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WITKOP FLUORSPAR MINE (PTY) LTD

VERDOORST KOLK PRA

Wetland Ecological Assessment Report

November 2017

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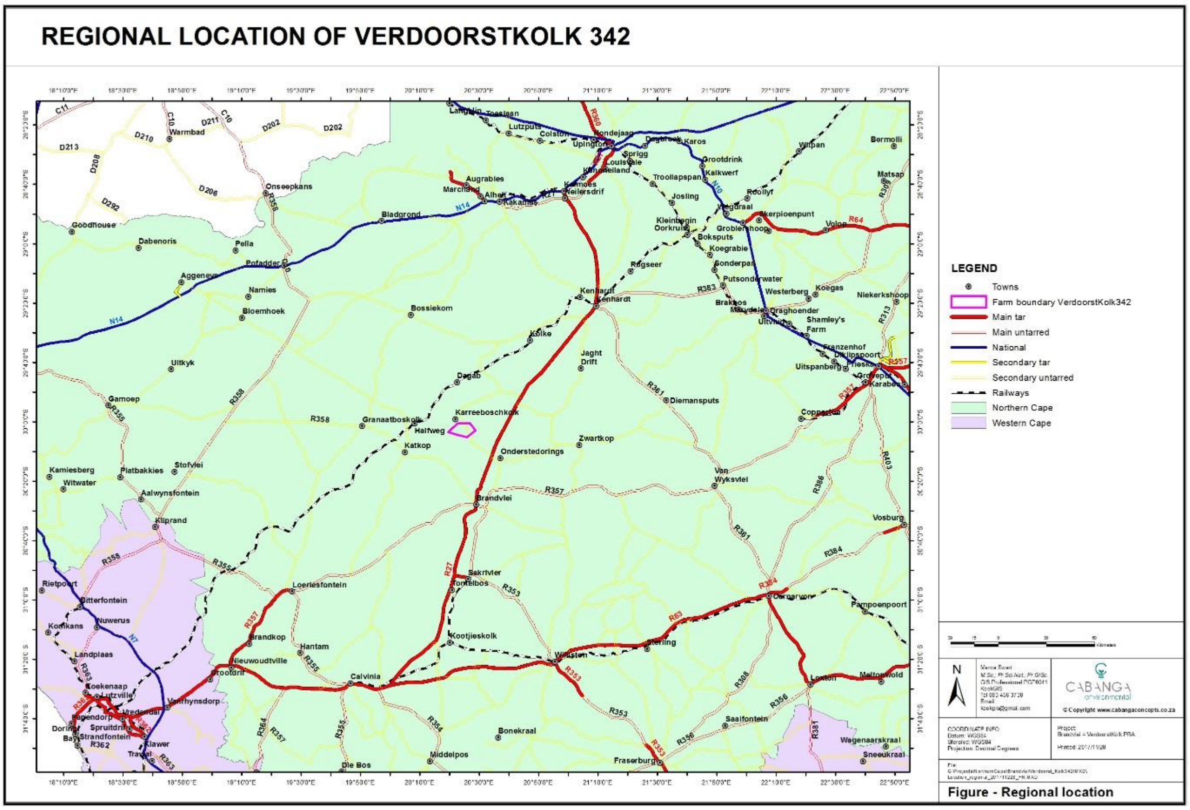
1 Introduction

Wetlands are sensitive ecosystems that perform many complex functions and supply important socially, ecologically and economically important goods and services (Kotze *et al.* 2009). The Ramsar Convention on Wetlands refers to wetlands as one of the most important life support systems on earth owing to the services provided. Wetlands are defined according to the National Water Act (NWA) (Act 36 of 1998) as: "*land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil*."

Depressions (pans) are specific types of wetlands that are classified as shallow, usually oval or round, depressions that typically undergo phases of complete desiccation, though some may be continuously inundated (Allan *et al*. 1995). Their endorheic (inward draining) and ephemeral (temporary) state results in fluctuations in water quality ranging from very low to high conductivity due to fresh rainfall and evaporation respectively (de Klerk, 2012). Furthermore, these characteristics increase the vulnerability of such wetlands to development within its catchment (Henri *et al*., 2013). Salt pans are the common type of depression wetlands that characterise arid to hyper-arid regions of Southern Africa, which are diverse in nature.

Wetlands of all kinds in South Africa have been poorly conserved in general owing primarily to a general underestimation of the ecological and economic importance of these systems (Swanepoel and Barnard, 2007). Some of the major contributing factors to the decline of wetlands in South Africa include agriculture, mining, industrial activities and urban and rural human development (Oberholster *et al.*, 2011). Impact assessments are an important process in which to identify risks to wetlands posed by a specific proposed activity in order to minimise and mitigate any further negative impacts to these nationally important ecosystems.

This report thus serves to detail the findings of a wetlands ecological, risk and impact assessment for the proposed prospecting for gypsum in the salt pan known as Verdoorskolk near the town of Brandvlei in the Northern Cape (Plan 1).



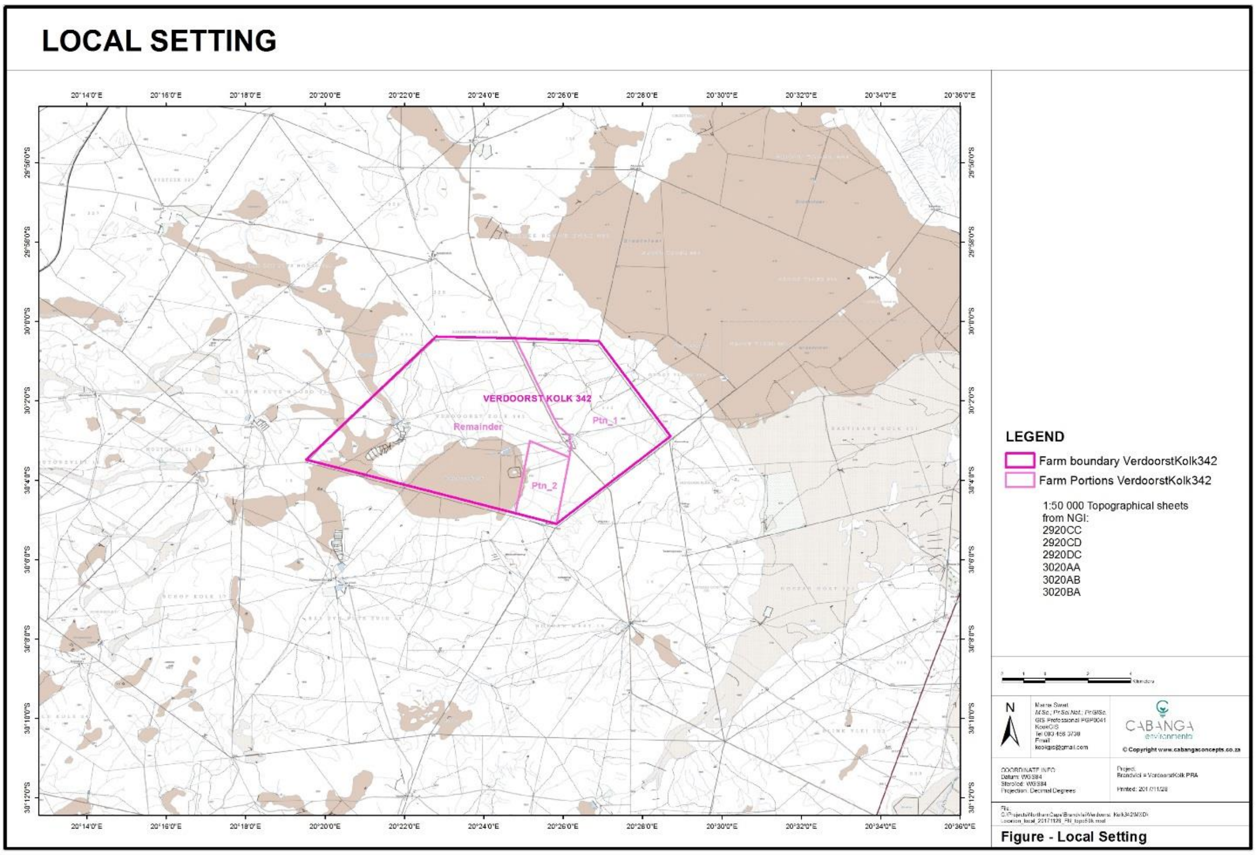
Plan 1: Regional Overview

2 Scope of Works

2.1 Project Overview

Witkop Fluorspar Mine (Pty) Ltd (hereafter Witkop) are investigating an area in the Northern Cape for Gypsum and thus have submitted an application for a Prospecting Right in terms of the Minerals and Petroleum Resources Development Act, Act 28 of 2002 (MPRDA) over Portions 1, 2 and the Remaining Extent of the farm Verdoorst Kolk No. 342. The proposed Prospecting Right Area comprises approximately 8,224 hectares and is located between the towns of Kenhardt and Brandvlei, within the Hantam Municipality of the Northern Cape Province (Plan 2).

Prospecting activities will consist of both non-invasive and invasive techniques as further described in Section 6.1. The results of the Prospecting investigations will be used to quantify the gypsum reserve and the economic feasibility of mining these in future.



Plan 2: The Local study area

2.2 Terms of Reference

Cabanga Environmental (hereafter Cabanga) was appointed by Witkop as the Environmental Assessment Practitioners (EAP) responsible for undertaking the necessary environmental studies as required in terms of the National Environmental Management Act, Act 107 of 1998 (NEMA) and the MPRDA. In terms of NEMA, a Basic Assessment (BA) process is applicable to the application process.

As part of the requirements of the BA, a wetland assessment is required according to best practice as the prospecting area involves a salt pan.

2.3 Aims and Objectives

The aim of the wetlands assessment is to provide a succinct report and accompanying maps describing the following:

- Delineation and ecological description of the pan;
- Assessment of the wetland Present Ecological Status (PES) and Ecological Importance and Sensitivity (EIS) using accepted methodologies;
- Completion of the Section 21 c & i Risk Assessment using the DWS Risk Assessment Protocol;
- Impact assessment for the pan from the proposed prospecting for scenarios before and after mitigation measures; and

- Discussion of recommended mitigation measures to be guided by the mitigation hierarchy.

2.4 Expertise of the Specialist

Caroline Wallington: received a Bachelor of Science and Honours in Botany from the University of Cape Town (UCT) and is currently completing her MSc in Environmental Science at the University of the Witwatersrand part time. Caroline is a registered Professional Natural Scientist (**Pr.Sci.Nat.)** in **Ecological Science**; registration number 116313. She is an environmental consultant specialising in baseline wetland assessments required for various environmental authorisation processes. She also does terrestrial floral assessments, biodiversity evaluations, land management plans and land rehabilitation. Caroline is competent in wetland assessment methodology and has experience in most Provinces of South Africa as well as in other African countries, including Malawi, Senegal and the Democratic Republic of Congo (DRC).

3 Methodology

In order to achieve the above mentioned aims and objectives, the methodologies as described in detail below were employed.

3.1 Literature Review

The following national and regional reports and spatial layers were reviewed to understand the freshwater and ecological context within which the pan wetlands are found including:

- The National Freshwater Ecosystem Priority Area (NFEPA) Project (Nel et al., 2011);
- National Vegetation Types (Mucina and Rutherford, 2012);
- Namakwa District Biodiversity Sector Plan (NDBSP, 2008).

Furthermore, specialist studies that were reviewed and findings incorporated herein include:

- Verdoorst Kolk Biodiversity Assessment (The Biodiversity Company, 2017).

3.2 Wetland Delineation and Ecological Assessments

The pan was assessed on site on 7th November 2017 to complete the below listed methodologies. The wetland ecological assessments completed include:

- Assess the wetland **Present Ecological Status** (PES) by conducting a Level 2 (in-field) WET-Health assessment according to Macfarlane et al. (2009). The health assessment attempts to evaluate the hydrological, geomorphological and vegetation health in three separate modules to attempt to estimate similarity to or deviation from natural conditions;
- The **Ecological Importance and Sensitivity** (EIS) of the pan will be determined according to updated methodology described by Rountree and Kotze (2013), which assesses the wetland's biodiversity, hydro-functional and human-derived benefits importance.
- In accordance with the **WET-EcoServices** method described by Kotze *et al.* (2009), an ecological functional assessment of the associated wetlands will be undertaken to

gain an understanding on the ecological goods and services (EcoServices) being provided by the pan in the catchment and watershed;

Refer to Appendix 1for more information regarding these methodologies.

3.3 DWS 21 c and i Risk Assessment

The risk assessment for the proposed project was completed according to the DWS 2015 publication for Section 21 c and i water use Risk Assessment Protocol, which is summarised in Appendix A of Government Gazette No. 40229 (DWS, 2016). The Risk Assessment must be conducted by a suitably qualified SACNASP professional who must:

- Consider both construction and operational phases of proposed activities;
- Consider risks to resource quality post-mitigation considering measures listed in the tables provided;
- Consider the sensitivity (EIS) and the status (PES) of the watercourse as receptor or risks posed;
- Consider positive impacts/ risk reduction as a very low risk in this assessment;
- Indicate confidence level of scores provided in the last column as a percentage;

Only low risk activities will quality for a GA where Medium and High risk activities will require a Section 21 (c) and (i) water use license. The table of rating classes is shown below.

Rating	Class	Management Description
1 – 55	**Low Risk (L)**	Acceptable as is or consider requirement for mitigation. Impact to watercourse and resource quality is small and easily mitigated.
56 – 169	**Medium Risk (M)**	Risk and Impact in watercourses are notable and require mitigation measures on a higher level, which costs more and require specialist input. License required.
170 – 300	**High Risk (H)**	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. License required.

3.4 Impact Assessment

The impact assessment methodology (Table 1) aims to achieve the following: (1) identify the potential impacts of a proposed development on the environment (here the wetland ecosystems); (2) predict the probability of these impacts and (3) evaluate the significance of the potential impacts. The impacts are rated before and after the proposed mitigation measures using Table 1, Equation 1 and Equation 2.

Table 1: Impact Assessment Methodology used by Cabanga Environmental

The status of the impact		
Status		Description
Positive:		a benefit to the holistic environment
Negative:		a cost to the holistic environment
Neutral:		no cost or benefit
The duration of the impact		
Score	Duration	Description

1	Short term	Less than 2 years
2	Short to medium term	2 – 5 years
3	Medium term	6 – 25 years
4	Long term	26 – 45 years
5	Permanent	46 years or more
The extent of the impact		
Score	Extent	Description
1	Site specific	Within the site boundary
2	Local	Affects immediate surrounding areas
3	Regional	Extends substantially beyond the site boundary
4	Provincial	Extends to almost entire province or larger region
5	National	Affects country or possibly world
The reversibility of the impact		
Score	Reversibility	Description
1	Completely reversible	Reverses with minimal rehabilitation & negligible residual affects
3	Reversible	Requires mitigation and rehabilitation to ensure reversibility
5	Irreversible	Cannot be rehabilitated completely/rehabilitation not viable
The magnitude (severe or beneficial) of the impact		
Score	Severe/beneficial effect	Description
1	Slight	Little effect – negligible disturbance/benefit
2	Slight to moderate	Effects observable – environmental impacts reversible with time
3	Moderate	Effects observable – impacts reversible with rehabilitation
4	Moderate to high	Extensive effects – irreversible alteration to the environment
5	High	Extensive permanent effects with irreversible alteration
The probability of the impact		
Score	Rating	Description
1	Unlikely	Less than 15% sure of an impact occurring
2	Possible	Between 15% and 40% sure of an impact occurring
3	Probable	Between 40% and 60% sure that the impact will occur
4	Highly Probable	Between 60% and 85% sure that the impact will occur
5	Definite	Over 85% sure that the impact will occur

Equation 1: Calculation of the Consequence Score for an impact in question

$$Consequence\ score = \text{Duration rating} + \text{Extent rating} + \text{Reversibility rating} + \text{Magnitude rating}$$

Equation 2: Calculation of final Impact Significance Score

$$Impact\ Significance\ rating = (Consequence\ Score) \times Probability$$

The rating is described as follows:

Score out of 100 (Equation 2 above)	Significance
1 to 20	Low
21 to 40	Moderate to Low

41 to 60	Moderate
61 to 80	Moderate to high
81 to 100	High

3.5 Assumptions and Limitations

The following assumptions accompany this report:

- The method statement received from Witkop at the time of writing the report was assumed to be accurate. Any changes to this may require changes to the findings of this report.
- Due to the large extent of the wetland and limited time, the areas where prospecting samples are planned was the focus of the rapid site assessment. The knowledge gained through the site visit was used then to extrapolate for areas not assessed.

The following knowledge gaps are to be noted as limitations to this study:

- A once off rapid site-visit was undertaken on 7th November 2017. At the time of sampling, the pan was completely dry and has been for at least five years due to very low rainfall. These systems are extremely ephemeral in that they only flood in rare high rainfall events in this hyper-arid region. Floral identification was therefore limited due to lack of characteristic features. Furthermore, many floral and faunal species will not be detectable as they will only appear in the presence of water. This significantly limits the biodiversity component of the assessment.
- The salt pans within the assessed vegetation type are called Bushmanland vloere according to Mucina and Rutherford (2006), where it is stated that these ecosystems are the least studied habitat type in the country. This lack of knowledge is a significant limitation to this ecological assessment and particularly limits the findings of the risk and impact assessment as their sensitivity are not well documented.
  - In order to assist with this, Dr. Betsie Milne, a wetlands ecologist in the Arids Lands Node of the South African Earth Observation Network (SAEON), was consulted for assistance as she is currently heading the national research on these systems.
  - The precautionary approach will therefore also be taken.

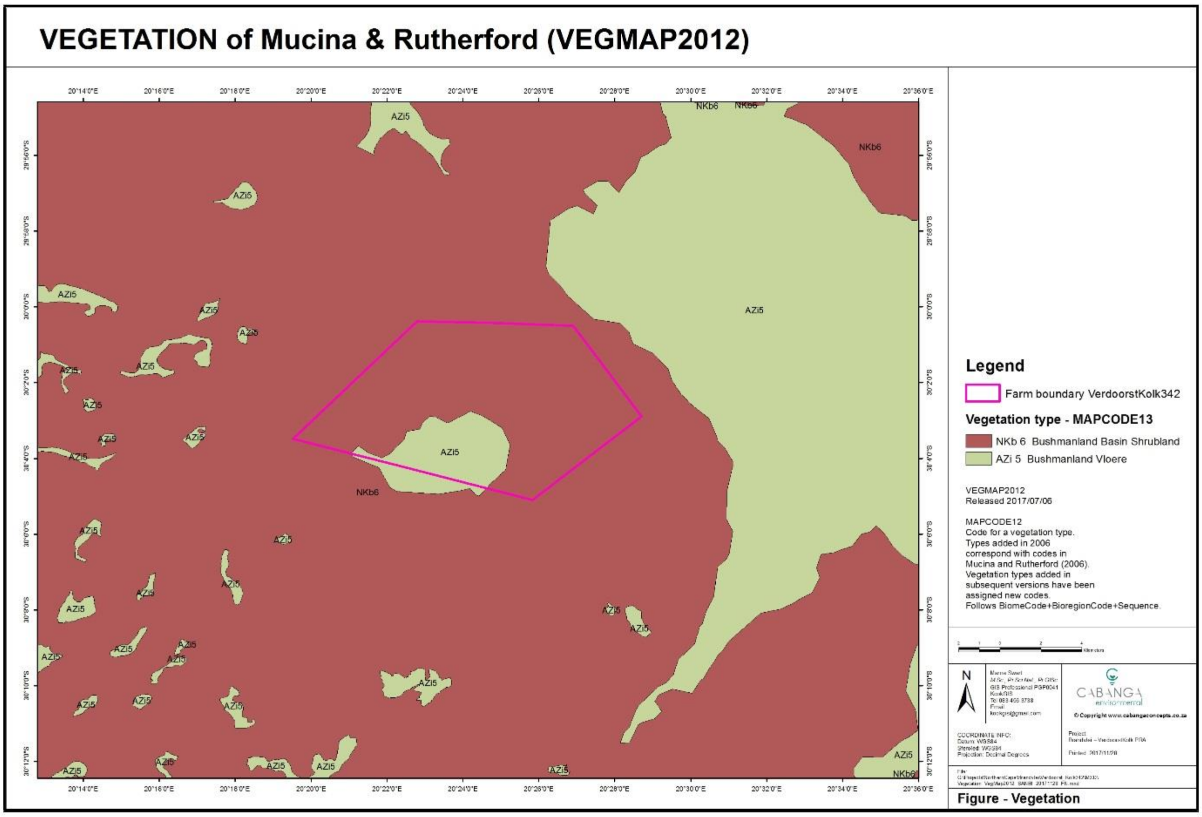
Therefore, the overall confidence level of the wetland assessment is **Moderate (60%)** due to the above.

4 Regional Setting Results

4.1 Vegetation Type

The study site is located in the Nama Karoo biome of the Northern Cape Province, and is associated with two nationally defined vegetation types being the Bushmanland Vloere (Azi5) and the Bushmanland Basin Shrubland (NKb6) (Mucina and Rutherford, 2012). The Vloere of the Northern Cape refer to the ephemeral pans and riverbeds of the Bushmanland basin, which represent the wetland ecosystems of this arid area and the focus of this report.

The floristic component and ecology of these Vloere are not well understood as it is the least studied vegetation type in the country where the dominant succulent shrub genus *Salsola* is pending taxonomic revision. However, in general the center of these pans (or the river drainage channel itself) are usually devoid of vegetation; where loosely patterned scrub are found around it are dominated by *Rhigozum trichotomum* and various species of *Salsola* and *Lycium*, with a mixture of nonsucculent dwarf shrubs of Nama-Karoo relationship. In places loose thickets of *Parkinsonia africana*, *Lebeckia lineariifolia* and *Acacia karoo* can be found (Mucina and Rutherford, 2006).



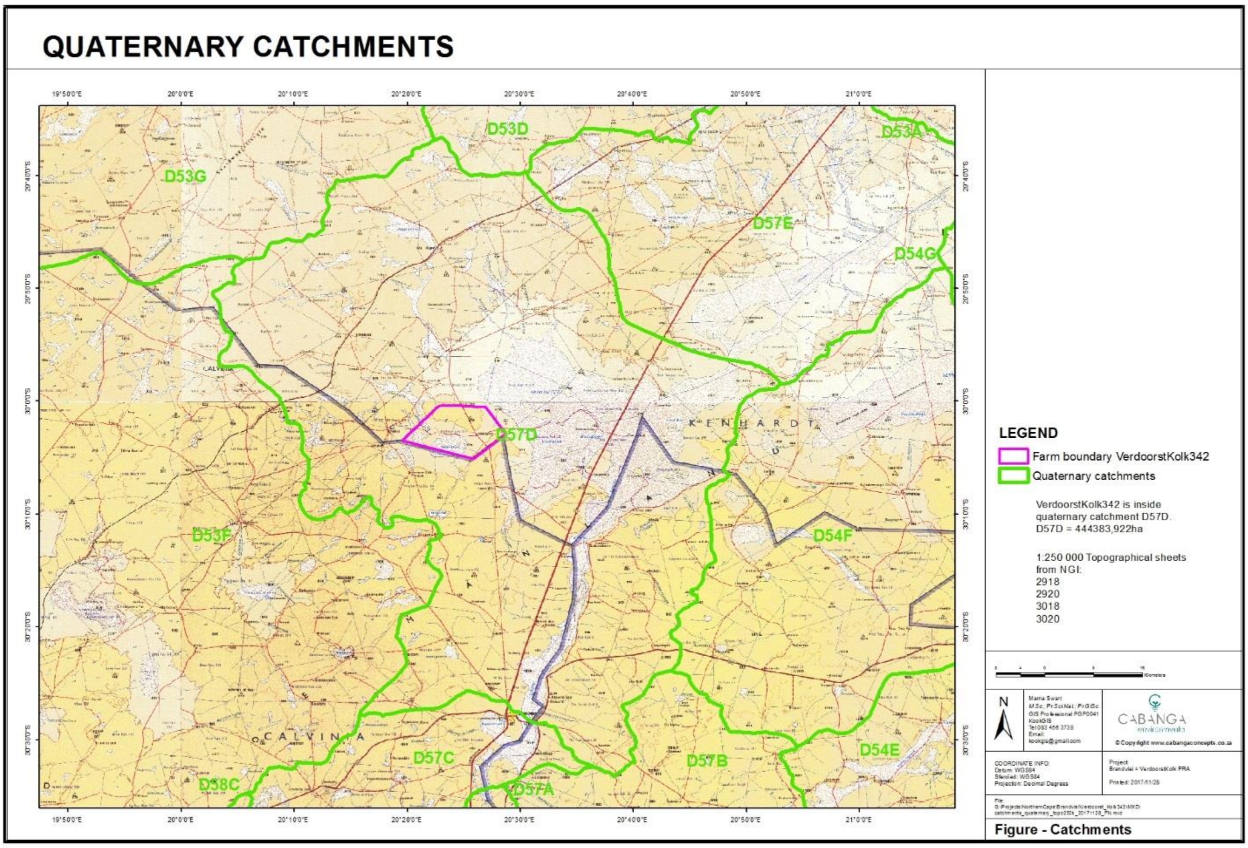
Plan 3: Vegetation Types (Mucina and Rutherford, 2006)

4.2 Climate and Catchment

The Bushamland region is characterized by an arid, seasonal climate with a bimodal precipitation regime – i.e. having two rain peaks, one in March and another in November.

Overall, the mean annual precipitation (MAP) is around 141 mm, which ranges from 91 mm in western Bushmanland to 306 mm at northern edges of the Roggeveld. The regions where the Bushmanland Vloere occur are known for thermic extremes, both annually and daily. Mean temperatures range from over 32°C to around zero in January to July where temperatures can have an amplitude (range) of around 25°C in one day. Frost occurrence is frequent in winter months.

The project area is located in the Lower Orange Water Management Area (WMA 6) and in the D57D quaternary catchment (Plan 4).



Plan 4: Quaternary Catchment

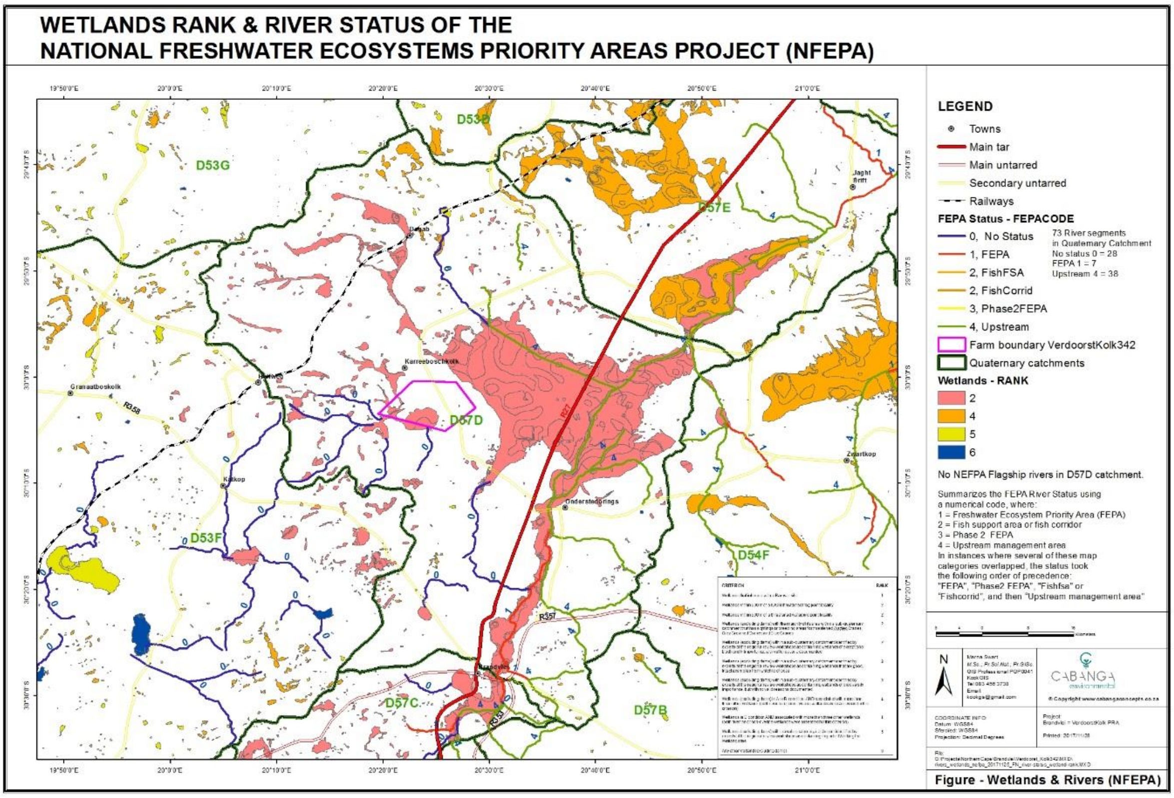
4.3 NFEPA Wetlands

The National Freshwater Ecosystem Priority Areas (NFEPA) project provides a collated, nationally consistent information source of wetland and river ecosystems for incorporating freshwater ecosystem and biodiversity goals into planning and decision-making processes (Nel, et al., 2011). The spatial layers (FEPA's) include the nationally delineated wetland areas that are classified into hydrogeomorphic (HGM) types and ranked in terms of their biodiversity importance (Table 7). This resource was consulted to evaluate the importance of the wetland areas located within the project area.

The pan associated with the study area as well as the drainage depression wetlands leading to it are assessed be **Rank 2** (Plan 5), which indicates that the wetlands are of very high national importance. The only wetlands that qualify for Rank1 are those associated with

Ramsar Wetlands of international importance; thus a Rank 2 is the highest possible rank for all other wetlands. A Rank 2 wetland means that the wetland qualifies for one or more of the following criteria:

- Wetlands within 500 m of an IUCN threatened frog point locality;
- Wetlands within 500 m of a threatened waterbird point locality;
- Wetlands (excluding dams) with the majority of their area within a sub-quaternary catchment that has sightings or breeding areas for threatened Wattled Cranes, Grey Crowned Cranes and Blue Cranes;
- Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands of exceptional Biodiversity importance, with valid reasons documented; and
- Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands that are good, intact examples from which to choose.



Plan 5: NFEPA Wetlands and Rivers

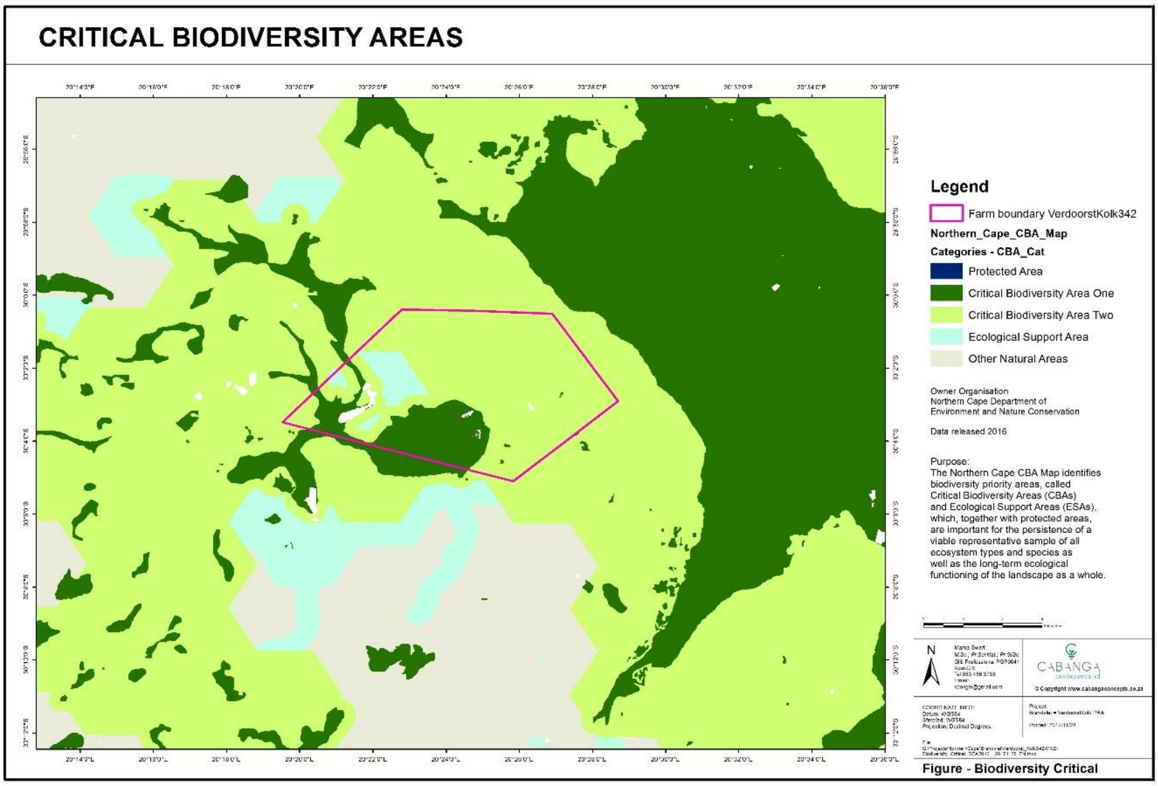
4.1 Regional Biodiversity Plans

The project area has been assessed for biodiversity importance at a local, district and provincial scales in the past decade. The plans have mapped areas within the region that have biodiversity importance and must be managed accordingly. These areas have been mapped from a combination of spatial layers resulting in importance as well as from expert opinion and include Critical Biodiversity Areas (CBA's) and Ecological Support Areas (ESA's). These areas must be protected to safeguard their role in maintaining critical ecosystem services

The Northern Cape Critical Biodiversity Areas was published in 2016 by the Northern Cape Department of Environment and Nature Conservation, which updates and replaces all older systematic biodiversity plans and associated products for the province, such as the Namakwa District Biodiversity Sector Plan (NDBSP, 2008) and the Cape Fine Scale Biodiversity Planning project (Ralston et al., 2009).

The vloere / salt pan and drainage areas (the wetlands) present in the study area was identified as a type 2 Critical Biodiversity Area (CBA2) by expert opinion (NDBSP, 2008). This area has been upgraded to **CBA1** in the updated Northern Cape plan. Therefore, the wetlands have been identified to be of the highest critical biodiversity importance in the area. Furthermore, much of the surrounding vegetation is mapped as **CBA 2** (Plan 6).

Thus, the habitat and biodiversity supported by this pan and its drainage areas is critical for the ecosystem functioning of the surrounding landscape and should be kept in natural state.



Plan 6: Northern Cape Critical Biodiversity Areas (2016)

5 Wetland Assessment Results

5.1 Delineation and Ecological Description

5.1.1 Delineation

The wetland site visit was undertaken on 9th November 2017 to ground-truth the above desktop findings and complete the ecological assessments. The wetland was dry at the time of sampling and has been so for at least five years – these systems are extremely ephemeral (intermittently wet). There are major limitations to completing a wetland assessment in dry conditions; however, by using a combination of detailed desktop review, in-field assessment, input from local land owners and expert opinion, an ecological health assessment can be completed with moderately high confident.

The nationally determined area of the wetland was found to be accurate; where the pan is ~ 1,582 ha in extent within a catchment of approximately 73,000 ha. In addition, there is a minimum of 800 ha of drainage wetlands found within this catchment draining into the pan, these are classified as valley floor depressions. The study area is focussed on the pan and some areas of the valley depressions close to the pan as this is where the proposed prospecting will take place. Associated with some of these drainage wetlands are non-perennial rivers. Refer to Plan 7 in Section 5.2 for the ecological delineation and Plan 8 in Section 0 for the proposed prospecting sampling layout.

5.1.2 Soils

Typically, these endorheic (inward draining) pans and associated intermittent rivers are filled with silty and clayey alluvial deposits with a high content of concentrated salt (sodic soils), supported by Ecca Group shales and Dwyka diamictites of the Karoo Supergroup (Mucina and Rutherford, 2006). Watkeys (1999) found that in the pan at Brandvlei, the orthic A horizon is underlain by a soft carbonate subsoil and the soils of the alluvial terraces of the Sak River are deep (more than 1 000 mm), stratified and weakly structured and calcareous.

The soils in the Verdoorskolk pan centre are similar to those described above. The upper soil horizon was relatively high in clay as large cracks are present in its dry condition also forming a crust layer (Figure 1a). The organic content of the soil increased down the soil profile as seen in the darker colour of the soil; also likely attributed to presence of manganese in the soil. The presence of calcite in these lower soil layers was very noticeable and crystallised full pieces were found (Figure 1 b-c). The indicator aquatic species are minute zooplankton called Branchiopods whose eggs are situated in the soil; although it is uncertain whether in the crust, lower layers or both and is currently under research (Milne, 2017, pers comm.).

The soils of the pan edges and in the drainage areas were slightly different to that of the pan centre as they were characterised often by the exposing or outcropping of the hard precipitate layers of either manganese, iron or calcium. Furthermore, these areas were more characterised by erosion than deposition of material and in many places the underlying shales were exposed and gave rise to sandy soils (Figure 1 d-f).

The soils of the Verdoorskolk pan were assessed and discussed in the BA report that can be referred to for greater detail (Cabanga, 2017).

Figure 1: Soils of the Verdoorskolk pan: a) high clay content in pan centre showing deep cracking, creating a crust layer; b) soil profile showing increasing organic content; c) presence of calcite; d + e) exposed hard iron and manganese precipitate layer over soft shales creating sandy soils in valley floor wetlands; f) outcropping of calcrete on edges

5.1.3 Vegetation

Floral observations and identifications were limited due to the extremely dry conditions present at the time of sampling. The pan centre appears to be devoid of vegetation; however it is dominated by many small shrubs of the *Salsola* genus (Figure 2). It is expected that many more species would appear in wet conditions. The pan was not entirely uniform as there was variation in the presence and density of vegetation, possibly in response to localised soil changes. The edges of the pan and valley floor drainage wetland areas had a different species composition and a higher species diversity than the central pan habitat - Figure 3.

Please note that a biodiversity assessment was completed by The Biodiversity Company and can be referred to for more detail (TBC, 2017).

Figure 2: Panoramic photo from centre of pan showing dry high clay soils (cracking) with sparsely distributed *Salsola* species shrubs

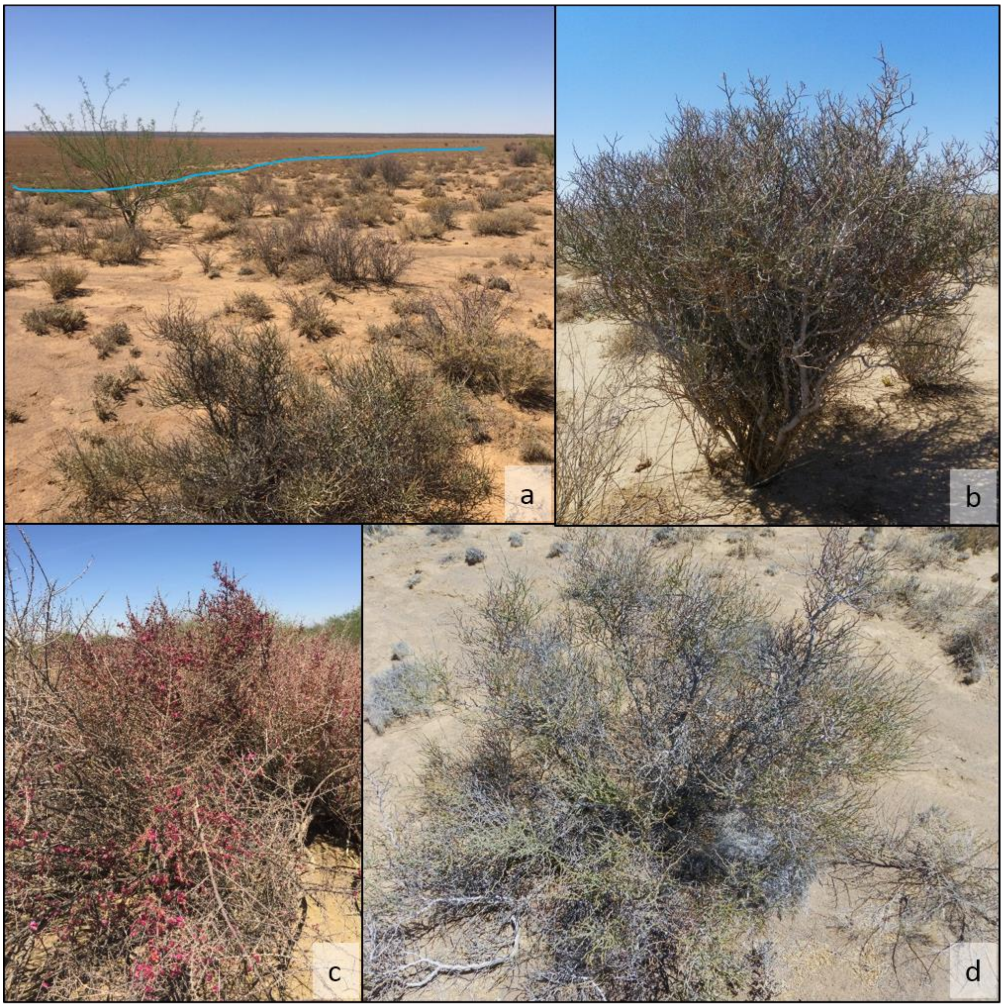


Figure 3: Examples of the flora found at the edge of the pan

5.2 Wetland Health Assessment (PES)

The site investigation and ecological assessments allowed the WET-Health methodology to be followed; however it must be noted that this methodology is not entirely suited to these systems and specialist interpretation was important in applying this methodology. The wetlands were divided into two units being the circular salt pan depression wetland as one and the drainage valley floor depressions as the other. These wetlands are functioning as a connected ecosystem within the catchment however they are slightly different from each other due to variation in vegetation composition, hydropedological functioning and dominant land uses occurring in the unit and thus they were assessed separately .

The pan was found to be in a near-pristine or natural condition (PES of A). The main impact to this area is two small old salt works at the eastern edge, which are still somewhat intact despite being abandoned for approximately 10 and 30 years (Figure 4a). There are some farm tracks which traverse some areas of this pan and around it; however these are not used very often and the farm occupants do not traverse over any other area of the pan to avoid disturbing the vegetation. No alien invasive species are present within the pan habitat but *Prosopis glandulosa* is present on the edges. Cattle farming occurs on the edge of the pan which will have some small impact on the pan and some evidence of cattle use of the pan was found. It can be concluded that the pan ecosystem struggles to regenerate from any impact due to the extreme climatic conditions; restoration of car tracks may occur during flood events.

The valley floor depression wetlands are in a largely natural condition (PES of B) with mostly intact soils and vegetation; however more land uses have been applied in these areas. The most widespread impact is the invasion of *Prosopis glandulosa*, which is a tree from South America and a declared category 3 invader in the region and thus should be actively removed from natural areas (Figure 4c). The valley floor areas have also been dammed in many areas of which most are abandoned and broken. In some areas there has been agricultural activities which has led to local soil disturbance and alteration of hydrological functioning. Again, most of these areas are not in use and have not been for decades but the scars of the disturbance are very clear due to passive restoration rates of these habitats being extremely slow in this area. Please refer to Figure 4 and Plan 7.

These wetlands as a whole system can be given an area weighted PES of A/B being largely natural (Table 2).

Table 2: Results of the WET-Health Assessment and PES

Wetland HGM Unit	Area (Ha)	Hydrology score	Geomorphology score	Vegetation score	Total Score	PES Category
Depression Wetland – Verdoors Kolk Salt Pan	1585	1.0	0.6	0.5	**0.7**	**A - Natural**
Valley Floor Depression Wetlands	±800	2.0	1.5	1.9	**1.8**	**B – Largely natural**
Area weighted impact scores		1.3	0.9	1.0	**1.1**	
PES Category		**B**	**A**	**A**	**A/B – Largely natural**	

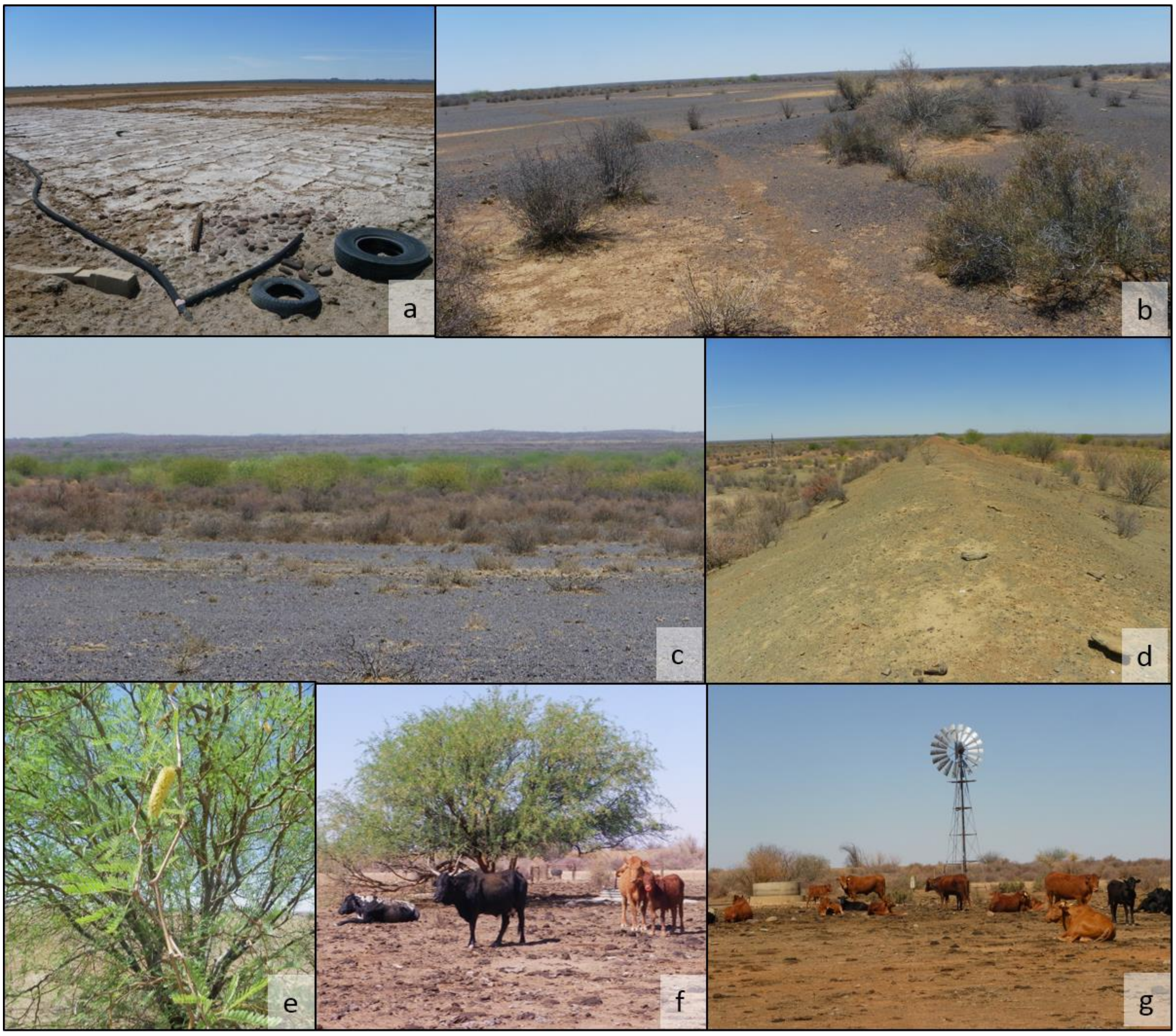
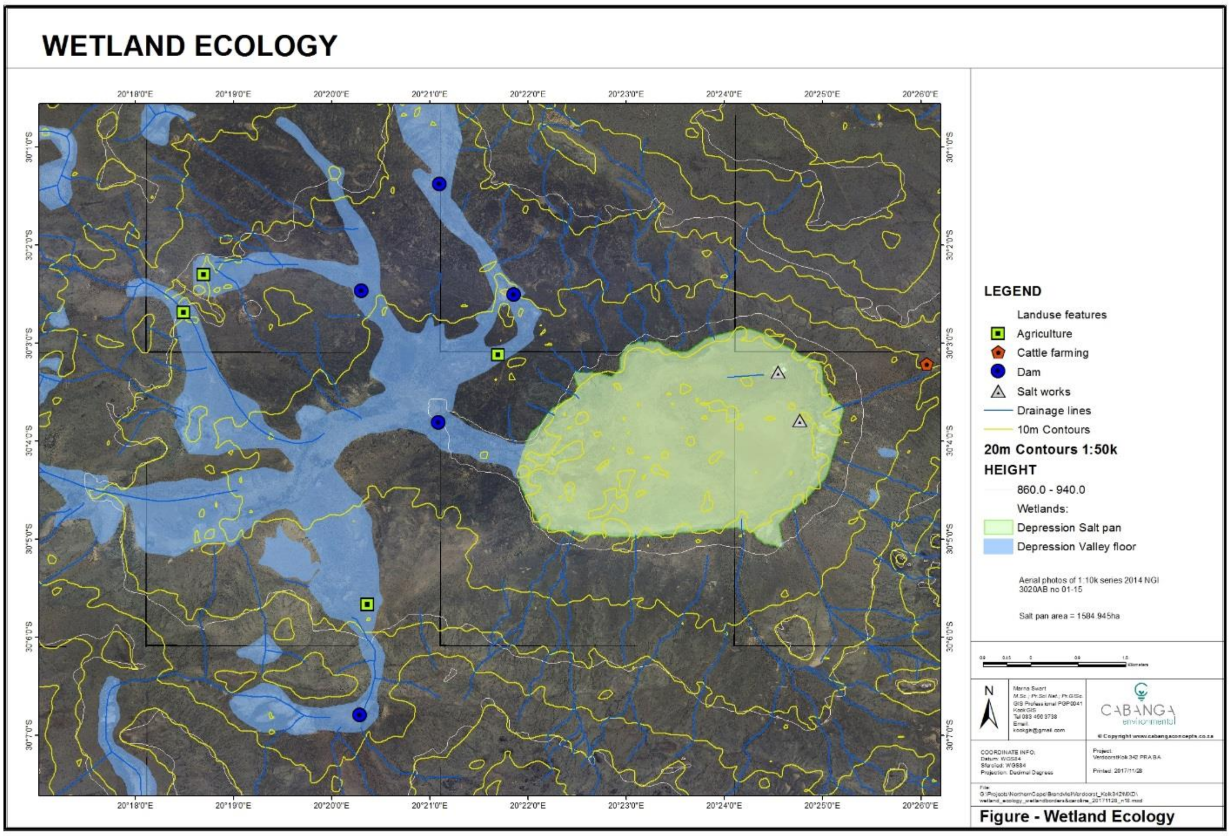


Figure 4: Evidence of land uses in and around the wetland leading to localised impacts: a) abandoned salt works; b) abandoned agriculture in upper drainage wetlands; c) invasion of *Prosopis glandulosa* in the valley floor drainage wetland areas as seen in green; d) dam walls across wetland; e & f) *P. glandulosa* and cattle farming; f) groundwater abstraction



Plan 7: Wetland Ecological Setting

5.3 Ecological Importance and Sensitivity (EIS)

The main importance of these pans is their role as ecological stepping-stone corridors in an arid landscape. These pans are significantly different from their surrounding habitat and provide unique and critical habitat for specially adapted aquatic biota and support the terrestrial species. The main aquatic organisms found within these systems are zooplankton, with Branchiopods being the indicator genus. These organisms are the main feeding source for many waterbirds such as Flamingos, who flock to feast on these systems when they are wet (Milne, 2017, pers comm.).

These pans are many times mistakenly regarded as lifeless wastelands because of their appearance; however, they harbour millions of eggs of these specialized aquatic organisms that can be dormant for decades until the pans receive enough rain for them to hatch (Milne, 2017 pers. comm). Furthermore, insects, frogs and other animals also come out in abundance during wet-periods. According to one of the farm managers, the Verdoorst Kolk pan is an impressive "inland lake" when flooded.

The methodology described by Rountree and Kotze (2013) assesses three aspects of wetland importance and sensitivity and both wetland units were determined to have their greatest significance in their Ecological and Biodiversity roles in the ecosystem, with the pan having an EIS of Very High and the drainage valley floor depressions being High (Table 3). Given that these systems are the only surface expression of water, albeit only in flood conditions, the hydrological and human benefit is also of importance. The valley floor depressions particularly so in that they drain into and feed the pan and provide damming capabilities. The main water source for land owners is borehole water, which is quite shallow as the borehole on Verdoorst Kolk farm has water at 4m.

Table 3: Results of Importance and Sensitivity scores for wetland units

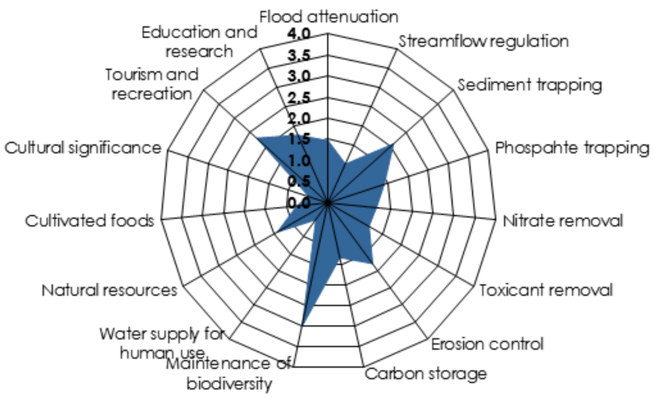
Aspect	Depression Wetland – Verdoorskolk Salt Pan	Valley Floor Depression Wetlands
Ecological Importance & Sensitivity	Very High (4.0)	High (3.0)
Hydrological/Functional Importance	Moderate (1.5)	High (2.4)
Direct Human Benefits	Moderate (2.0)	Moderate (1.7)

5.4 Ecosystem Goods and Services

In addition to the above methodology, WET-EcoServices allows for a further detailed analysis of the goods and services provided by the wetlands to the surrounding natural ecosystem and to land users, the results of which are summarised in Table 4 below. Similarly to the above findings, the most important role of these ecosystems is the maintenance of Biodiversity. Due to the presence of charismatic species such as flamingos and other rare birds during flood events, the potential role of tourism and recreation is of moderate-high importance. As the two wetland units as assessed herein are functioning as a single large ecosystem in a catchment of ±73,000 ha, the hydrological and pedological services provided by these units are important as they support the functioning of this critical biodiversity habitat.

Table 4: Extent of EcoServices supplied by both wetland units

Depression Wetland – Verdoorskolk Salt Pan



High benefit:

- Mainetenance of Biodiversity (3)

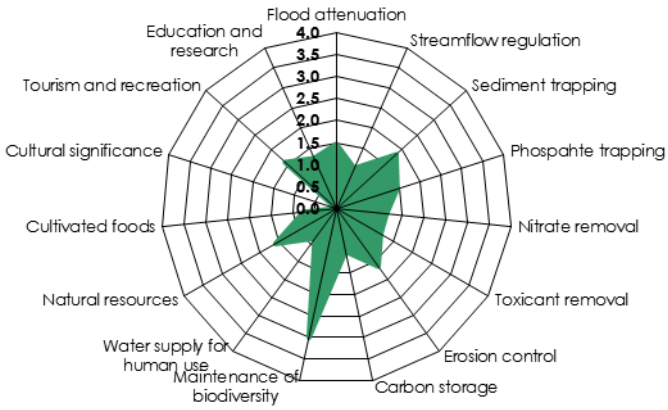
Moderately-High benfit:

- Tourism and recreation (2.3)
- Sediment trapping (2.1)

Intermediate benefit:

- Sediment trapping (2.1)
- Erosion control (1.8)
- Education and research (1.8)
- Flood attenuation (1.5)
- Natural resources (1.4)
- Phosphate trapping (1.4)

Valley Floor Depression wetlands leading to Salt Pan



High benefit:

- Mainetenance of Biodiversity (3)

Intermediate benefit:

- Tourism and recreation (2.3)
- Sediment trapping (2.1)
- Sediment trapping (1.8)
- Erosion control (1.6)
- Natural resources (1.6)
- Tourism and recreation (1.6)
- Flood attenuation (1.5)
- Phosphate trapping (1.5)

6 Wetland Risk and Impact Assessment

6.1 Method statement

Prospecting activities will consist of both non-invasive and invasive techniques. Non-invasive techniques will include desktop investigations of available data, reconnaissance mapping and site visits. Thereafter, prospecting investigations will include invasive sampling of the study area for testing, the results of which the will be used to quantify the gypsum reserve and the economic feasibility of mining these in future.

Specific surface sampling and widespread TLB mounted auger drilling will be undertaken to allow access to both the powdery surface gypsum as well as the secondary and older layer of crystalline gypsum, if any. The primary drilling program will involve the sampling of 50 holes across the prospecting area; where after based on the results of this, a secondary drilling program will be undertaken where samples are collected on a 300m x 300m grid (approx. 200 holes). Plan 8 shows the likely location of these points throughout the wetlands; however this is subject to change depending on the results of the preliminary borehole samples.

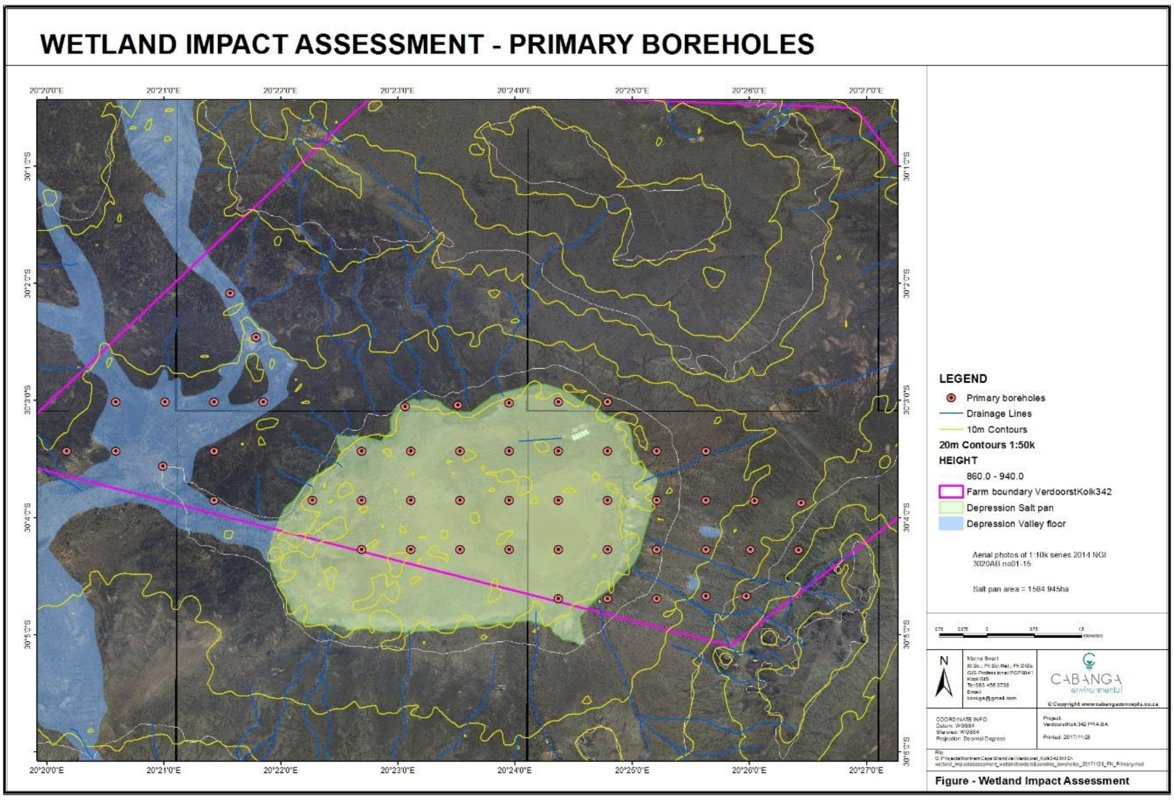
The sampling methodology includes the use of a TLB mounted auger (Figure 5) to conduct the drilling to a maximum depth of 5m, with the accompaniment of at least one supporting vehicle for sample collection. The likely associated activities include for this project include:

- Establishment of a site camp, laydown area and storage site. Including fuel storage and portable chemical toilet.
- No formal roads will be constructed; farm tracks will be used as far as possible to access the site.
- Clearance of vegetation in areas where drilling is proposed.
- Relocation of species of conservation concern in areas to be disturbed (assumed at this stage).
- Rehabilitation: The auger holes will be concurrently rehabilitated, by backfilling with material (drilling mud, soils and topsoils where applicable).

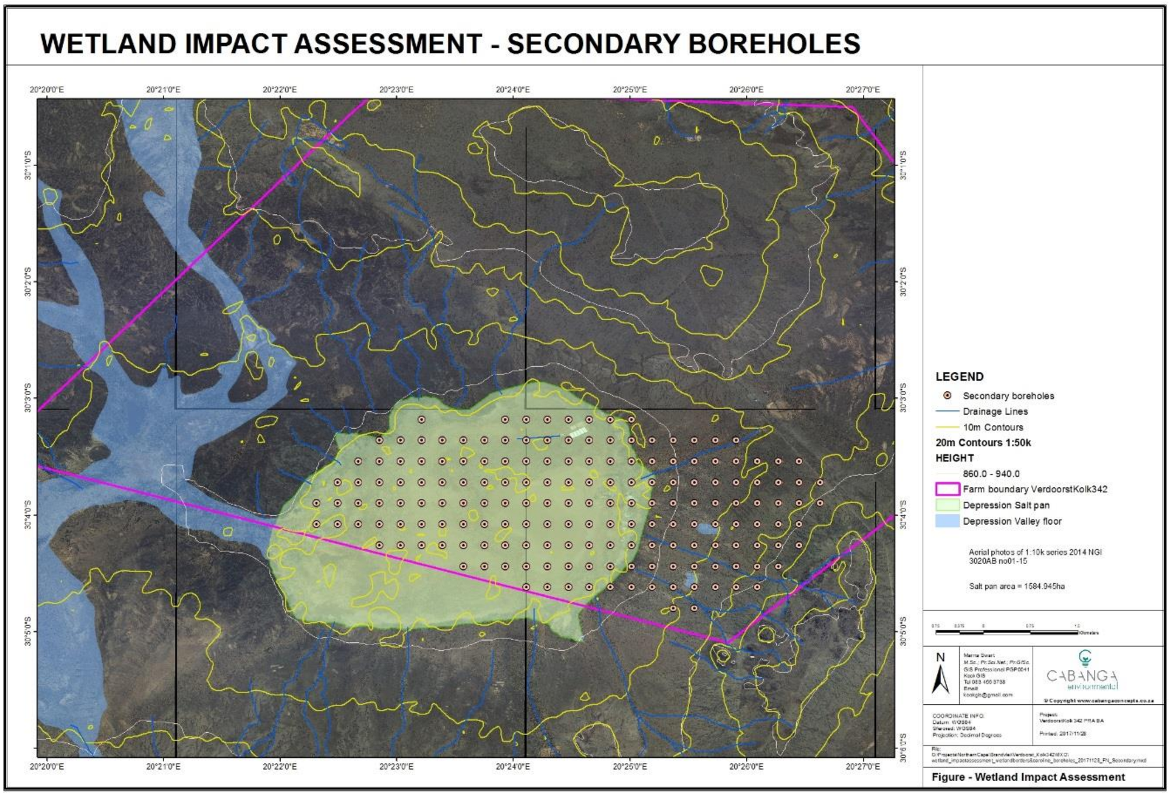
Figure 5: Example of a TLB mounted auger drill (Source: http://augertorqueusa.com)

6.1 Risk Assessment Findings

The DWS 21 c & i risk assessment was undertaken by the SACNASP registered professional described in Section 2.4 as per the requirements (DWS, 2016). The primary and secondary drilling program were assessed separately. Due to the invasive nature of the activity and the very high ecological sensitivity, the drilling and sampling was determined to represent a moderate risk to the wetlands. This result can be motivated to be lowered to a Low Risk for the preliminary drilling program (50 holes - Plan 8); however, this is not so for the secondary program (200 holes - Plan 9). These results are detailed in Table 5 overleaf. The recommended mitigation measures are summarised in Section 6.3.



Plan 8: Primary borehole location in relation to Wetlands



Plan 9: Secondary borehole location in relation to Wetlands

Table 5: Results for DWS 21 c&i Risk Assessment Results

Aspect	Impact	1. Severity	2. Spatial scale of impact	3. Duration	**Consequence** (sum 1, 2 & 3)	4. Frequency of activity	5. Frequency/ Likelihood of impact	6. Legal Issues	7. Detection of impact	**Likelihood** (sum 4, 5, 6 & 7)	**Significance** (Consequence * Likelihood) & **Risk Rating**	Borderline Low/Moderate risk with additional mitigation measures?
Activity: Preliminary drilling program – 50 auger holes across study area												
Driving of TLB and accompanying vehicle within and around wetlands including the salt pan, drainage wetlands and their buffer areas.	Disturbance to near-pristine and sensitive vegetation and soils across all wetland areas and their buffer areas. Note areas are of critical biodiversity importance.	5 – Wetlands involved	1 – Area specific	2 – One month to a year, PES impacted but not lowered	**8**	1 – Annually or less	2 – Highly unlikely to impact PES >40%	5 – Wetlands legally governed; also a CBA	1 - Immediately	**9**	**72 Moderate**	**55 Low**
Clearing of vegetation and drilling of 50 auger holes to max 5 m depth. Immediate backfilling and rehabilitation of impact footprint. See Plan 8.	Drilling will lead to the ancient and intact pan geological profile being impacted through the perforation of the consolidated layers, which have led to the wetland habitat forming. Realised impacts to the functioning of the hydropedological system are uncertain; but may result in localised dewatering of rain water as intact impermeable layers are disturbed.	5 – Wetlands involved	1 – Area specific	2 – One month to a year	**8**	1 – Annually or less	2 – Highly unlikely to impact PES >40%	5 – Wetlands legally governed; also a CBA	1 - Immediately	**9**	**72 Moderate**	**55 Low**
Activity: Secondary drilling program – additional 200 auger holes across study area in 300x300m grid												
Driving of TLB and accompanying vehicle in grid pattern within and around wetlands including the salt pan some of its buffer area.	Further disturbance to near-pristine and sensitive vegetation and soils across all pan and buffer area. Near-permanent damage to vegetation and possibly zooplankton egg banks. Natural restoration rate is extremely slow in this system. Note areas are of critical biodiversity importance.	5 – Wetlands involved	1 – Area specific	3 – One year to 10 years; PES lowered but can be mitigated	**9**	1 – Annually or less	3.5 – Possibly will impact PES >70%	5 – Wetlands legally governed; also a CBA	1 - Immediately	**10.5**	**95 Moderate**	
Clearing of vegetation and drilling of 200 auger holes to max 5 m depth. Immediate backfilling and rehabilitation of impact footprint. See Plan 9.	Drilling will lead to the ancient and intact geological profile of the pan being impacted through the perforation of the consolidated layers. Realised impacts to the functioning of the hydropedological system are uncertain; but may result in a localised 'dewatering' effect of rain water as intact impermeable layers are disturbed.	5 – Wetlands involved	1 – Area specific	3 – One year to 10 years; PES lowered but can be mitigated	**9**	1 – Annually or less	4 – Likely will impact PES >80%	5 – Wetlands legally governed; also a CBA	5 – Covered; realised impact will be very difficult to ascertain	**15**	**135 Moderate**	

6.2 Impact Assessment Findings

Similarly to the above, the two drilling programs are assessed separately and it was found that the secondary drilling program will have higher impact to the wetlands due to the greater number of auger holes within the wetland. Whilst not being hugely detrimental to the functioning the wetlands, the surface disturbance to the near-pristine pan ecosystem is recognised as an impact. The below ground activity (5m drilling) will possibly have a greater impact to the wetland. Furthermore, due to the lack in scientific knowledge on these systems, the precautionary approach is taken to quantify the potential impacts to the system. This is further motivated by the known ecological importance of this wetland in the eco-region as well as the extremely slow rates of natural restoration in response to any disturbance in the hyper-arid ecosystem.

Therefore, with mitigation the preliminary drilling program is expected to have moderate-low impact whereas the secondary drilling program is expected to have a moderate impact regarding the below ground activity (i.e. drilling 5m) and a moderate-low impact for the surface disturbance – refer to Table 6 below.

Table 6: Wetland Impact Assessment results

Activity	Impact	STATUS	Duration	Extent	Reversibility	Magnitude	CONSEQUENCE	PROBABILITY	SIGNIFICANCE (pre-mitigation)	Mitigation	Duration	Extent	Reversibility	Magnitude	CONSEQUENCE	PROBABILITY	SIGNIFICANCE (post-mitigation)
Activity: Preliminary drilling program – 50 auger holes across study area																	
Driving of TLB and accompanying vehicle within and around wetlands including the salt pan, drainage wetlands and their buffer areas.	Disturbance to near-pristine and sensitive vegetation and soils across all wetland areas and their buffer areas. Note areas are of critical biodiversity importance.	Neg	3	1	2	3	9	5	45 Moderate	**CONTROL/ PREVENT** Detailed plan of route for driving between sample areas must be done and ensure activity is maintained within these areas to keep affected area as small as possible. Botanist must do detailed walk of proposed routes to check for species of conservation concern, which must first be relocated. Wetland specialist and/or EO must be present to monitor activity and ensure minimal environmental damage. **REMEDY** All disturbed areas may need to be rehabilitated after vehicle traversing is complete. This is to be assessed and soils sampled to test the impact to the area.	3	1	2	2	8	4	32 Moderate - Low
Clearing of vegetation and drilling of 50 auger holes to max 5 m depth. Activity includes immediate backfilling and rehabilitation of impact footprint.	Drilling will lead to the ancient and intact pan geological profile being impacted through the perforation of the consolidated layers, which have led to the wetland habitat forming. Realised impacts to the functioning of the hydropedological system are uncertain; but may result in localised dewatering of rain water as intact impermeable layers are disturbed.	Neg	4	1	2	3	10	5	50 Moderate	**CONTROL/ PREVENT** Properly demarcate areas for auger drilling and ensure activity is maintained within the demarcations to keep affected area as small as possible. Wetland specialist and/or EO must be present to monitor activity and ensure minimal environmental damage. Vegetation removal must be over as small an area as possible. Plastic sheeting can be placed around expected auger hole and soil displacement area on top of top soils to prevent damage to intact crust layer during augering and replacement of material. **REMEDY** Auger holes must be backfilled immediately after samples have been taken. Replaced material must be compacted. A small raised mound can be present to allow for settlement of material.	3	1	2	2	8	5	40 Moderate - Low
Activity: Secondary drilling program – additional 200 auger holes across study area in 300x300m grid																	

Activity	Impact	STATUS	Duration	Extent	Reversibility	Magnitude	CONSEQUENCE	PROBABILITY	SIGNIFICANCE (pre-mitigation)	Mitigation	Duration	Extent	Reversibility	Magnitude	CONSEQUENCE	PROBABILITY	SIGNIFICANCE (post-mitigation)
Driving of TLB and accompanying vehicle in grid pattern within and around wetlands including the salt pan some of its buffer area.	Further disturbance to near-pristine and sensitive vegetation and soils across all pan and buffer area. Near-permanent damage to vegetation and possibly zooplankton egg banks. Natural restoration rate is extremely slow in this system. Note areas are of critical biodiversity importance.	Neg	3	1	2	3	9	5	45 Moderate	**CONTROL/ PREVENT** Detailed plan of route for driving between sample areas must be done and ensure activity is maintained within these areas to keep affected area as small as possible. Botanist must do detailed walk of proposed routes to check for species of conservation concern, which must first be relocated. Wetland specialist and/or EO must be present to monitor activity and ensure minimal environmental damage. **REMEDY** All disturbed areas may need to be rehabilitated after vehicle traversing is complete. This is to be assessed and soils sampled to test the impact to the area.	3	1	2	2	8	4	32 Moderate - Low
Clearing of vegetation and drilling of 200 auger holes to max 5 m depth. Immediate backfilling and rehabilitation of impact footprint.	Drilling will lead to the ancient and intact pan geological profile being impacted through the perforation of the consolidated layers, which have led to the wetland habitat forming. Realised impacts to the functioning of the hydropedological system are uncertain; but may result in localised dewatering of rain water as intact impermeable layers are disturbed.	Neg	4	1	5	4	14	5	70 Moderate - High	**CONTROL/ PREVENT** Properly demarcate areas for auger drilling and ensure activity is maintained within the demarcations to keep affected area as small as possible. Wetland specialist and/or EO must be present to monitor activity and ensure minimal environmental damage. Vegetation removal must be over as small an area as possible. Plastic sheeting can be placed around expected auger hole and soil displacement area on top of top soils to prevent damage to intact crust layer during augering and replacement of material. **REMEDY** Auger holes must be backfilled immediately after samples have been taken. Replaced material must be compacted. A small raised mound can be present to allow for settlement of material.	3	1	4	3	11	5	55 Moderate

6.3 Mitigation measures

The project area is associated with a highly sensitive ephemeral wetland in a very arid area of which there is very little biological and ecological knowledge. The risk to the region from impacting this systems is thus not well understood.

Mitigation measures are important aspects taken in a project guided by the mitigation hierarchy, which is defined as "*the sequence of actions to anticipate and avoid impacts on biodiversity and ecosystem services; and where avoidance is not possible, minimize; and, when impacts occur, rehabilitate or restore; and where significant residual impacts remain, offset*" (CSBI, 2013).

The following mitigation actions are recommended:

- **CONTROL/ PREVENT:**
    - Activity must be carried out in dry conditions only.
    - Detailed plan of route for driving between sample areas must be done and ensure activity is maintained within these areas to keep affected area as small as possible.
    - Botanist must do detailed walk of proposed routes to check for species of conservation concern, which must first be relocated.
    - Wetland specialist and/or environmental officer (EO) must be present to monitor activity and ensure minimal environmental damage.
    - Properly demarcate areas for auger drilling and ensure activity is maintained within the demarcations to keep affected area as small as possible.
    - Vegetation removal must be over as small an area as possible.
    - Plastic sheeting can be placed around expected auger hole and soil displacement area on top of top soils to prevent damage to intact crust layer during augering and replacement of material.
- **REMEDY:**
    - All disturbed areas may need to be rehabilitated after vehicle traversing is complete. This is to be assessed and soils sampled to test the impact to the area.
    - Auger holes must be backfilled immediately after samples have been taken. Replaced material must be compacted. A small raised mound can be present to allow for settlement of material.
- **ADDITIONAL**:
    - Research is currently underway on these pans by the South African Earth Observation Network (SAEON) in the Arid Lands Node; led by Dr. Betsie Milne. If desired, Dr. Milne or a member of her research team may be present during drilling to observe the contents of the augers and take samples. Data results from the prospecting analysis should also be shared with SAEON research team.
    - Monitoring of rehabilitation can occur to understand impact and ensure a no-net loss of wetland ecosystem function occurs.

7 Conclusion

The proposed prospecting drilling programs are associated with an ephemeral depression wetland known as Verdoorskolk pan and its drainage wetlands. These pans do not fit within the normal scope of the typical wetland assessment tools that are available and therefore it is difficult to score them based on these tools. As a result their value/sensitivity/importance are always underestimated; thus expert opinion and interpretation is important and the precautionary approach has been adopted herein regarding the risk and impact assessment.

According to the Northern Cape provincial biodiversity assessment, the wetlands are identified as **Critical Biodiversity Area 1 (CBA1),** which is the highest rank of biodiversity importance possible for the area. The site investigation concluded that these wetlands are overall in a largely natural condition (PES of B) with very high ecological importance and are supplying important ecosystem goods and services to the region.

The DWS 21 c and i risk assessment protocol was followed to determine the risk posed by the prospecting borehole sampling in the plan, where it is concluded that the preliminary drilling program can be mitigated and manged to a **Low Risk**. However, the secondary drilling program is assessed to be of **Moderate Risk** even with mitigation and therefore a water use license is required prior to commencement.

The impact assessment methodology led to the conclusion that, with mitigation, the preliminary drilling program is expected to have **Moderate-Low** impact whereas the secondary drilling program is expected to have a **Moderate** impact regarding the below ground activity (i.e. drilling 5m) and a **Moderate-Low** impact for the surface disturbance. Mitigation measures are included herein that can be done in addition to mitigation measures proposed in other reports.

It must be noted that the assessment contained herein has only assessed the prospecting activities and not the risk of the potential mining of the pan. This will need to be done through an additional process.

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Appendix 1: Detailed Methodologies

- **NFEPA**

The National Freshwater Ecosystem Priority Areas (NFEPA) project provides a collated, nationally consistent information source of wetland and river ecosystems for incorporating freshwater ecosystem and biodiversity goals into planning and decision-making processes (Nel, et al., 2011). The spatial layers (FEPA's) include the nationally delineated wetland areas that are classified into hydrogeomorphic (HGM) types and ranked in terms of their biodiversity importance (Table 7).

This resource was consulted to evaluate the importance of the wetland areas located within the project area. Whilst being an invaluable tool, it is important to note that the FEPA's were delineated and studied at a desktop and low resolution level. Thus, the wetlands delineated via the ground-truthing work done through this study may differ from the NFEPA layers.

Table 7: NFEPA wetland classification ranking criteria (Nel, et al., 2011)

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

- **Wetland PES**

The health of a wetland can be defined as a measure of the deviation of wetland structure and function from the wetland's natural reference condition (Macfarlane, et al., 2009). Thus, the health assessment attempts to evaluate the hydrological, geomorphological and vegetation health in three separate modules to attempt to estimate similarity to or deviation from natural conditions. The overall health score of the wetland is calculated using Equation 3, which provides a score ranging from 0 (pristine) to 10 (critically impacted in all respects).

The Present Ecological State (PES) for the associated wetlands is then determined from the final impact score (Table 8).

A Level 2 (in-field[1]) WET-Health assessment was done to determine the integrity (health) of the characterised HGM units for the project area (Macfarlane, et al., 2009).

Equation 3: Overall Wetland Ecological Health Impact Score

$$Wetland\ Health = \frac{3(Hydrology)\ + 2(Geomorphology) + 2(Vegetation)}{7}$$

Table 8: Impact scores and Present Ecological State categories (Macfarlane, et al., 2009)

Description	Combined Impact Score	PES Category
Unmodified, natural.	0-0.9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota has taken place.	1-1.9	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2-3.9	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognisable.	6-7.9	E
Modifications have reached a critical level and ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	F

- **<u>EIS</u>**

The Ecological Importance and Sensitivity (EIS) tool was derived to assess the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Rountree, et al., 2013). The purpose of assessing importance and sensitivity of water resources is to be able to identify those systems that provide higher than average ecosystem services, biodiversity support functions or are especially sensitive to impacts. Water resources with higher ecological importance may require managing such water resources in a better condition than the present to ensure the continued provision of ecosystem benefits in the long term.

The nationally accepted EIS tool was used for this study where three suites (detailed below) of importance criteria exist and these determinants are assessed for the wetlands on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance (Table 9) (Rountree & Kotze, 2013). It is recommended that the highest of these three suites of scores

[1] It is important that the in-field assessment is done in the summer wet season when plants are flowering. But if not, limitations must be stated.

be used to determine the overall Importance and Sensitivity category of the wetland system. The three areas of assessment are:

- **Biodiversity (Ecological) Importance and Sensitivity**: this considers presence of red data species and suitable habitat, diversity of the habitat types, protection status of the habitat and sensitivity of the habitat to changes in water dynamics (previously this was the only component of EIS);
- **Hydro-functional Importance**: this considers water quality, flood attenuation and sediment trapping services that the wetland may provide; and
- **Importance in terms of Basic Human Benefits**: this suite of criteria considers the subsistence uses and cultural benefits of the wetland system.

Table 9: Interpretation of overall Ecological Importance and Sensitivity (EIS) scores for biotic and habitat determinants (Rountree & Kotze, 2013)

Ecological Importance and Sensitivity Category (EIS)	Range of Scores
Very high	
Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4
High	
Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3
Moderate	
Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2
Low/marginal	
Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1

- **EcoServices**

In accordance with the method described by Kotze *et al.* (2009), an ecological functional assessment of the associated wetlands was undertaken. This methodology provides for a scoring system to establish the services of the wetland ecosystem. The onsite wetlands are grouped according to homogeneity and assessed utilizing the functional assessment technique, WET-EcoServices to provide an indication of the benefits and services. This methodology computes a score out of 4 for each index and provides an indication of the ecological services offered by the different HGM units for the study area. Results are given in the form of a radial plot showing the relative importance of the 15 indices. The score represents the extent to which the wetland is proving the benefit of assessed good/service and is interpreted as below in Table 10.

Table 10: Interpreting EcoServices scores on the extent to which the benefit of the good/service is being supplied from the assessed wetland (Kotze *et al.*, 2009)

Score:	< 0.5	0.5 – 1.2	1.3 – 2.0	2.1 – 2.8	> 2.8
Extent:	Low	Moderately low	Intermediate	Moderately high	High