Supply Scheme near Underberg, Kwazulu-Natal**
Client:	(Final Client) Umgeni Water, Pietermaritzburg
Project duration/date:	2022 - 2023
Job Title and Duties:	Aquatic Specialist. Undertook aquatic faunal and floral surveys in relation to the construction of a dam on the Umzimkhulu River, and the associated water treatment works and bulk potable water pipeline. Study included impact assessments and management/mitigation recommendations. The Department of Water Affairs and Sanitation Risk Assessment Matrix was included.
Name of Project:	**Assessment of the terrestrial biodiversity at the site of a proposed new dam on the Farm Glen Locky Near Franklin, Kwazulu-Natal**
Client:	Memeza Farming (Pty) Ltd, Franklin
Project duration/date:	2022 - 2023
Job Title and Duties:	Terrestrial Biodiversity Specialist. Undertook terrestrial faunal and floral surveys in relation to the construction of a dam on the Mzintlava River. Study included specialist species of conservation concern assessments, impact assessments, and management/mitigation recommendations.
Name of Project:	**Assessment Of The Wetlands At The Site Of A Proposed New Dam On The Farm Glen Locky Near Franklin, Kwazulu-Natal**
Client:	Memeza Farming (Pty) Ltd, Franklin

Project duration/date:	2022 - 2023
Job Title and Duties:	Aquatic Specialist. Undertook aquatic faunal and floral surveys in relation to the construction of a dam on the Mzintlava River. Study included impact assessments and management/mitigation recommendations. The Department of Water Affairs and Sanitation Risk Assessment matrix was included.
Name of Project:	**Desktop wetland screening and classification assessment on various properties within the Umdloti, Tongaat and Umhlali Catchment Areas for suitability to meet offsite wetland mitigation obligations for Dube Tradezone 2, Agrizone 2, Support Zone 2 And Tradezone 3**
Client:	Dube TradePort Corporation
Project duration/date:	2020 to 2021 Ongoing
Job Title and Duties:	Wetland and Biodiversity Specialist Screening of three wetland sites for possible use in offsetting wetland loss at the Dube TradePort Complex and then putting forward selection recommendations.
Name of Project:	**Assessment of the wetlands in the vicinity of the Lafarge Cement Factory In Lichtenburg together with management recommendations**
Client:	Greenmined Environmental
Project duration/date:	January April 2021
Job Title and Duties:	Wetland and Biodiversity Specialist A section of wetland that has been infilled is to be rehabilitated or the damage repaired. The findings of a survey and management recommendations are put forward.
Name of Project:	**Assessment of two wetlands in the vicinity of the Lafarge Tswana Limestone Mine near Bodibe in relation to a Water Use Licence Application**
Client:	Greenmined Environmental

Project duration/date:	January April 2021
Job Title and Duties:	Wetland and Biodiversity Specialist The wetlands in and around the mine, including a small river, were assessed and modelled. The findings of the survey included management recommendations which were partly based on the DWS Risk Assessment Matrix.
Name of Project:	**Findings of an aquatic survey done in regard to the upgrading of a rural water supply scheme on the Ibisi River, KwaZulu-Natal**
Client:	SiVEST SA (Pty) Ltd
Project duration/date:	April - May 2021
Job Title and Duties:	Wetland Specialist Undertaking the wetland specialist study in support of the application for environmental authorisation for a water scheme upgrade.
Name of Project:	**Consideration of the possible risks to wetlands and watercourses along the routes of the bulk pipelines of the proposed Gunjana Community Water Scheme upgrade**
Client:	JG Afrika (Pty) Ltd
Project duration/date:	June to July 2020
Job Title and Duties:	Wetland Specialist Construction and upgrade of a rural potable water scheme near Pomeroy, KwaZulu-Natal, is planned. In terms of the National Water Act, 1998 (Act No. 36 of 1998) attention must be given to wetlands and watercourses as a Water Use Licence may be necessary. This study assesses the watercourse crossings and the risks posed to the aquatic systems. It then puts forward a series of management recommendations.
Name of Project:	**Consideration of the possible risks to wetlands and watercourses as a result of upgrading two sections of Road P419 Near Bulwer, Kwazulu-Natal**
Client:	Ilifa Africa Engineers (Pty) Ltd

Project duration/date:	March – April 2020
Job Title and Duties:	Wetland Specialist A total of 10 km of road which was to be upgraded from a gravel surface to a tar surface were surveyed. Some 19 watercourse crossings were found although most were small seasonal channels. No wetlands were crossed but, in keeping with the National Water Act (Act No. 36 of 1998), wetlands within 500 m of the site were examined and one required management recommendations for the road construction phase.
Name of Project:	**Southport Housing Project Vegetation and Estuarine Survey**
Client:	**Private landowner**
Project duration/date:	2019
Job Title and Duties:	Wetland and Vegetation Specialist. The vegetation at the site of a proposed housing project, as well as a nearby stream and the Umhlangamkulu River Estuary were surveyed and assessed. Management recommendations were put forward.
Name of Project:	**Assessment of the terrestrial biodiversity in relation to the upgrade of a treatment works and a new potable water pipeline near Moyeni/Zwelisha, Kwazulu-Natal**
Client:	JG Afrika (Pty) Ltd
Project duration/date:	April 2021 - ongoing
Job Title and Duties:	Biodiversity and Wetland Specialist The terrestrial and aquatic biodiversity in the vicinity of a water treatment works and along a new bulk main pipeline have been assessed and management recommendations are put forward.
Name of Project:	**Road R61 Upgrade**
Client:	SANRAL SOC
Project duration/date:	2019

Job Title and Duties:	Wetland and Biodiversity Specialist. The rivers, wetlands, and vegetation along a 24 km section of Road R61 were surveyed and assessed together with a vegetation specialist. Especial attention was given to the larger rivers as their nearby estuaries are of high importance. Management recommendations were put forward.
Name of Project:	**Widening of the N2 Freeway between the Isipingo Interchange and the Edwin Swales Interchange**
Client:	SANRAL SOC
Project duration/date:	2020
Job Title and Duties:	Wetland and Biodiversity Specialist. The rivers, wetlands, and vegetation along a 12 km section of National Road N2 (Section 25), including the Higginson Highway Interchange, were surveyed and assessed. Especial attention was given to watercourse crossings and to the Umhlatuzana and Mbilo Rivers as they are of high importance since they discharge into Durban Bay. Management recommendations were put forward.
Name of Project:	**Assessment of the possible risks to Wetlands and Watercourses as a result of the construction of the Greater Kilimon Water Scheme near Coleford, Kwazulu-Natal**
Client:	iMvula Engineers
Project duration/date:	December 2019 – April 2020
Job Title and Duties:	Biodiversity, Wetland and River Specialist. The routes of some 82 km of pipelines as well as the sites of 11 reservoirs, a water abstraction works, and a water treatment works were assessed in regard to biodiversity, wetlands and watercourses. The work was done for both EIA and Water Use Licence purposes. The report included management recommendations as well as risk assessment.
Name of Project:	**Consideration of Impacts, and Determination of a Possible Offset Area, in Relation to the Proposed Sokhulu Agricultural Project**
Client:	Department of Rural Development and Land Affairs

Project duration/date:	2018
Job Title and Duties:	Wetland Specialist. Surveys of wetlands on the Mfolozi/Umsunduze rivers floodplain were undertaken in relation to rehabilitation of an old agricultural project. Management recommendations were prepared and wetlands offsets were proposed.
Name of Project:	**Biodiversity, River and Wetland Assessments associated with the proposed upgrade of housing and services in Ngwelezane, KwaZulu-Natal**
Client:	City of Mhlatuze
Project duration/date:	2018
Job Title and Duties:	Wetland and Biodiversity Specialist. Surveys were done on the wetlands and river in the vicinity of Ngwelezane in relation to the provision of new housing and municipal infrastructure.
Name of Project:	**Biodiversity and Wetland Survey for a Bulk Water Supply Upgrade for the Estcourt Industrial Area**
Client:	uThukela District Municipality
Project duration/date:	2017 - 2018
Job Title and Duties:	Wetland and Biodiversity Specialist. Conducted surveys along the routes of several pipelines. The wetlands were assessed, and management recommendations were put forward.
Name of Project:	**Wetlands Search and Delineation Along the Route of a Proposed New Bulk Raw Water Supply Pipeline from Spioenkop Dam to Ladysmith Water Treatment Works**
Client:	uThukela District Municipality
Project duration/date:	2015
Job Title and Duties:	Wetland Specialist.

	Searches for wetlands along the proposed pipeline route were undertaken and the systems found were delineated and assessed. Terrestrial biodiversity surveys were also undertaken at the same time.
Name of Project:	**Biodiversity Assessment – Proposed New Durban Dig-out Container Port**
Client:	Transnet SOE
Project duration/date:	2012 - 2013
Job Title and Duties:	Survey Team Leader. Assembled a team of biodiversity specialist to undertake surveys of the terrestrial biodiversity (mammals, birds, reptiles, amphibians, vegetation) and wetland biodiversity at the site of the old Durban Airport in relation to the proposed excavation of a new container shipping terminal. Also undertook wetland and biodiversity surveys and