PB CONSULT
ENVIRONMENTAL MANAGEMENT SERVICES

BOTANICAL ASSESSMENT

CALVINIA BULK WATER SUPPLY

PROPOSED DEVELOMENT OF NEW BOREHOLES AND CONNECTING PIPELINES ALONG THE R355, R27 AND A NUMBER OF MINOR GRAVEL ROADS HANTAM LOCAL MUNICIPALITY, NORTHERN CAPE PROVINCE

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EXECUTIVE SUMMARY

VEGETATION TYPE

Hantam Karoo (Figure 9)

Classified as "Least Threatened" (GN 1002, December 2011). More recently the 2018 National Biodiversity Assessment (NBA) was published. Hantam Karoo vegetation remains classified as "Least Threatened" in terms of the 2018 NBA.

VEGETATION ENCOUNTERED

In terms of vegetation, the Kreitzberg area was by far the most interesting in terms of plant species diversity, followed by the area next to the Klipwerf road.

The proposed footprint(s) will only impact on one broad vegetation type, namely Hantam Karoo, which is considered "Least Threatened". Hantam Karoo is a subtype of the Succulent Karoo Biome with a low winter rainfall and hot and dry summers. Globally there are few other places than can claim to be as biologically distinct as the Succulent Karoo Biome. At the time of the study the area was still in the grips of a severe dry spell, which had lasted almost seven years. This reflected in the species composition and the condition of the plants (e.g. very few annual-, herbaceous- or bulbaceous plants were observed). The vegetation was relatively similar over most of the study area, but differences in soil, variation in altitude and rainfall (dryer areas) influenced species composition. The vegetation to the north of Calvinia (Loeriesfontein-, Toren and Klipwerf roads) were generally much dryer. The soils in the lower lying areas at Calvinia and its surrounds were generally more clayey and probably more prone to being waterlogged. Historic and on-going agricultural practices and urban associated disturbances near the town of Calvinia meant that the vegetation surrounding the town was generally in poor condition and most often dominated by hardy pioneer and weedy species.

CONSERVATION PRIORITY AREAS

According to the NCCBA (Figure 14), portions of the pipeline route will impact on both ESA's and CBA's. Fortunately, the pipeline will be located within the road reserve wherever possible. Road reserves can be very good ecological corridors, but can are also mostly slightly more disturbed as a result of road maintenance actions and the edge effect of the road itself (coupled with impacts from the road users). It was taken into account that the placement of the pipeline (underground) will only result in a short to medium term temporary impact, while locating it in the road reserve (rather than in the adjacent remaining natural veld), will also minimise the impact.

According to Van Wyk & Smith (2001), the proposed infrastructure falls within the Hantam-Roggeveld Centre (HRC) of endemism (Figure 15**Error! Reference source not found.**). However, the more recent Northern Cape Critical Biodiversity Areas map (2016), aims at the conservation of important corridors and local priority areas. As such the finer scale maps given in the NCCBA were used as basis to identify priority conservation areas within the study area.

CONNECTIVITY

95% of the pipeline will be located within existing road reserves and the impact will be temporary or nature. In general connectivity is still very good across most of the footprint and the proposed development is not expected to have any significant additional (long lasting) impact on connectivity.

LAND-USE

95% of the approximate 100 km pipeline will be located within existing road reserves. About 5.5 km will be located on active livestock farms. The temporary nature of the construction should result in a temporary impact on these activities, which can be significantly reduced (or managed) with good communications with the land-owner.

PROTECTED PLANT SPECIES

The Succulent Karoo Biome is unrivalled in its status as the world's only entirely arid region diversity hotspot and has a high diversity of dwarf leaf-succulent shrubs. However, endemism species diversity is less pronounced in the Hantam Karoo (which is part of the Succulent Karoo). Seventy three (73) plant species where identified of which a number is South African endemics, and three (3) are naturalised weeds. No red-listed, NEMBA or NFA protected species were observed, but 27 NCNCA protected species were encountered (a number of which were weedy/pioneer species often viewed as disturbance indicator species).

MAIN CONCLUSION

The proposed development will result in a temporary impact on natural vegetation along an approximate 100 km footprint. Only one vegetation type is expected, namely Hantam Karoo vegetation, which is not considered vulnerable. However, it will impact on CBA's and ESA's (some of which are also disturbed). However, 95% of the pipeline will be placed within existing road reserves and pipelines on private land can potentially be located above ground (which will result in a long term visual impact, but a very low construction related impact).

Probably the most significant botanical observations made relates to a number of protected plant species observed (refer to Table 4). In terms of vegetation, the Kreitzberg area was by far the most interesting in terms of species diversity, but all the water courses were also taken as areas of special significance.

According to the impact assessment given in Table 7 the development (without mitigation) is expected to result in a **Medium** impact, but can be reduced to **Low** through simple and very viable mitigation options.

With the correct mitigation it is unlikely that the development will contribute significantly to any of the following:

- Significant loss of vegetation type and associated habitat.
- Loss of ecological processes (e.g. migration patterns, pollinators, river function etc.) due to construction and operational activities.
- Loss of local biodiversity and threatened plant species.
- Loss of ecosystem connectivity.

WITH THE AVAILABLE INFORMATION IT IS RECOMMENDED THAT PROJECT BE APPROVED, WITH THE PROPOSED MITIGATION ACTIONS.

NO-GO OPTION

The No-Go option is not likely to result in a "no-impact" scenario, for it will have a negative socio-economic impact (and slow degradation may still continue).

COMPLIANCE WITH APPENDIX 6 OF GN. 982 (4 DECEMBER 2014)

Specialist reports

1. A specialist report prepared in terms of these regulations must contain -	
a) Details of –	**Refer to:**
(i) The specialist who prepared the report; and	Refer to Page iv – v & Appendix 1
(ii) The expertise of the specialist to compile a specialist report including a curriculum vitae;	Refer to Appendix 1
b) A declaration that the specialist is independent in a form as may be specified by the competent authority;	Refer to Page iii
c) An indication of the scope of, and the purpose for which the report was prepared;	Refer to Heading 1.1
d) The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Refer to Heading 3
e) A description of the methodology adopted in preparing the report or carrying out the specialist process inclusive of equipment and modeling used;	Refer to Heading 3
f) Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructures, inclusive of a site plan identifying site alternatives;	Refer to Headings 4.5, 4.7 & Figure 16
g) An identification of any areas to be avoided, including buffers;	Refer to Figure 16
h) A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Refer to Figure 16
i) A description of any assumptions made and any uncertainties or gaps of knowledge;	Refer to Heading 3
j) A description of the findings and potential implications of such findings on the impact of the proposed activity, [including identified alternatives on the environment] or activities;	Refer to Heading 6 & 7.1
k) Any mitigation measures for inclusion in the EMPr;	Refer to Heading 7
l) Any conditions for inclusion in the environmental authorization;	Refer to Heading 7.1
m) Any monitoring requirements for inclusion in the EMPr or environmental authorization;	Refer to Heading 7
n) A reasoned opinion -	
(i) [as to] whether the proposed activity, activities or portions thereof should be authorized;	Refer to the "*Main conclusion*" within the executive summary (Page i)
(iA) regarding the acceptability of the proposed activity or activities; and	
(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorized, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable the closure plan;	Refer to Heading 7
o) A description of any consultation process that was undertaken during the course of preparing the specialist report;	N/a
p) A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/a
q) Any information requested by the competent authority.	N/a
2. Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	

INDEPENDENCE & CONDITIONS

PB Consult is an independent entity with no interest in the activity other than fair remuneration for services rendered. Remunerations for services are not linked to approval by decision making authorities and PB Consult have no interest in secondary or downstream development as a result of the authorization of this proposed project. There are no circumstances that compromise the objectivity of this report. The findings, results, observations and recommendations given in this report are based on the author's best scientific and professional knowledge and available information. PB Consult reserve the right to modify aspects of this report, including the recommendations if new information become available which may have a significant impact on the findings of this report.

RELEVANT QUALIFICATIONS & EXPERIENCE OF THE AUTHOR

Mr Peet Botes holds a BSc. (Hons.) degree in Plant Ecology from the University of Stellenbosch (Nature Conservation III & IV as extra subjects). Since qualifying with his degree, he had worked for more than 20 years in the environmental management field, first at the Overberg Test Range (a Division of Denel) managing the environmental department of OTR and being responsible for developing and implementing an ISO14001 environmental management system, ensuring environmental compliance, performing environmental risk assessments with regards to missile tests and planning the management of the 26 000 ha of natural veld, working closely with CapeNature (De Hoop Nature Reserve).

In 2005 he joined Enviroscientific, an independent environmental consultancy specializing in wastewater management, botanical and biodiversity assessments, developing environmental management plans and strategies, environmental control work as well as doing environmental compliance audits and was also responsible for helping develop the biodiversity part of the Farming for the Future audit system implemented by Woolworths. During his time with Enviroscientific he performed more than 400 biodiversity en environmental legal compliance audits.

During 2010 he joined EnviroAfrica in order to move back to the biodiversity aspects of environmental management. Experience with EnviroAfrica includes NEMA EIA applications, environmental management plans for various industries, environmental compliance audits, environmental control work as well as more than 70 biodiversity & botanical specialist studies.

Towards the end of 2017, Mr Botes started his own small environmental consulting business focusing on biodiversity & botanical assessments, biodiversity management plans and environmental compliance audits.

Mr Botes is a registered Professional Botanical, Environmental and Ecological Scientists at SACNASP (South African Council for Natural Scientific Professions) as required in terms of Section 18(1)(a) of the Natural Scientific Professions Act, 2003, since 2005.

DECLARATION OF INDEPENDENCE

THE INDEPENDENT PERSON WHO COMPILED A SPECIALIST REPORT OR UNDERTOOK A SPECIALIST PROCESS

I Petrus, Jacobus, Johannes Botes, as the appointed independent specialist hereby declare that I:

- act/ed as the independent specialist in this application;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014, as amended, and any specific environmental management Act;
- have and will not have no vested interest in the proposed activity proceeding;
- have disclosed, to the applicant, EAP and competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- am fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2014 (specifically in terms of regulation 13 of GN No. R. 326) and any specific environmental management Act, and that failure to comply with these requirements may constitute and result in disqualification;
- have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- have ensured that the names of all interested and affected parties that participated in terms of the specialist input/study were recorded in the register of interested and affected parties who participated in the public participation process;
- have provided the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
- am aware that a false declaration is an offence in terms of regulation 13 of GN No. R. 326.

Note: The terms of reference must be attached.

Signature of the specialist:

PB Consult (Sole Proprietor)

Name of company:

8 March 2021

Date:

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ABBREVIATIONS

BGIS	Botanical Geographical Information System
CARA	Conservation of Agricultural Resources Act 43 of 1983
CBA	Critical Biodiversity Areas (Municipal)
DEA	Department of Environmental Affairs
EAP	Environmental assessment practitioner
EIA	Environmental impact assessment
EMF	(Municipal) Environmental Management Framework
EMP	Environmental management plan
NCNCA	Northern Cape Nature Conservation Act, Act 9 of 2009
NEMA	National Environmental Management Act, Act 107 of 1998
NEMAQA	National Environmental Management Air Quality Act 39 of 2004
NEMBA	National Environmental Management Biodiversity Act, Act 10 of 2004
NEMPAA	National Environmental Management Protected Areas Act 57 of 2003
NEMWA	National Environmental Management Waste Act 59 of 2008
NFA	National Forests Act 84 of 1998
NSBA	National Spatial Biodiversity Assessment
NVFFA	National Veld and Forest Fire Act 101 of 1998
NWA	National Water Act 36 of 1998
SABIF	South African Biodiversity Information Facility
SANBI	South African National Biodiversity Institute
SIBIS	SANBI's Integrated Biodiversity Information System
SKEP	Succulent Karoo Ecosystem Project

1. INTRODUCTION

Calvinia was founded in 1845 on the farm Hoogekraal which was purchased by the Dutch Reformed Church in order to establish a parish for the far flung community of the Hantam Karoo. The original name of the region and the village was Hantam. The name Hantam has its origins with the Khoi people and it is believed that the name refers to "the hill where the red bulbs grows" (www.karoo-southafrica.com). During 1851 the town was renamed to Calvinia after the religious reformer John Calvin. The town is located on one of the main access roads from the Cape (Vanrhynsdorp) to the Northern Cape and developed into one of the main towns of the south-western part of the Northern Cape.

Since 2015, Calvinia has increasingly been experiencing water supply problems as a result of population growth, continual drought situations (winter rainfall not being sufficient to fill the Karee Dam or re-charge the existing boreholes), deterioration of the existing borehole resources (only 4 of the 7 existing boreholes still supplying their tested yields). During August 2019, BVi engineers concluded a feasibility study with the aim of providing a sustainable technical and socio-economic solution for Calvinia's long term water supply challenges, during which various options were evaluated (including pumping water from the Doorn River system). The study indicated that the development of new boreholes in the area surrounding Calvinia (20 – 30 km away from Calvinia as all current avenues with regards to groundwater in the immediate vicinity of the town had been exhausted) represents the most viable long term solution (BVi, 2019). The connecting pipelines will be between 100 – 120km in length, most of which will be underground and located within existing road-reserves, wherever possible. However, portions of these pipelines will cross farm properties (with its remaining natural veld) in order to reach the road reserves.

The proposed project will trigger listed activities in terms of the National Environmental Management Act, 1998 (NEMA) and the Environmental Impact Assessment (EIA) regulations. EnviroAfrica (Pty) Ltd was appointed by BVi Engineers (Pty) Ltd as the independent Environmental Assessment Practitioner (EAP) to undertake the NEMA EIA application for the proposed development. PB Consult was appointed by EnviroAfrica to conduct a botanical study of the areas that will be impacted by the proposed project.

According to the 2018 Vegetation map of South Africa, Lesotho and Swaziland (Mucina & Rutherford, 2006), the proposed footprint(s) will mainly impact on one broad vegetation type, namely Hantam Karoo, which is considered "Least Threatened" (a status which it maintained in the 2018 National Biodiversity Assessment, Skowno, 2019). But it must be noted that the Hantam Karoo also falls within the Succulent Karoo Biome (the fourth largest Biome in South Africa), which is proclaimed as one of the most biologically distinct areas in South Africa (Mucina *et. al,* 2006).

The vegetation encountered was relatively well preserved, especially along the Calvinia – Ceres road and along the smaller gravel roads. The areas in the immediate vicinity of Calvinia and along the R27, was much more disturbed and mostly in poor condition.

1.1. TERMS OF REFERENCE

The terms of reference for this appointment were to:

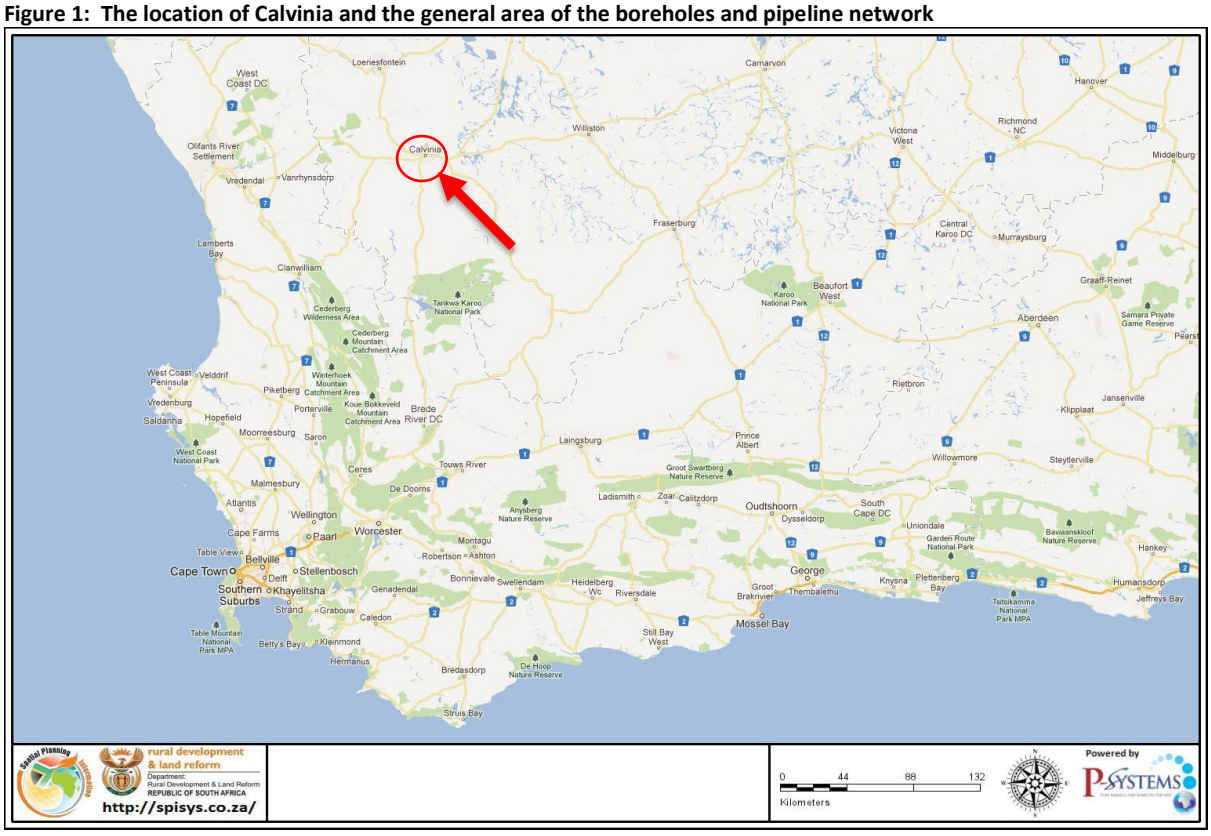
- Evaluate the proposed site(s) in order to determine whether any significant botanical features will be impacted as a result of the proposed development.
- Determine and record the position of any plant species of special significance (e.g. protected tree species, or rare or endangered plant species) that should be avoided or that may require "search & rescue" intervention.
- Locate and record sensitive areas from a botanical perspective within the proposed development footprint that may be interpreted as obstacles to the proposed development.
- Make recommendations on impact minimization should it be required
- Consider short- to long-term implications of impacts on biodiversity and highlight irreversible impacts or irreplaceable loss of species.

2. STUDY AREA

2.1. LOCATION & LAYOUT

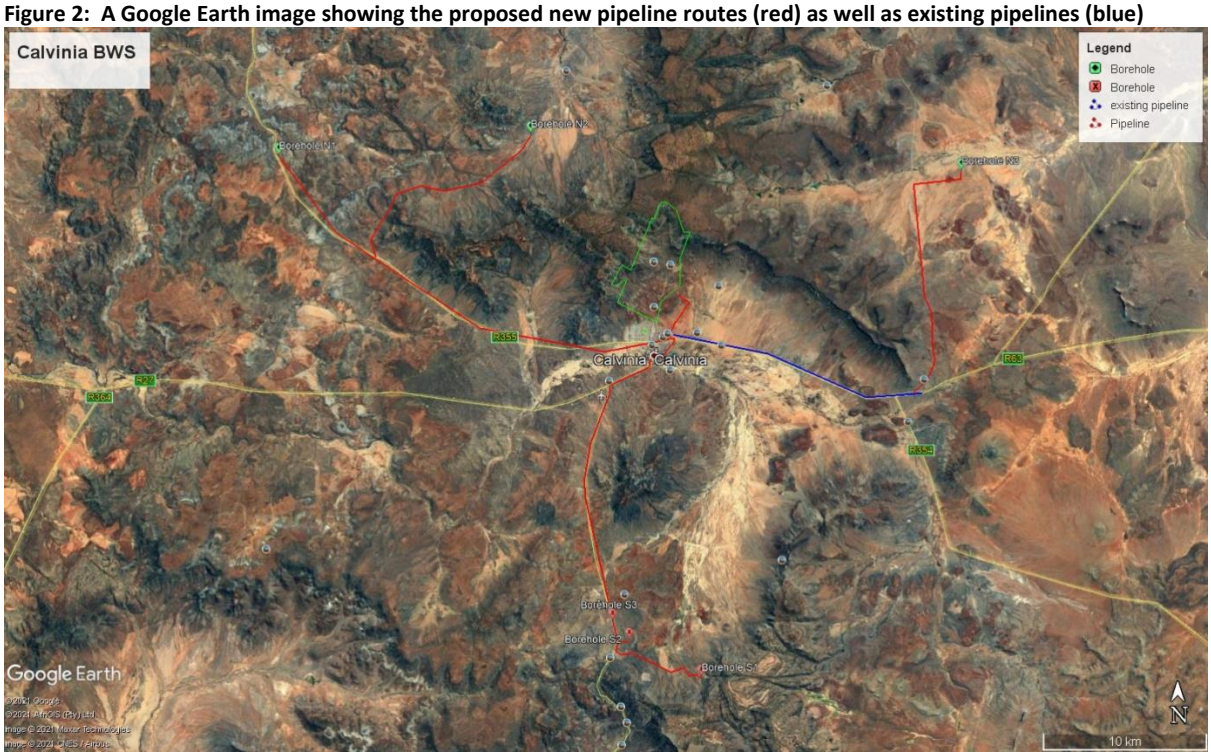
Calvinia is located at the foot of the Hantam Mountains, in the south-western part of the Northern Cape. The town is placed on the R27 between Nieuwoudville and Brandvlei. Nieuwoudville is about 60 km west of Calvinia, while Brandvlei is about 140 km north-north-east of Calvinia (Figure 1).

Figure 1: The location of Calvinia and the general area of the boreholes and pipeline network



A number of boreholes were investigated (drilled) as part of the feasibility study done by BVi Engineers. The development of the boreholes will result in relative small localised concrete structures to protect and house the pumping & telemetry equipment. In order to connect these boreholes to the existing water network a number of new pipelines (and power supply lines) will have to be constructed (Refer to the red lines in Figure 2). Most of these pipelines (and power supply lines) will be located within the road reserves of various existing access roads. However, 3 of them will be located on farm properties and will impact on natural veld within these farms (Refer to Table 1).

Figure 2: A Google Earth image showing the proposed new pipeline routes (red) as well as existing pipelines (blue)



Four boreholes will be developed to the south of Calvinia (Boreholes CAL-S2-3, CAL-S2-4, CAL-S2-10 and CAL-Phase3-9), while another 3 will be developed to the north of Calvinia (Boreholes G39602, CAL-Phase3-4A and CAL-Phase3-6) (Refer to Figure 2 and Table 1).

Table 1: GPS coordinates for the for the boreholes of the proposed Calvinia Bulk Water Supply

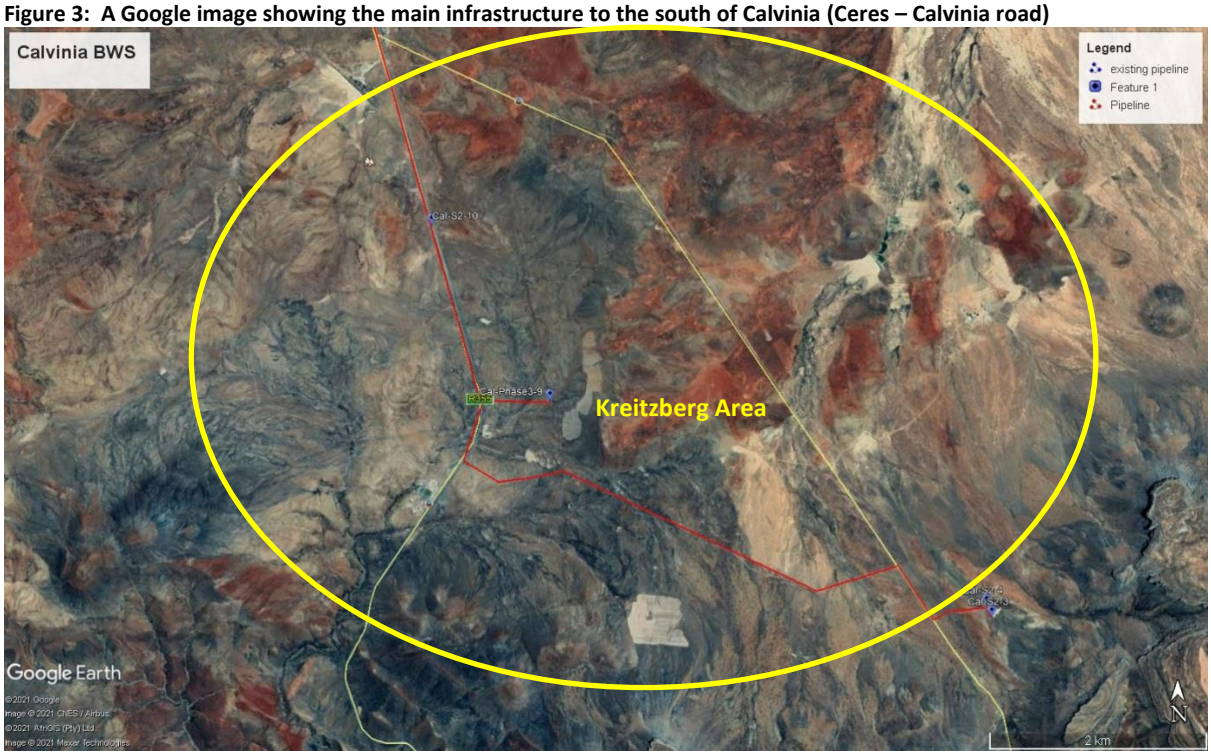
Borehole No.	Location	GPS Coordinates
G39602 (north)	Farm Rietfontein 550/0	S31° 22' 22.3" E19° 58' 15.0"
CAL-S2-3 (south)	Farm Aurets Kloof 854/0 (in close proximity to CAL-S2-4)	S31° 39' 04.8" E19° 48' 05.7"
CAL-S2-4 (south)	Farm Aurets Kloof 854/0 (in close proximity to CAL-S2-3)	S31° 39' 01.3" E19° 48' 03.8"
CAL-S2-10 (south)	Within the R355 Road reserve (Ceres – Calvinia road)	S31° 37' 02.9" E19° 44' 41.0"
CAL-Phase3-4A (north)	Within the R355 road reserve (Loeriesfontein road)	S31° 24' 04.2" E19° 33' 24.0"
CAL-Phase3-6 (north)	Within the road reserve of the Toren road (AP2286)	S31° 21' 27.8" E19° 41' 29.4"
CAL-Phase3-9 (south)	Farm Vlakke Fontein 766/0	S31° 37' 57.8" E19° 45' 24.4"

2.1.1. Infrastructure south of Calvinia

From the Kreitzberg area (most of the area south of Calvinia), four new boreholes is proposed to be linked to the existing Calvinia bulk water system (Refer to Figure 3). Apart from the connecting pipelines (30 – 35 km in length) a connecting power supply lines will also have to be constructed (where needed). Please note that the engineers are willing to locate some of these pipelines above ground (in more sensitive areas).

Starting from the furthest point, both CAL-S2-3 and CAL-S2-4 will be located on the remainder of Farm Aurets Kloof No. 854 (located in the Kreitzberg Area), in close proximity to each other. A 600 to 700 m pipeline and power supply line will have to be constructed (through natural veld) from these boreholes to a secondary gravel road (the Kreitzberg road). This pipeline can be placed above- or below ground. The pipeline will then run underground within the road reserve of the Kreitzberg road for a short distance, before it turns west to follow the road reserve of another secondary gravel road (the Nooiensfontein road) until it meets up with the R355 (the Ceres – Calvinia road). The pipeline will then be placed underground within the road reserve of the R355 running north till it meets up with the R27 (Vanrhynsdorp – Brandvlei road). Along the way it will be connected with CAL-Phase3-9, which will be located about 700 m east of the R355 on the Remainder of Farm Vlakke Fontein 766. Again a pipeline and power supply line will have to be constructed from the R355 to this borehole (through natural veld). The last borehole, CAL-S2-10, will be located within the western road reserve of the R355 (Figure 3).

Figure 3: A Google image showing the main infrastructure to the south of Calvinia (Ceres – Calvinia road)

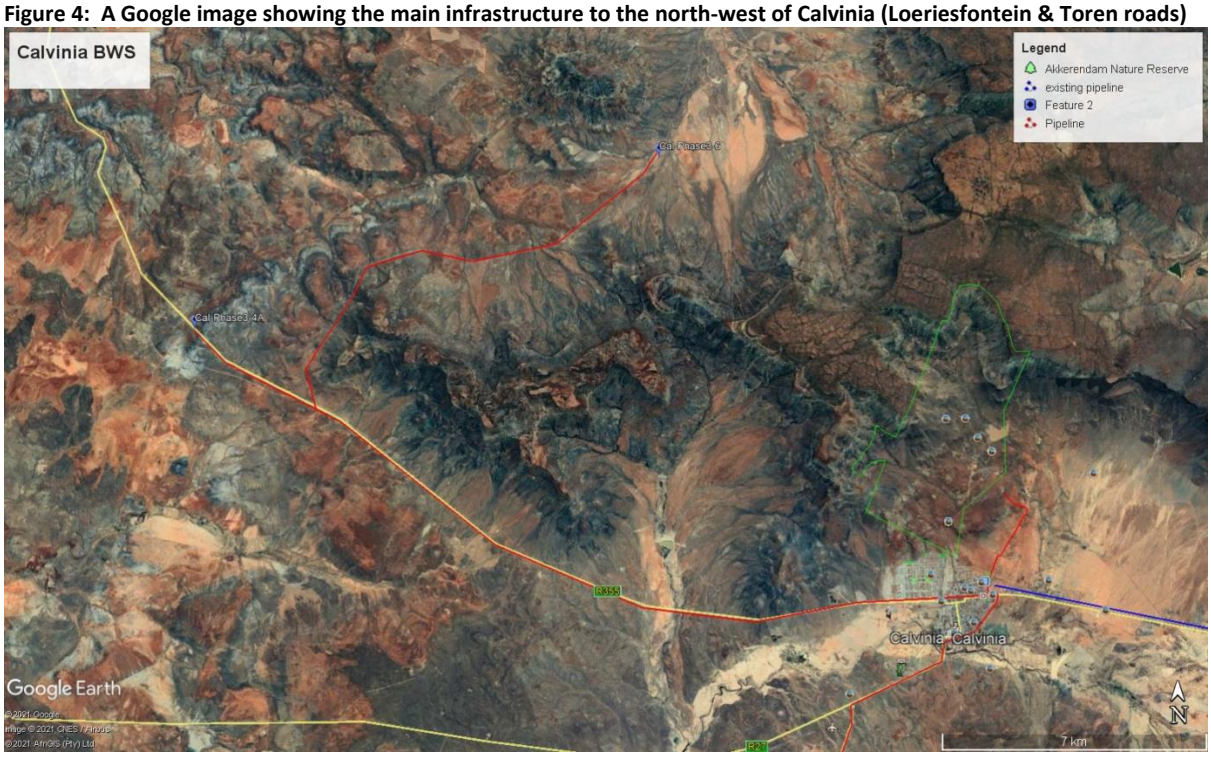


2.1.2. Infrastructure to the north-west of Calvinia

Two new boreholes are located to the north-west of Calvinia (both within the road reserve). CAL-Phase3-4A is located within the Calvinia – Loeriesfontein road reserve (the R355 north), while CAL-Phase3-6 is located in the road reserve of the Toren road (north of the Hantam Mountains (Refer to Figure 4). A connecting pipeline of approximately of approximately 23 km will be constructed within

the road reserve of the R355 (Loeriesfontein road) with a further 14 km branch to the east within the road reserve of the Toren road.

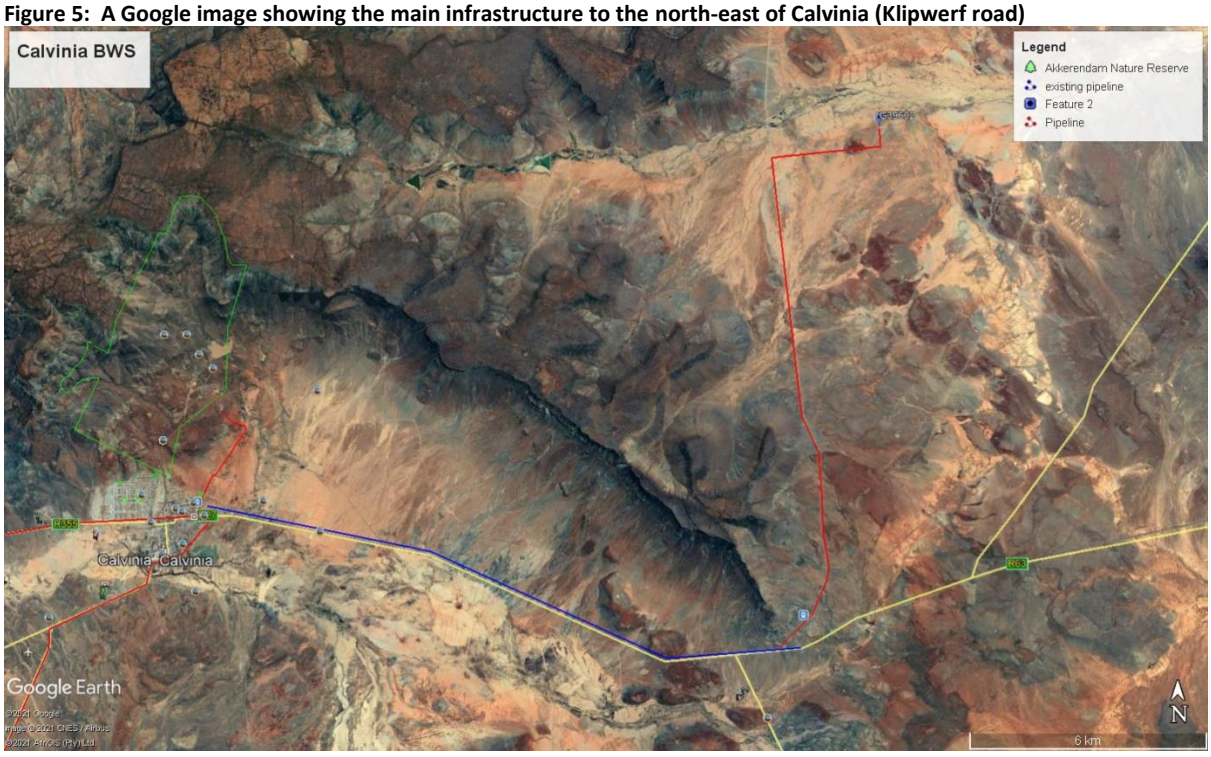
Figure 4: A Google image showing the main infrastructure to the north-west of Calvinia (Loeriesfontein & Toren roads)



2.1.3. Infrastructure to the north-east of Calvinia

One new borehole (G39602) will be located to the north-east of Calvinia on the remainder of the Farm Rietfontein no. 550 (Refer to Figure 5).

Figure 5: A Google image showing the main infrastructure to the north-east of Calvinia (Klipwerf road)

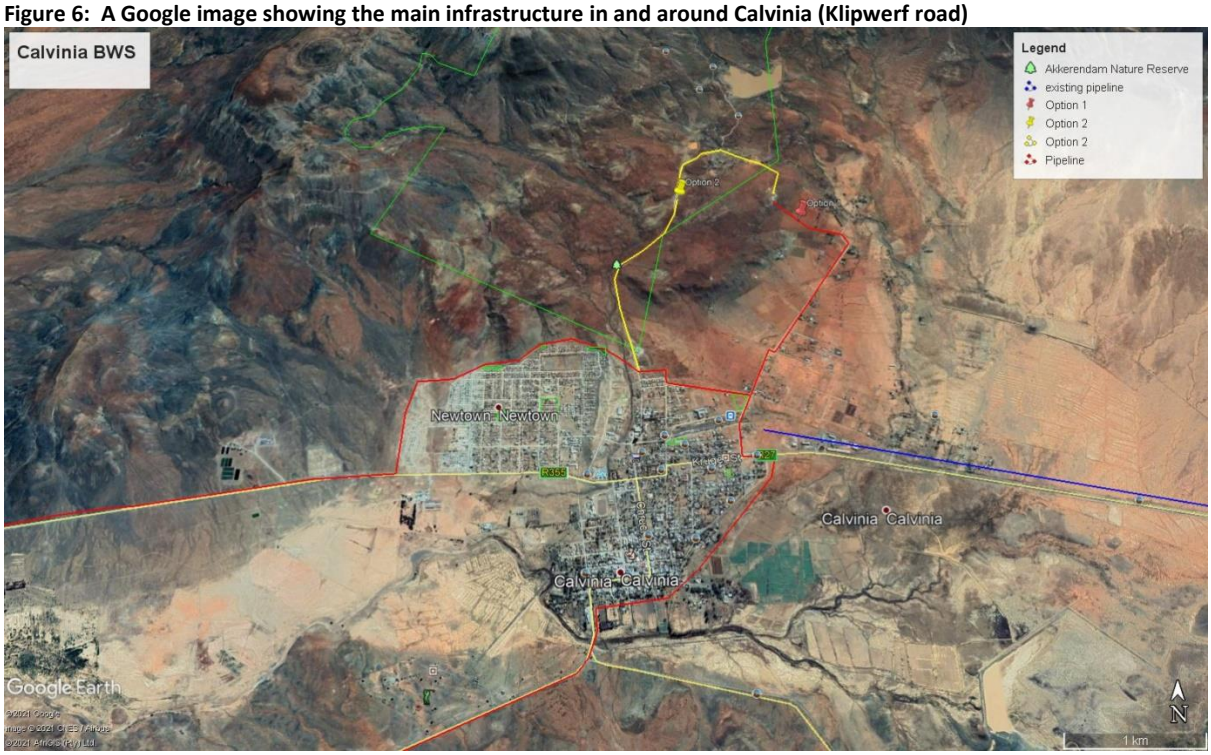


The borehole is located about 4 km east of the Klipwerf road (a secondary gravel road) and the connecting pipeline will have to cross to properties to reach this road. The proposed pipeline (and power supply line) will follow existing twee-spoor roads from the borehole over the remainder of Farm Rietfontein no. 550 south and west and then cross over portion 10 of the Farm Spitskop no. 552 until it reaches the Klipwerf road (both of these properties belongs to the same land owner). It will then be located within the road reserve of the Klipwerf road, running south (about 13 km) until it link-up with an existing pipeline, located within the road reserve of the R26 (Calvinia – Brandvlei road).

2.1.4. Infrastructure in and around Calvinia

Since these pipelines will enter Calvinia from the west and south, various options were investigated. It is important to note that the Kareedam (the main water storage facility for Calvinia) is located within the Akkerendam Nature Reserve, while the access road to the existing water treatment works (WTW) is also through the Reserve (although the WTW itself is located to the east of the Reserve).

Figure 6: A Google image showing the main infrastructure in and around Calvinia (Klipwerf road)



From the R355 (Ceres – Calvinia road) to the south of Calvinia, the pipeline will run within the road reserve of the R27 using the existing bridge to cross the Oorlogskloof River, from where it will turn east running through a number of small holdings (agricultural land) skirting the town of Calvinia to the south and east, then turning north to follow existing roads on the outskirts of Calvinia, almost to the existing water treatment works (the last 200 – 300m will be trough remaining natural veld within the Akkerendam Nature Reserve (Figure 6).

From the west (Loeriesfontein road) the pipeline will enter Calvinia and then turns north (skirting Newtown), following the outline of the built-up areas, staying within existing road reserves or disturbed areas, crossing the Kleinhoek River before either:

- turning north, following the existing Akkerendam entrance road (Option 2 in Figure 6), or
- running further east linking up with the new pipeline from the south of Calvinia (Option 1 in Figure 6).

2.2. TOPOGRAPHY AND CLIMATE

Calvinia is located at the foot of the Hantam Mountains (about 987 m above sea level). The connecting pipeline will be located in the gently to steeply undulating lower lying areas of the Bokkeveld Plateau. Elevation varies from approximately 1160 m above sea level at Kreitzberg to 1034 at the WTW, while the Loeriesfontein road pipeline will start at 895 m above sea level rising to about 1034 at the WTW. The pipeline along the Klipwerf road will start at 1079 m, rising over a small hill (1157 m) before connecting to the existing pipeline at about 1072 m above sea level.

The Hantam Karoo has a semi-desert climate receiving its rainfall mainly in winter (although the eastern portions of the Hantam Karoo lies in the transition to summer rainfall). The mean annual precipitation is unreliable and can vary from year to year (Van Wyk & Smith, 2001). Average annual precipitation is about 232 mm which falls mainly during the winter months, with June normally the wettest month of the year, while January normally is the driest month of the year. Summers (October to March) are mild too hot with January normally being the warmest month with an average temperature of 23.1°C and maximum temperatures reaching 30°C. Winters are cold to very cold with regular snow on the higher mountains (e.g. the Hantam Mountains). July is normally the coldest month with average temperatures of 9.7°C. (Refer to Table 2). (www.climate-data.org).

Table 2: Weather averages for Calvinia (www.climate-data.org)

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C	23.1 °C	23 °C	21 °C	17.1 °C	13.2 °C	9.4 °C	9.3 °C	10.1 °C	13.3 °C	17 °C	19.2 °C	21.4 °C
(°F)	(73.5) °F	(73.4) °F	(69.8) °F	(62.8) °F	(55.7) °F	(48.9) °F	(48.7) °F	(50.2) °F	(55.9) °F	(62.7) °F	(66.5) °F	(70.6) °F
Min. Temperature °C	15.6 °C	15.8 °C	14 °C	10.7 °C	7.4 °C	4.1 °C	3.6 °C	4.1 °C	6.4 °C	9.5 °C	11.4 °C	13.9 °C
(°F)	(60.1) °F	(60.4) °F	(57.2) °F	(51.3) °F	(45.3) °F	(39.4) °F	(38.5) °F	(39.4) °F	(43.4) °F	(49) °F	(52.4) °F	(57) °F
Max. Temperature °C	30.3 °C	30.2 °C	27.9 °C	23.4 °C	19.2 °C	15.2 °C	15.4 °C	16.6 °C	20.2 °C	24.3 °C	26.5 °C	28.8 °C
(°F)	(86.6) °F	(86.4) °F	(82.2) °F	(74.2) °F	(66.5) °F	(59.4) °F	(59.6) °F	(61.8) °F	(68.4) °F	(75.7) °F	(79.7) °F	(83.9) °F
Precipitation / Rainfall	13	17	26	23	22	28	24	22	12	15	15	15
mm (in)	(0.5)	(0.7)	(1)	(0.9)	(0.9)	(1.1)	(0.9)	(0.9)	(0.5)	(0.6)	(0.6)	(0.6)
Humidity(%)	34%	36%	39%	45%	51%	59%	54%	52%	41%	34%	33%	34%
Rainy days (d)	2	2	3	3	3	4	3	3	2	2	2	2

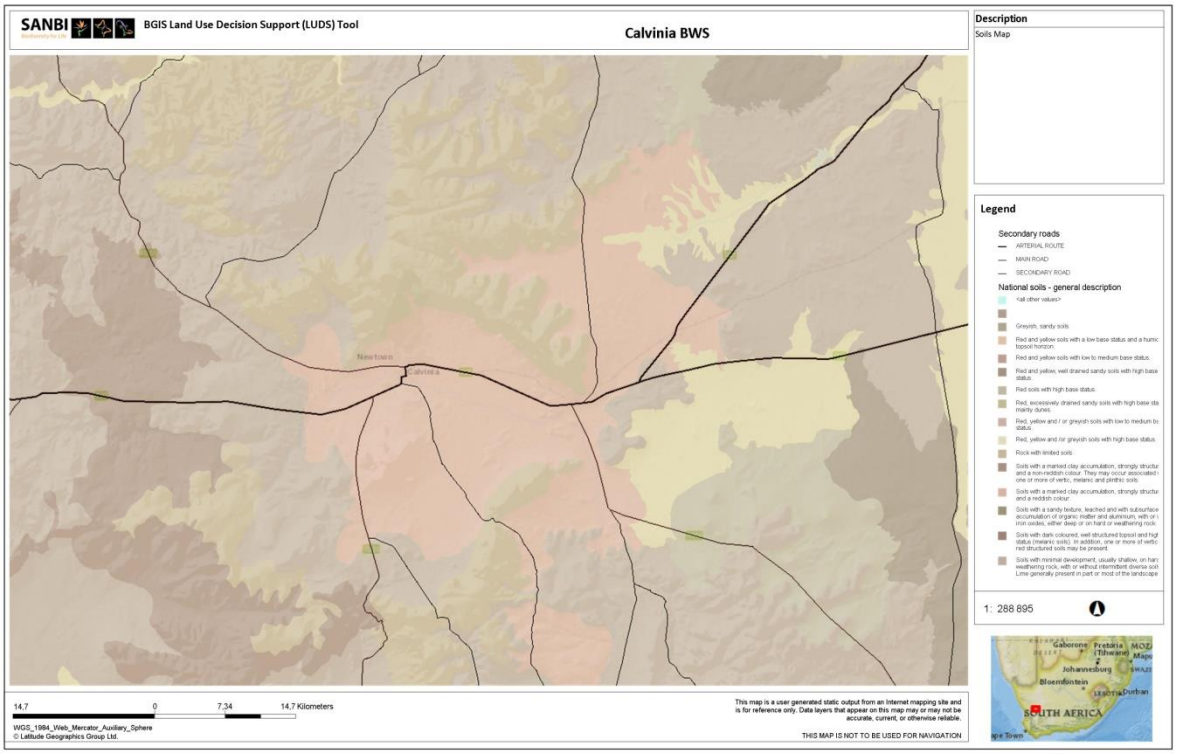
NB: According to the Namakwa District Biodiversity Sector Plan (2008), it is expected that the climate will change drastically over the next millennium. Effects of global climate change lead scientists to the conclusion that the entire Succulent Karoo will most likely experience increased temperatures. It is projected that a 2°C increase in temperature in the area will lead to a 10% reduction in rainfall – a significant loss in an area that is already severely water restricted. This

decrease in rainfall is projected to result in a 35% decrease in livestock carrying capacity over the coming 200 years. These projections point to the need for the development of alternative economic opportunities in the area, in order to successfully cope with the changes that are already underway.

2.3. GEOLOGY AND SOILS

According to Mucina & Rutherford (2006), geology and soils associated with the Hantam Karoo vegetation type is sediments of the Karoo Sequence (predominantly Ecca Group shales and Dwyka tillites), both significantly intruded by dykes and sills of the Jurassic Karoo Dolerite Suite. Regional geology is discussed in much more detail within the Geohydrological study report done by GEOSS during 2018 for the same project (GEOSS, 2018).

Figure 7: Soil map of South Africa, showing the Calvinia area (SANBI BGIS)



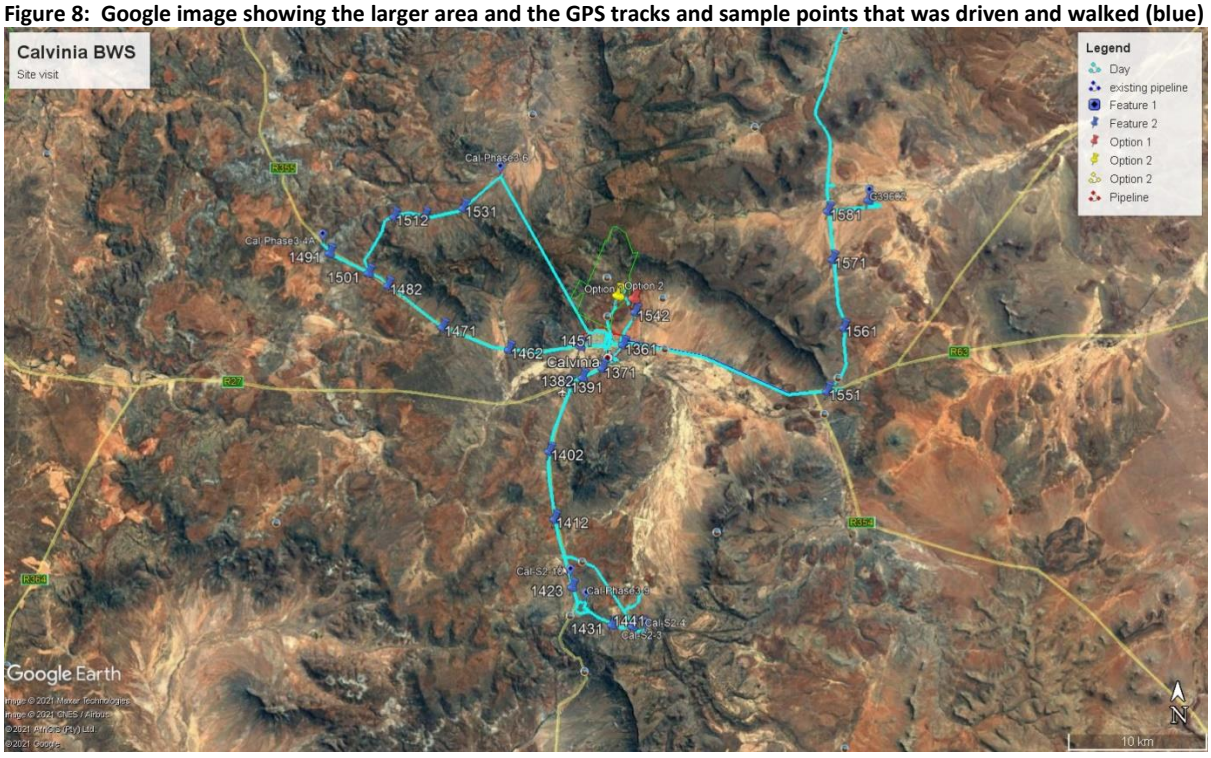
The South African soil map (SANBI BGIS) indicate that most of the proposed pipelines (Calvinia and surroundings) will be located in soils with a marked clay accumulation, strongly structured and a reddish colour, while the soil towards Loeriesfontein and in the Kreitzberg area is expected to be soils with minimal development, usually shallow, on hard or weathering rock, with or without intermittent diverse soils. Lime generally present in part or most of the landscape (Figure 7). Soils tend to be stony and shallow in most parts of the study area and seem to be easily waterlogged (especially south-west of Calvinia).

3. EVALUATION METHOD

The botanical survey was conducted over 3 days from 16th to the 18th of November 2020. The timing of the site visit was not very good, in that whole of the Northern Cape was still in the midst of a severe drought which had by then already lasted almost 7 years. Because of the drought many of the annual Asteraceae, Scrophulariaceae and bulb species would not have been encountered. However, in normal years the timing of the site visit would have been reasonable and would have overlapped the back end of the flowering season. Some rains had fallen in the Kreitzberg area and as a result a few bulb and annual plant species were observed. Further north towards Calvinia and Loeriesfontein rain was still absent and the areas were decidedly dry, which were very apparent in the condition of many of the plants encountered.

Desktop studies coupled with a site survey were performed. Spatial information from online databases such as SANBI BGIS, CapeFarmMapper and Google Earth were used to evaluate the site in terms of vegetation type(s) expected, potential significant features that might be encountered (e.g. variations in soil type, rocky outcrops etc.) and obvious differences in landscape or vegetation densities, which might indicate differences in plant community or species composition. Expected plant species lists were prepared and species of special significance were flagged (to be used as reference during the site visit).

Figure 8: Google image showing the larger area and the GPS tracks and sample points that was driven and walked (blue)



The following general conclusions were drawn on completion of the desktop assessment:

- The site and surrounding areas still support natural vegetation;
- The vegetation type is expected to be Hantam Karoo, considered "*least threatened*" in terms of the National list of threatened terrestrial ecosystems (2011) (The more resent 2018 National Spatial Biodiversity Assessment still lists Hantam Karoo as "*least threatened*") Refer to Heading 4.2).

- According to the 2016 Northern Cape Critical Biodiversity Map (Refer to Heading 4.3), the pipeline route will overlap critical biodiversity areas (CBA) and ecological support areas (ESA), but most of it would be located in areas identified as other natural areas.
- According to Van Wyk & Smith (2001) the site falls within the Hantam-Roggeveld Centre of endemism (Refer to Heading 4.4).

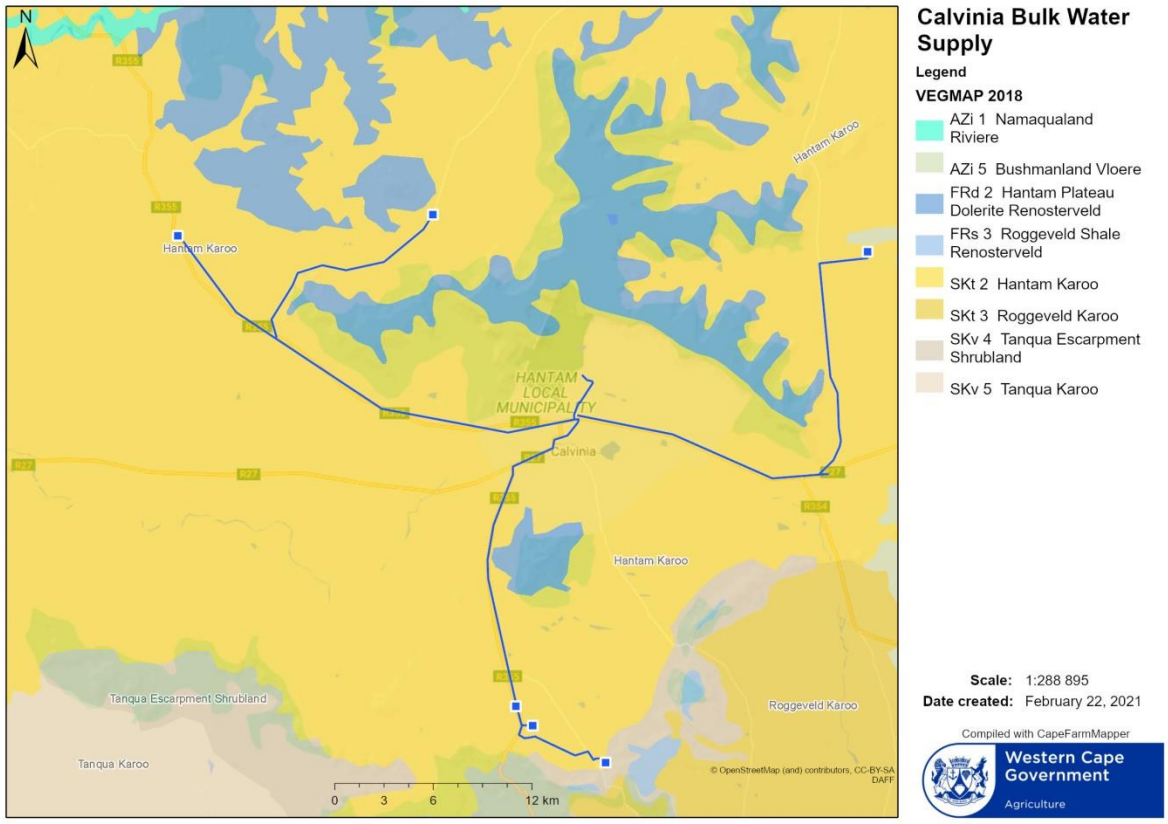
The survey was conducted over 3 days, starting from town driving each route, stopping every 5 km (or if any special feature presents itself in between the 5 km intervals) to sample the vegetation at that point (Refer to the waypoint markers in Figure 8). Sampling was done by walking the site and examining, marking and photographing any plant or feature of interest (Refer to Figure 8). A hand-held Garmin GPSMAP 62s was used to track the sampling route and for recording waypoints of locations of specific importance. During the survey notes, together with a photographic record, were compiled for the vegetation and landscape. The author endeavoured to identify and locate all significant biodiversity features, special plant species and or specific soil conditions which might indicate special botanical features (e.g. rocky outcrops or silcrete patches).

4. THE VEGETATION

Hantam Karoo corresponds largely with Acock's (1953) Western Mountain Karoo veld and to Low & Rebello's (1996) Upland Succulent Karoo vegetation type. In accordance with the 2018 Vegetation map of South Africa, Lesotho and Swaziland (Mucina & Rutherford, 2006), the proposed footprint(s) will only impact on one broad vegetation type, namely **Hantam Karoo** (Figure 9), a vegetation type classified as "Least Threatened" in terms of the NEM: BA "*national list of ecosystems that are threatened and in need of protection*" (GN 1002, December 2011).

More recently the 2018 National Biodiversity Assessment (NBA) was published (Skowno *et al.*, 2019a & Skowno *et a*l, 2019b). Although the findings of the 2018 NBA it is not yet formally adopted by NEM: BA in terms of regulations it is important to consider these findings. However, Hantam Karoo vegetation remains classified as "Least Threatened" in terms of the 2018 NBA.

Figure 9: Vegetation map of South Africa (2018), showing the expected vegetation types



4.1. THE VEGETATION IN CONTEXT

Hantam Karoo is a subtype of the Succulent Karoo Biome (the fourth largest Biome in South Africa); a semi-desert region with a strong maritime influence characterized by even, mild climate, that interfaces with the Fynbos Biome (with which it also shares its greatest floristic affinity) to the south and east, the Nama-Karoo to the north and west and the Desert Biome to the north. Globally there are few other places than can claim to be as biologically distinct as the Succulent Karoo Biome. It is unrivalled in its status as the world's only entirely arid region diversity hotspot and has a high diversity of dwarf leaf-succulent shrubs. "Vygies" or members of the Aizoaceae are particularly

prominent, with "spurges" or Euphorbiaceae and "stone crops" or Crassulaceae and succulent members of the Asteraceae, Iridaceae and Hyacinthaceae also prominent. The Succulent Karoo Biome has an equal status to the other biomes in South Africa – it is not a subtype of "a Karoo Biome." However, it is important to note that unlike in other parts of the Succulent Karoo, succulence (measured by the proportions of species in the Mesembryanthemaceae family) is poorly developed in the Hantam Karoo.

The Succulent Karoo Biome is primarily determined by the presence of low winter rainfall and extreme summer aridity. Rainfall varies between 20 and 290 mm per year. Because the rains in this area are cyclonic (and not thunderstorms) the erosive power is far less than of the summer rainfall biomes. During summer, temperatures in excess of 40°C are common. The vegetation is dominated by dwarf, succulent shrubs. Mass flowering displays of annuals (mainly Daisies, Asteraceae) occur in spring, often on degraded or fallow lands. Grasses are rare, except in some sandy areas, and are of the C3 type. The number of plant species (mostly succulents) is very high and unparalleled elsewhere in the world for an arid area of this size. Of importance in the area are heuweltjies, raised mounds of calcium-rich soil, thought to have been created by termites. (Mucina *et al*, 2006).

The Karoo used to support millions of antelope, mainly springbuck, but also numerous other larger antelope (and other grazing animal). These animals roamed the vast plains of the Karoo, utilizing different selections of plants and allowing for long "rest" periods as they move around, and as a result preventing overgrazing (Shearing, 1994). The Succulent Karoo has little agricultural potential due to the lack of water. The scarcity of grasses limits grazing, and the low carrying capacity requires extensive supplementary feeds. However, much soil has been lost from the biome, through sheet erosion, as a consequence of nearly 200 years of grazing. Tourism, on the other hand, is a major industry with the coastal scenery and the spring mass flower displays the main attractions, while mining, although to a lesser degree is also important, especially in the north (Mucina *et al*, 2006).

Lastly it is important to note that less than 0.5% of the Succulent Karoo Biome is formally conserved. The high species richness, high number of rare and Red Data Book species and unique global status of the biome require urgent conservation attention (Mucina *et al*, 2006).

4.2. VEGETATION ENCOUNTERED

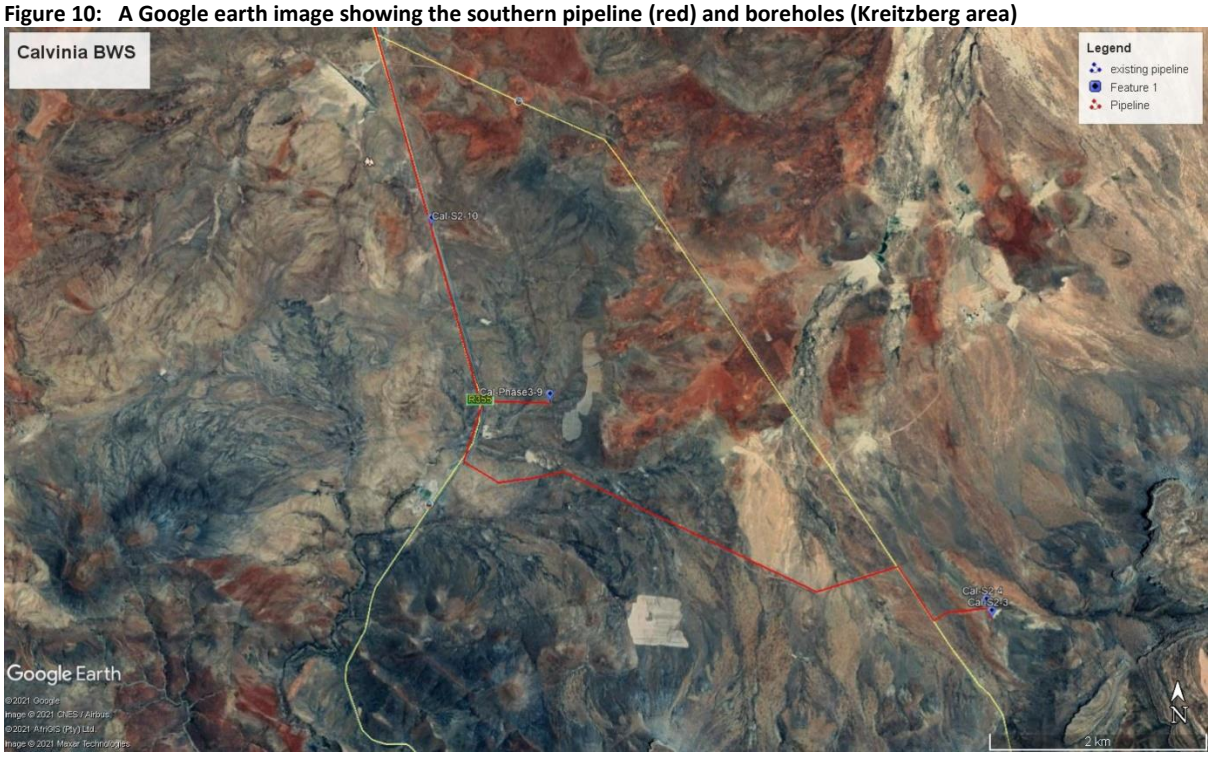
At the time of the study the area was still in the grips of a severe dry spell, which had lasted almost seven years at that stage. The Kreitzberg area seems to have had some recent rains, but the rest of the area was still dry to very dry. This reflected in the species composition and the condition of the plants (e.g. very few annual-, herbaceous- or bulbaceous plants were observed). The vegetation was relatively similar over most of the study area, but differences in soil, variation in altitude and rainfall (dryer areas) influenced species composition. The vegetation to the north of Calvinia (Loeriesfontein-, Toren and Klipwerf roads) were generally much dryer. The soils in the lower lying areas at Calvinia and its surrounds were generally more clayey and probably more prone to being waterlogged. Historic and on-going agricultural practices and urban associated disturbances near the town of Calvinia meant that the vegetation surrounding the town was generally in poor condition and most often dominated by hardy pioneer and weedy species. For discussion purposes the following broad distinctions were made:

- The southern pipeline and boreholes (Kreitzberg area);
- The dryer vegetation north-west of Calvinia (along the foothills of the Hantam Mountains);
- The vegetation to the north-east of Calvinia (Klipwerf road & Farm Rietfontein).
- The disturbed vegetation around Calvinia;

4.2.1. The southern pipeline and boreholes (Kreitzberg area)

The southern boreholes (CAL-S2-3 and CAL-S2-4) are found on the remainder of Farm Aurets Kloof No. 854 (located in the Kreitzberg Area), which is located on the plateau just north of the Tanqua escarpment (just north of the Bloukrans Pass) (Refer to **Error! Reference source not found.**). The boreholes are also located near to the interface between the Hantam Karoo and the Tanqua Escarpment Shrubland vegetation types and next to a small seasonal stream. However, the vegetation itself was dominated by hardy low-growing small-leaved perennial shrubs (<0.5 m), which conformed to the Hantam Karoo vegetation type (Photo 1). Even though this area was slightly wetter than the rest of the study area, very few herbaceous-, annuals and geophytic plants were observed because of the on-going severe draught.

Figure 10: A Google earth image showing the southern pipeline (red) and boreholes (Kreitzberg area)



In fact the shrubland encountered near the boreholes on the Farm Aurets Kloof and that encountered along the road reserve from Aurets Kloof to CAL-Phase3-and further north to CAL-S2-10, as well as the vegetation on the Vlakke Fontein itself was very similar, with the only differences being the vegetation encountered next to seasonal drainage lines and streams.

On Aurets Kloof, the veld was slightly more disturbed as the boreholes were located next to an existing watering point for domestic animals. Because of the regular (and more intensive grazing) of the area near the watering holes, the vegetation was dominated by the disturbance indicator *Galenia africana* (Photo 1). The remainder of the veld (including the road reserves) was usually

dominated by a combination of *Galenia africana*, *Ruschia intricata* (very common), *Mesembryanthemum noctiflorum* (very common), *Dicerothamnus rhinocerotis* (Renosterbos), *Eriocephalus africanus, E. ericoides,* the reddish *Mesembryanthemum dinteri* (Kraalbossie), *Osteospermum sinuatum, Pentzia incana, Pteronia glauca* and *Pteronia incana* (Photo 2). In between these shrubs species like *Anisodontea triloba*, *Asparagus capensis*, the tall dried out remains of *Bulbinella* cf. *elegans*, the grass *Ehrharta calycina* (occasionally), *Cheiridopsis namaquensis* (only observed at Vlakke Fontein), *Crassula subaphylla*, *Drosanthemum* cf. *framesii, Euryops lateriflorus, Euryops multifidus, Euryops nodosus, Euryops* species, the kukumakranka *Gethyllis lanuginosa, Hirpicium alienatum, Mesembryanthemum guerichianum,* the prostrate *Mesembryanthemum fastigiatum,* the bulb *Moraea pritzeliana,* the beautiful *Pelargonium rapaceum* (only at Vlakke Fontein), *Tylecodon wallichii* and *Ursinia nana* were often observed.

Photo 1: *Galenia africana* dominated near the watering hole at Aurets Kloof

Photo 2: Typical natural veld observed in the Kreitzberg area. *Ruschia intricata* in the foreground with *Eriocephalus* and *Euryops* species also visible.

The seasonal streams were usually demarcated by a riparian zone of slightly larger shrubs, although riparian vegetation was not always as conspicuous or obvious as one might have expected. Near the permanent surface water patches (the drinking hole and boreholes) on farm Aurets Kloof (Photo 3), sedges and restios such as *Afroscirpoides dioeca, Typha capensis* and *Willdenowia incurvata* were observed, which was not observed elsewhere near seasonal streams. One individual of the Natal bottlebrush (*Greyia sutherlandii*) was also observed (a tree normally found in the rocky ridges of the

Eastern Cape). It is expected that this tree was planted as a shade- or decorative tree (it was observed next to the stream but also near to the ruins of old buildings). Normally the vegetation associated with seasonal streams included small to medium trees like *Searsia undulata* (the parasitic plant *Viscum cf. hoolei* observed within one of these trees), *Searsia lancea* and *Diospyros austro-africana*, while larger shrubs like, *Lycium amoenum, Nenax microphylla* and the herbs *Ballota africana* and *Berkheya heterophylla* was normally only associated with these streams. A few of the alien invasive *Prosopis* trees was also observed near the boreholes on Farm Aurets Kloof

Photo 3: One of the boreholes at Aurets Kloof. Note the *Searsia lancea* and *Greyia sutherlandii* in the background with *Galenia africana*, *Typha capensis* and other sedges in the foreground.

Following the Kreitzberg- and Nooiensfontein roads, the vegetation remains basically the same as described above, although *Berkheya* cf. *fruticosa, Pteronia camphorata* and *Bromus pectinatus* was also observed. The pipeline will then follow the road reserve of the upper parts of the R355 or the Ceres – Calvinia road (Refer to Figure 10). Along the R355, the road reserve showed more signs of disturbances and the veld itself was also generally more disturbed than the neighbouring farmlands (Photo 4). The vegetation still remains the same, although *Ruschia intricata* was much more dominant in patches, while *Galenia africana* would dominate disturbed areas. The attractive Kankerbossie (*Lessertia frutescens)* was occasionally observed as well as the invasive alien plant *Opuntia ficus-indica* (occasionally*),* (occasionally).

Photo 4: A typical picture of the vegetation along the R355 looking towards Calvinia.

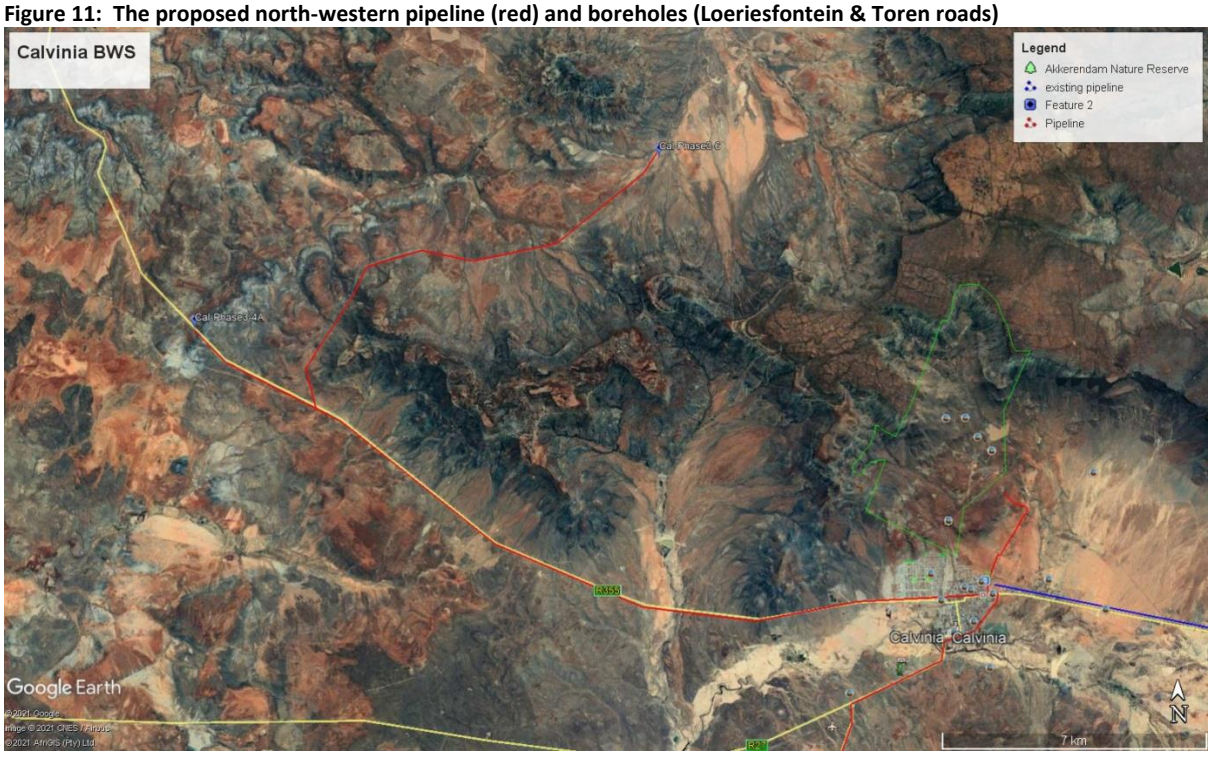
Nearer to Calvinia the soils becomes more clayey and dry and the vegetation composition changes slightly with *Galenia africana*, the weed *Salsola kali*, *Ursinia nana*, *Mesembryanthemum dinteri* (most of them also disturbance indicators) and *Eriocephalus ericoides* becoming more dominant.

Photo 5: The flower of *Pelargonium rapaceum* observed on the Farm Vlakke Fontein.

4.2.2. The dryer vegetation north-west of Calvinia

Two new proposed boreholes will be developed to the north-west of Calvinia. Both these boreholes are located within existing road reserves, one about 35 km north of Calvinia next to the Calvinia-Loeriesfontein road (R355 north) and one 14 km east on the Toren road (Figure 11). It is proposed that the new connecting pipelines (and power supply lines) are located within the road reserves of these roads (the eastern reserve of the Loeriesfontein road) and either the northern or southern reserve of the Toren road (depending on specialist studies).

Figure 11: The proposed north-western pipeline (red) and boreholes (Loeriesfontein & Toren roads)



Almost the first observation made, when initially driving from Calvinia along the Loeriesfontein road (the R355 north) is that the vegetation, although very similar, is a much drier version of the vegetation encountered along the R355 south towards Kreitzberg. The road reserve itself is also in general much wider (sometimes 50 – 70 m wide) along this section of the road.

Photo 6: The borehole next to the Loeriesfontein road, also showing a typical disturbed road reserve and its vegetation. Note the *Galenia africana* in the foreground with *Mesembryanthemum dinteri* (reddish plant) and *Oncosiphon* also visible.

Again the observations of annual plants, herbaceous plants and geophytes were limited as a result of the on-going drought. Along the road reserve, portions of the road reserve did show physical disturbances (Photo 6), but in general the vegetation was still very much natural (although typically along road reserves, weedy species were commonly observed).

Photo 7: Typical vegetation encountered along the R355 to Loeriesfontein (*Lycium* in the foreground).

The vegetation can be described as dominated by low growing (<0.5 m high) small-leaved perennial shrubs, with succulents scattered in between (Photo 7). *Eriocephalus ericoides* were more dominant in combination with *Pentzia incana*, *Galenia africana*, *Mesembryanthemum dinteri (=Psilocaulon), Osteospermum sinuatum, Mesembryanthemum noctiflorum (=Aridaria)*, *Euryops lateriflorus, Pteronia incana*, *Dicerothamnus rhinocerotis, Ruschia intricata, Lycium cinereum*, *Hirpicium alienatum, Anisodontea triloba* and the grass *Ehrharta calycina.* The herb *Tetragonia fruticosa*, the climbers *Microloma sagittatum* (in seed) and *Asparagus* species as well as *Euphorbia mauritanica, Roepera flexuosa (=Zygophyllum),* the weed *Salsola aphylla* and the succulents *Mesembryanthemum amplectens* and *Mesembryanthemum* cf. *nitidum* were observed for the first time.

In disturbed areas and road verges species like *Galenia africana*, *Mesembryanthemum guerichianum, Salsola kali*, *Oncosiphon piluliferus*, *Ursinia nana* and *Mesembryanthemum dinteri* were more prominent (Photo 6).

The vegetation along the 14 km Toren road is very much the same as that find along the Loeriesfontein road (especially the lower lying areas) (Photo 8). It remains a dry low shrubland, generally in good condition, although patch disturbances within the road reserve were also common. *Eriocephalus ericoides*, *Ruschia intricata*, *Pentzia incana*, *Galenia africana*, *Lycium cinereum* and *Hirpicium alienatum* were still very common. *Euphorbia mauritanica* becomes more dominant in areas where the road runs over the foothills of the Hantam Mountains (Photo 9), while a number of small seasonal streams cross the road from south to north down into the valley bottom.

Photo 8: A typical view of the vegetation encountered along most of the Toren road.

Photo 9: *Euphorbia mauritanica* prominent along the foothills of the Hantam Mountains.

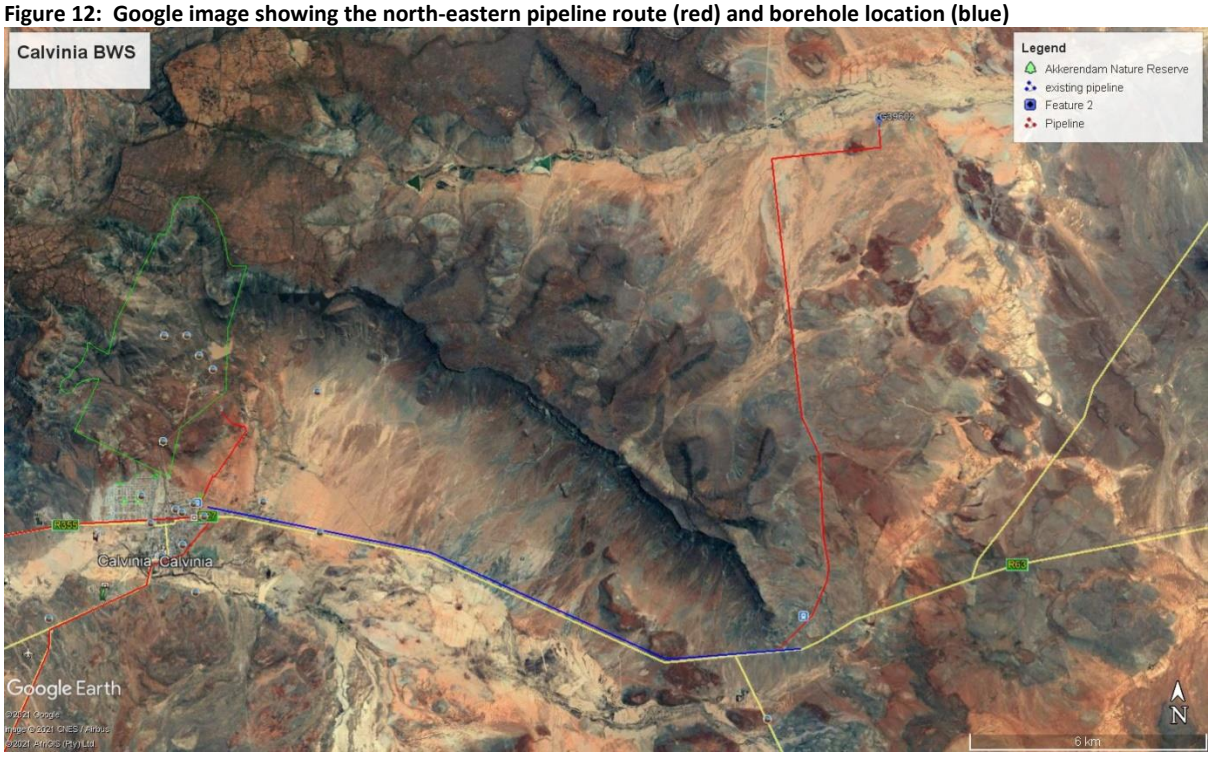
Searsia lancea and *Searsia undulata* usually dominates the upper canopy of the vegetation along these seasonal streams (Photo 10). The only new plants observed were a patch *Montinia caryophyllacea* (next to one of these water courses) and *Phragmites australis* (within the stream) while the climber *Cysticapnos vesicaria* was observed in one of the larger *Searsia lancea* trees. In the area the main objective should be to minimise the impact on larger indigenous trees (next to the water courses). They are mostly on the downslope (or northern side of the road verge). Unfortunately, the southern or upper slope is in places very narrow and steep, which might result in future erosion problems. The location of the pipeline should thus be a careful consideration between the protection of larger indigenous trees and the minimisation of future erosion problems.

Photo 10: One of the seasonal streams crossing underneath the road. Note the large *Searsia lancea* tree and the *Phragmites australis* within the stream.

4.2.3. The vegetation to the north-east of Calvinia (Klipwerf road & Farm Rietfontein)

The last proposed borehole is located to the north-east of Calvinia, on the remainder of the farm Rietfontein no. 550, about 4 km east of the Klipwerf road. The proposed pipeline (and power supply line) will follow the shortest route from the borehole south, to link up and then follow an existing twee-spoor road on the farm west towards the Klipwerf road. On its way it will cross portion 10 of the farm Spitskop no. 552 (both properties belonging to the same land owner). The proposed pipeline will then be placed within the road reserve of the Klipwerf road to link up with an existing pipeline next to the R26 (Calvinia – Brandvlei road) (Figure 12).

Figure 12: Google image showing the north-eastern pipeline route (red) and borehole location (blue)



The vegetation along the Klipwerf road is similar to the vegetation found along the R355 south (Calvinia – Ceres road), although a slightly drier version. It is again dominated by hardy low-growing small-leaved perennial shrubs (<0.5 m), but with succulent species equally common. Species diversity of both the shrub and succulent components was not very high (the same species being dominant for most of the way). The road reserve along the Klipwerf road is already disturbed by a cut-off (erosion prevention) trench running between the road verge and the fence delineating the road reserve.

Photo 11: *Cotyledon orbiculata* and *Euphorbia mauritanica* encountered within the road reserve of the first section of road.

In general the vegetation along the Klipwerf road was dominated by *Eriocephalus ericoides*, *Ruschia intricata* and *Pentzia incana* with individuals of *Euphorbia mauritanica* dotted throughout the first section (going over the small hills which rises from the R27). *Cotyledon orbiculata* was also commonly observed along this first section of the road as well as *Atriplex lindleyi* (Photo 11).

Photo 12: Typical vegetation encountered within the road reserve of the valley behind the first low hills. Note the disturbance next to the cut-off trench and the *Eriocephalus* and *Mesembryanthemum* species.

Going over the first hills into the valley behind, the soils became more clayey (Photo 12). *Eriocephalus* and *Ruschia* still dominated the vegetation, but the *Euphorbia* – and *Cotyledon* plants were replaced by a *Mesembryanthemum* species, most notably *M. noctiflorum and M. dinteri.* The dried out remains of *Moraea* cf. *bifida* were found throughout and would have made a spectacular show when in flower. Disturbed areas along the road were almost always dominated by

Mesembryanthemum fastigiatum, Galenia africana and *Mesembryanthemum dinteri*. Seasonal streams were associated with slightly larger bush clumps formed by a combination of species like *Lycium cinereum*, *Asparagus capensis*, *Galenia fruticosa* and *Melianthus comosus*.

From the Klipwerf road the proposed pipeline will turn east for the last 14 km to the borehole on Rietfontein. Turning onto the farm Spitskop the vegetation changes almost immediately to a very sparse Gannabos veld (*Salsola tuberculata*) as one enters one of the typical brackish lower lying areas or "vloere" of the Northern Cape (Photo 13 and Photo 14) (with its salty and clayey soils). The pipeline will fallow an existing twee-spoor pad over Skipskop (Photo 13) onto Rietfontein up until it is level with the borehole. It will then fallow the shortest route north (Photo 14), partially still following an existing twee-spoor road.

Photo 13: The vegetation on the Farm Spitskop, looking from the eastern boundary of the farm back towards the Klipwerf road.

Photo 14: Gannaveld encountered on the farm Rietfontein.

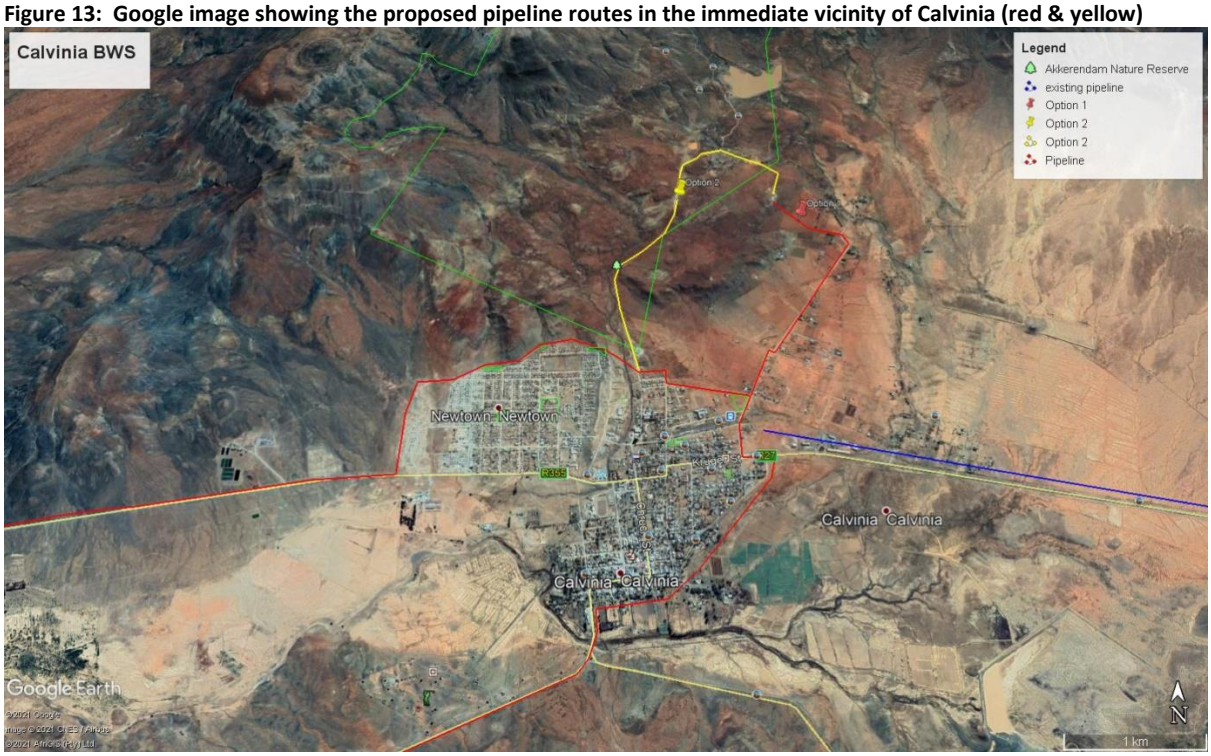
On Skipskop the vegetation is especially sparse with only a few individuals of *Salsola tuberculata*, *Mesembryanthemum junceum* and *Mesembryanthemum fastigiatum* plants encountered (Photo 13). The farm Rietfontein is on a slightly higher elevation as Skipskop and as a result the vegetation becomes slightly denser (Photo 14). The veld were very uniform in species composition and remains dominated by *Salsola tuberculata* in combination with *Mesembryanthemum noctiflorum*, *M. amplectens,* M. fastigiatum, *Rosenia* cf. *glandulosa*, *Lycium cinereum* and *Mesembryanthemum*

junceum. Scattered within this veld individuals of *Galenia fruticosa*, Atriplex lindleyi, A. *semibaccata, Oncosiphon piluliferus* and *Ursinia nana* were also encountered.

4.2.4. The disturbed vegetation around Calvinia

In terms of infrastructure, new pipelines will have to be constructed to the south (from the Calvinia – Ceres) road, from the east (the Loeriesfontein road), which will run to the south and north of Calvinia to be connected to the existing water treatment works (WTW), which is located to the north of town (just east of the Akkerendam Nature Reserve) (Figure 13). Please note that the access road to the WTW runs through this Nature Reserve.

Figure 13: Google image showing the proposed pipeline routes in the immediate vicinity of Calvinia (red & yellow)



From the R355 south (Calvinia – Ceres road) the proposed pipeline will run in the road reserve of the R27 using the existing bridge to cross the Oorlogskloof River, from where it will turn east running through a number of small holdings (agricultural land) skirting the town of Calvinia to the south and east, then turning north to follow existing roads on the outskirts of Calvinia, almost to the existing water treatment works (the last 200 – 300m will be trough remaining natural veld within the Akkerendam Nature Reserve (Figure 6).

The vegetation within the road reserve along the R27 (in this section) was disturbed to very disturbed (Photo 15) and dominated by a number of typical disturbance indicator species (or weedy species), like *Galenia africana*, *Mesembryanthemum junceum*, *M. subnodosum*, *Salsola kali, Atriplex semibaccata, Salsola kali* and *Atriplex lindleyi*. Hardy species like *Eriocephalus ericoides, Limonium sinuatum* and *Lycium cinereum* was observed occasionally as well as *Radyera urens* (another plant mostly found in disturbed areas).

Photo 15: Typical disturbed road reserve along the R27. Note the physical disturbance as well as the dominance by weedy species.

To the south, between the Oorlogskloof River and Calvinia, a series of small holdings were encountered, most of which is still actively farmed (Photo 16). In this section the vegetation was mostly transformed or very disturbed. Again only weedy species remains, apart from stands of reeds (*Phragmites australis* and *Typha capensis)* encountered within and along a very narrow shoulder of the Oorlogskloof River. Alien and invasive *Prosopis* trees were common along the river banks as well as *Atriplex lindleyi*, *Salsola kali*, with patches of *Salsola aphylla* (encountered in the salty silt areas next to the Oorlogskloof River) as well as a number of disturbance indicator succulents (refer to the next paragraph).

Photo 16: Typical small holding to the south of Calvinia, between the town of Calvinia and the Oorlogskloof River.

The vegetation to the east of Calvinia (from the Oorlogskloof River northwards over the R27) was also very disturbed. This was a common feature of all the areas around Calvinia where the proposed pipeline will be located, apart from the remaining natural veld within the Akkerendam Nature Reserve (Refer to Photo 17 to Photo 22).

Most of these areas were dominated by weedy species like *Galenia africana*, *Salsola kali, Atriplex lindleyi, Atriplex semibaccata, Oncosiphon piluliferus, Salsola aphylla* and various weedy succulents, which included *Mesembryanthemum junceum*, *M. fastigiatum* and *M. guerichianum*. *Prosopis* trees were also common, especially along water courses. Scattered in these disturbed areas, remaining individuals of the following species were sometimes encountered: *Anisodontea triloba*, *Bulbinella* cf.

elegans, Dicerothamnus rhinocerotis, Eriocephalus ericoides, *Lachenalia* cf. *carnosa, Lycium cinereum, Mesembryanthemum amplectens, M. dinteri, M. noctiflorum, M. subnodosum* and *Radyera urens.*

Photo 17: The disturbed vegetation to the east of Calvinia (just south of the R27) where the proposed pipeline will be located.

Photo 18: The weedy succulents encountered to the north of the R27, within the other edges of the north eastern section of Calvinia where the pipeline is proposed to be located.

Photo 19: The existing waterworks and the small section or remaining natural veld through which the pipeline will have to cross to link up with the existing water treatment works.

The vegetation encountered just east of the water treatment works (Photo 19) described by Van der Merwe & Hoffman (2019) as falling into the *Galenia africana – Eriocephalus ericoides* community of the Hantam Karoo vegetation type in their excellent work on the vegetation of Akkerendam Nature

Reserve. According to this study species expected includes *Amphiglossa triflora*, *Aristida vestita*, *Chrysocoma ciliata*, *Ehrharta calycina*, *Eriocephalus ericoides*, *E. spinescens*, *Galenia africana*, *Hermannia cuneifolia*, *Pteronia incana* and *Ruschia intricata*.

Photo 20: The typically disturbed vegetation encountered at Newtown (to the northwest of Calvinia) .

Photo 21: A photo overlooking the disturbed landscape to the north of Calvinia, between Newtown and the north eastern section of Calvinia..

Photo 22: The outer edge of the north eastern section of Calvinia. Note the existing earthen storm water protection structures.

Lastly: Figure 13 shows two potential pipeline route options for linking the pipeline from the northwest of Calvinia to the existing water treatment works (WTW). The red route (which should be

the preferred route), will follow the outer edge of the existing build footprint of Calvinia and could link up with the southern and eastern pipeline (existing) to enter the WTW from the east. This route will NOT impact on the Akkerendam NR and will have only a small impact on remaining natural veld (<200 m). The proposed yellow route will run along the existing entrance route to the WTW through the Akkerendam NR (for about 3.5 km). This will mean the pipeline will have an impact on remaining natural veld for almost the whole of the 3.5 km, which is not preferable, especially within a Nature Reserve in a semi-desert region where rehabilitation will be very slow.

4.3. CRITICAL BIODIVERSITY AREAS MAPS

The 2016 Northern Cape CBA Map (NCCBA) identifies biodiversity priority areas, called Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs), which, together with protected areas, are important for the persistence of a viable representative sample of all ecosystem types and species as well as the long-term ecological functioning of the landscape as a whole (Holness & Oosthuysen, 2016). The 2016 Northern Cape Critical Biodiversity Area (CBA) Map updates, revises and replaces all older systematic biodiversity plans and associated products for the province (including the Namakwa District Biodiversity Sector Plan, 2008). Priorities from existing plans such as the Namakwa District Biodiversity Plan, the Succulent Karoo Ecosystem Plan, National Estuary Priorities, and the National Freshwater Ecosystem Priority Areas were incorporated. Targets for terrestrial ecosystems were based on established national targets, while targets used for other features were aligned with those used in other provincial planning processes.

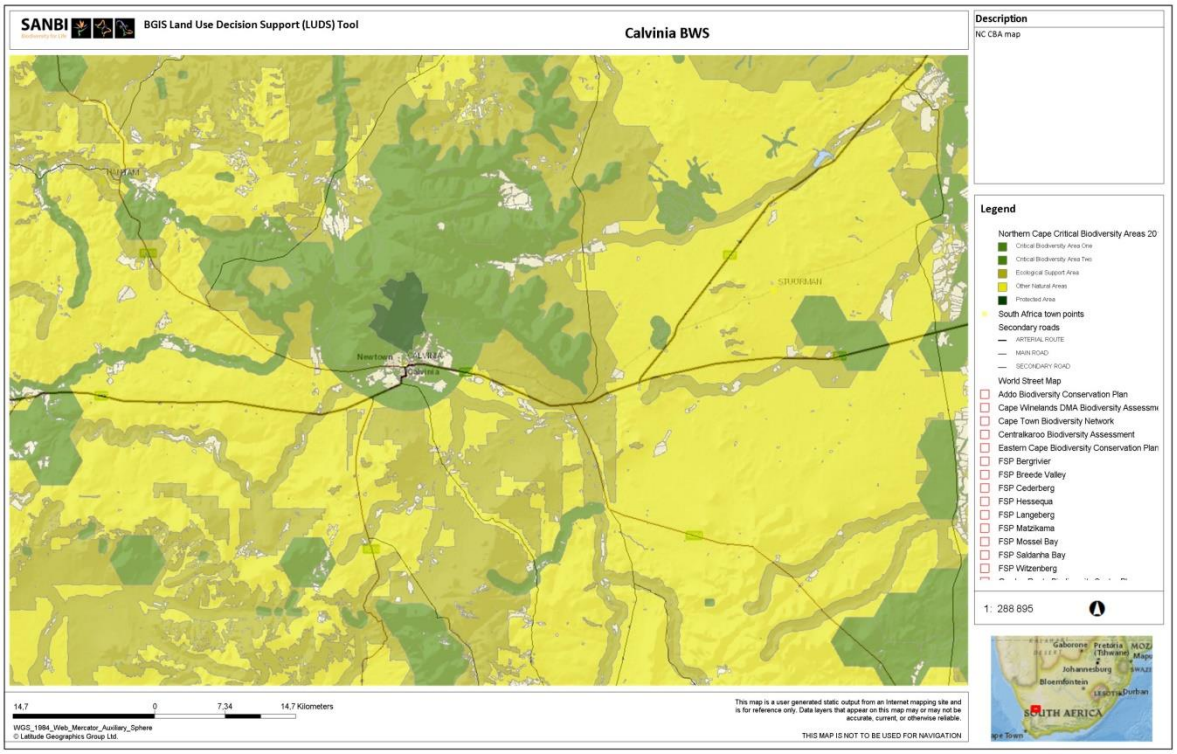
Critical biodiversity areas (CBA's) are terrestrial and aquatic features in the landscape that are critical for retaining biodiversity and supporting continued ecosystem functioning and services (SANBI 2007). The primary purpose of CBA's is to inform land-use planning in order to promote sustainable development and protection of important natural habitat and landscapes. CBA's can also be used to inform protected area expansion and development plans.

- **Critical biodiversity areas (CBA's)** are areas of the landscape that need to be maintained in a natural or near-natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. In other words, if these areas are not maintained in a natural or near-natural state then biodiversity conservation targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity-compatible land uses and resource uses.
- **Ecological support areas (ESA's)** are areas that are not essential for meeting biodiversity representation targets/thresholds but which nevertheless play an important role in supporting the ecological functioning of critical biodiversity areas and/or in delivering ecosystem services that support socio-economic development, such as water provision, flood mitigation or carbon sequestration. The degree of restriction on land use and resource use in these areas may be lower than that recommended for critical biodiversity areas.

From a land-use planning perspective it is useful to think of the difference between CBA's and ESA's in terms of where in the landscape the biodiversity impact of any land-use activity action is most significant:

- For CBA's the impact on biodiversity of a change in land-use that results in a change from the desired ecological state is most significant locally at the point of impact through the direct loss of a biodiversity feature (e.g. loss of a populations or habitat).
- For ESA's a change from the desired ecological state is most significant elsewhere in the landscape through the indirect loss of biodiversity due to a breakdown, interruption or loss of an ecological process pathway (e.g. removing a corridor results in a population going extinct elsewhere or a new plantation locally results in a reduction in stream flow at the exit to the catchment which affects downstream biodiversity).

Figure 14: Northern Cape Critical Biodiversity Areas Map (2016) showing the Calvinia area (SANBI BGIS)



According to the NCCBA (Figure 14), portions of the pipeline route will impact on both ESA's and CBA's. Fortunately, the pipeline will be located within the road reserve wherever possible. Road reserves can be very good ecological corridors, but can are also mostly slightly more disturbed as a result of road maintenance actions and the edge effect of the road itself (coupled with impacts from the road users). It was taken into account that the placement of the pipeline (underground) will only result in a short to medium term temporary impact, while locating it in the road reserve (rather than in the adjacent remaining natural veld), will also minimise the impact.

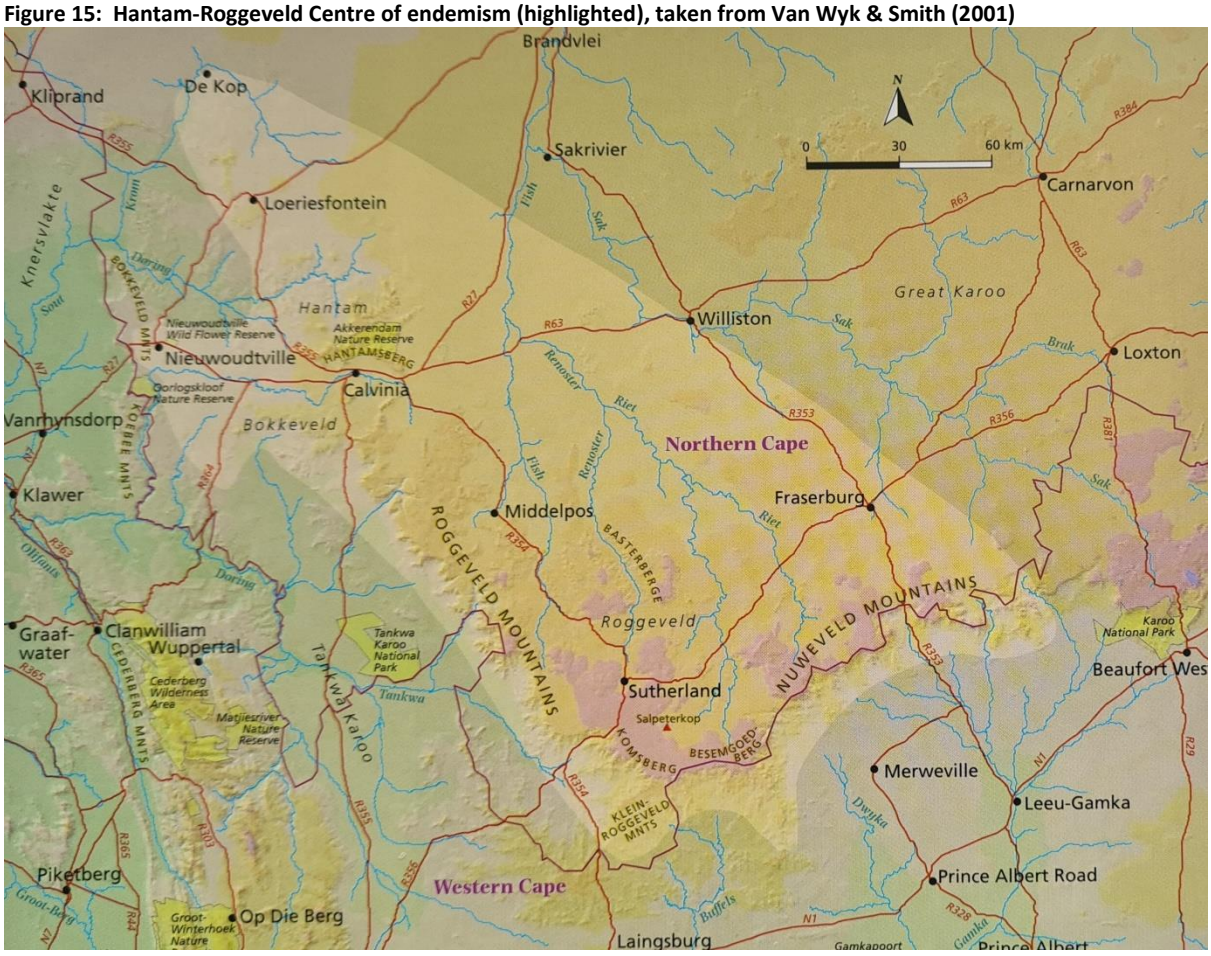
4.4. CENTRES OF ENDEMISM: POTENTIAL IMPACT

According to Van Wyk & Smith (2001), the proposed infrastructure fall within the Hantam-Roggeveld Centre (HRC) of endemism (Figure 15**Error! Reference source not found.**), which is named after the Hantam and Roggeveld regions in the Western Karoo of the Northern Cape Province. The Hantam is centred on the town of Calvinia and includes most of the Bokkeveld Plateau. The HRC occupies the

high-lying far south-western corner of the inland plateau of South Africa. It is bounded by the Bokkeveld Mountains in the west, the Renoster River in the east, the Bushmanland in the north and the Roggeveld Mountains in the south. Hantam is most probably derived from the KhoeKhoe word "*heyntame*", the name for *Pelargonium bifolium* (a plant with a reddish edible tuber). Diels (1908) mentioned the high levels of endemism in the Hantam-Roggeveld and concurred that the region is floristically more closely related to the Succulent Karoo and the Great Karoo than the Cape Floristic Region, although Cape floristic elements are clearly present, especially on the Hantam Mountains.

The HRC is one of the subdivisions of the Karoo and forms part of the Succulent Karoo Region, which is recognised as an important centre of plant diversity. The vegetation is typically dominated by low-growing small leaved perennial bushes up to 0.5 m in height. Common species include *Pentzia incana, Galenia africana, Zygophyllum gilfillanii, Euphorbia mauritanica, Ruschia caroli* and several species of *Eriocephalus*, *Salsola* and *Pteronia*. Grasses are few, apart from *Ehrharta calycina* and *Merxmuellera stricta*. Succulents, although present, are not very prominent, except in the drier areas north and west of Calvinia (which had been mapped as Upland Succulent Karoo by Low & Rebelo, 1996), which is described as a rather diverse vegetation type. At higher altitudes and in moister areas (200 – 300 mm), located mainly on the slopes and plateaux of mountains associated with the Great Escarpment it merges into a rare type of Mountain Renosterveld (with strong Karoo affinities) endemic to the HRC (Van Wyk & Smith, 2001).

Figure 15: Hantam-Roggeveld Centre of endemism (highlighted), taken from Van Wyk & Smith (2001)



In contrast to other areas of the Succulent Karoo, succulence as measured by the proportion of species in the Mesembryanthemaceae is poorly developed in the HRC and no succulent genera are

endemic to this centre of endemism (probably due to a less reliable or consistent rainfall pattern). However, the HRC is exceptionally high in geophytes and petaloid monocots, many of which are endemic to the region (Snijman & Perry, 1987).

The more recent Northern Cape Critical Biodiversity Areas map (2016), aims at the conservation of important corridors and local priority areas. As such the finer scale maps given in the NCCBA were used as basis to identify priority conservation areas within the study area (Refer to Heading 4.3).

4.5. FLORA ENCOUNTERED

Table 3 gives a list of the plant species encountered during this study. Because of the limitations (single site visits) it is likely that a number of annuals and geophytes might have been missed, but the author is confident that a good understanding of the vegetation was achieved and confidence in the findings is high.

Seventy three (73) different plant species where identified of which a number is South African endemics, and three (3) are naturalised weeds. No red-listed, National Environmental Management: Biodiversity Act, (Act 84 of 1998) or National Forest Act (Act 84 of 1998) protected species were observed, but twenty seven (27) Northern Cape Nature Conservation Act (Act 9 of 2009) protected species were encountered (a number of which were weedy/pioneer species often viewed as disturbance indicator species) (Refer to Table 4).

Table 3: Species checklist of flora observed within the study areas

No.	Species name	FAMILY	Status	Additional notes
1.	*Afroscirpoides dioeca*	CYPERACEAE		Large sedge
2.	*Anisodontea triloba*	MALVACEAE	LC	Medium herb
3.	*Asparagus capensis*	ASPARAGACEAE	LC	Scrambler / shrub
4.	*Asparagus* species (dried out remains)	ASPARAGACEAE		Scrambler / shrub
5.	*Atriplex lindleyi**	AMARANTHACEAE	Naturalised weed	Small shrub/herb
6.	*Atriplex semibaccata**	AMARANTHACEAE	Naturalised weed	Prostrate herb
7.	*Ballota africana*	LAMIACEAE	LC	Dwarf shrub/herb
8.	*Berkheya* cf. *fruticosa*	ASTERACEAE	LC	Thorny Shrub
9.	*Berkheya heterophylla*	ASTERACEAE	LC	Thorny herb
10.	*Bulbinella* cf. *elegans*	ASPODELACEAE	LC (SA endemic) NCNCA, Schedule 2 protected	Large geophyte
11.	*Cheiridopsis namaquensis*	AIZOACEAE	LC (SA Endemic) NCNCA, Schedule 2 protected	Small succulent
12.	*Chrysocoma ciliata*	ASTERACEAE	LC	Small shrub
13.	*Cotyledon orbiculata*	CRASSULACEAE	LC (SA endemic) NCNCA, Schedule 2 protected	Succulent shrub
14.	*Crassula subaphylla*	CRASSULACEAE	LC NCNCA, Schedule 2 protected	Straggling succulent
15.	*Cysticapnos vesicaria*	FUMARIACEAE	LC	Climber / herb
16.	*Dicerothamnus rhinocerotis (=Elytropappus rhinocerotis)*	ASTERACEAE	LC	Pioneer shrub

No.	Species name	FAMILY	Status	Additional notes
17.	*Diospyros austro-africana*	EBENACEAE	LC	Small tree
18.	*Drosanthemum* cf. *framesii*	AIZOACEAE	LC (SA endemic) NCNCA, Schedule 2 protected	Succulent
19.	*Ehrharta calycina*	POACEAE	LC	Slender graminoid
20.	*Eriocephalus africanus*	ASTERACEAE	LC (SA endemic)	Small shrub
21.	*Eriocephalus ericoides*	ATERACEAE	LC	Small Shrub
22.	*Euphorbia mauritanica**	EUPHORBIACEAE	LC NCNCA, Schedule 2 protected	Succulent shrub
23.	*Euryops lateriflorus*	ASTERACEAR	LC	Large shrub
24.	*Euryops multifidus*	ASTERACEAE	LC (SA endemic)	Medium shrub
25.	*Euryops nodosus*	ASTERACEAE	LC (SA endemic)	Medium shrub
26.	*Euryops* species	ASTERACEAE		Medium shrub
27.	*Felicia australis*	ASTERACEAE	LC (SA endemic)	Small herb
28.	*Galenia africana**	AIZOACEAE	LC NCNCA, Schedule 2 protected	Medium shrub
29.	*Galenia fruticosa*	AIZOACEAE	LC NCNCA, Schedule 2 protected	Leaf succulent shrub
30.	*Gethyllis lanuginosa*	AMARYLLIDACEAE	LC (SA endemic) NCNCA, Schedule 2 protected	Small geophyte
31.	*Hirpicium alienatum*	ASTERACEAE	LC	Dwarf shrub
32.	*Lachenalia* cf. *carnosa*	HYACINTACEAE	LC (SA endemic) NCNCA, Schedule 2 protected	Small geophyte
33.	*Lessertia frutescens*	FABACEAE	LC NCNCA, Schedule 1 protected	Small shrub
34.	*Limonium sinuatum*	PLUMBAGINACEAE	Naturalised weed	Small herb
35.	*Lycium amoenum*	SOLANACEAE	LC (SA endemic)	Large Shrub
36.	*Lycium cinereum*	SOLANACEAE	LC	Medium shrub
37.	*Melianthus comosus*	MELIANTHACEAE	LC	Medium shrub
38.	*Mesembryanthemum amplectens*	AIZOACEAE	LC (SA endemic) NCNCA, Schedule 2 protected	Succulent shrub
39.	*Mesembryanthemum* cf. *nitidum*	AIZOACEAE	LC (SA endemic) NCNCA, Schedule 2 protected	Succulent shrub
40.	*Mesembryanthemum dinteri (=Psilocaulon dinteri)**	AIZOACEAE	LC NCNCA, Schedule 2 protected	Succulent shrub
41.	*Mesembryanthemum fastigiatum**	AIZOACEAE	LC (SA endemic) NCNCA, Schedule 2 protected	Prostrate succulent
42.	*Mesembryanthemum guerichianum**	AIZOACEAE	LC NCNCA, Schedule 2 protected	Succulent shrub
43.	*Mesembryanthemum junceum (=Psilocaulon junceum)**	AIZOACEAE	LC NCNCA, Schedule 2 protected	Succulent shrub
44.	*Mesembryanthemum noctiflorum (=Aridaria noctiflora)*	AIZOACEAE	LC NCNCA, Schedule 2 protected	Succulent shrub
45.	*Mesembryanthemum subnodosum (=Psilocaulon subnodosum)**	AIZOACEAE	LC NCNCA, Schedule 2 protected	Succulent shrub
46.	*Microloma sagittatum*	APOCYNACEAE	LC NCNCA, Schedule 2 protected	Climbing herb

No.	Species name	FAMILY	Status	Additional notes
47.	*Moraea* cf. *bifida*	IRIDACEAE	LC (SA endemic) NCNCA, Schedule 2 protected	Medium geophyte
48.	*Moraea* cf. *pritzeliana*	IRIDACEAE	LC (SA endemic) NCNCA, Schedule 2 protected	Small geophyte
49.	*Nenax microphylla*	RUBIACEAE	LC	Dwarf shrub
50.	*Oncosiphon piluliferus**	ASTERACEAE	LC	Small herb
51.	*Osteospermum sinuatum**	ASTERACEAE	LC	Shrub
52.	*Pelargonium rapaceum*	GEREANIACEAE	LC (SA endemic) NCNCA, Schedule 1 protected	Small herbaceous plant
53.	*Pentzia incana*	ASTERACEAE	LC	Medium shrub
54.	*Phragmites australis*	POACEAE	LC	Large graminoid
55.	*Pteronia camphorata*	ASTERACEAE	LC (SA endemic)	Large shrub
56.	*Pteronia glauca*	ASTERACEAE	LC	Medium shrub
57.	*Pteronia glomerata*	ASTERACEAE	LC (SA endemic)	Medium/small shrub
58.	*Pteronia incana*	ASTERACEAE	LC	Shrub
59.	*Radyera urens**	MALVACEAE	LC	Prostrate herb
60.	*Roepera flexuosa (=Zygophyllum flexuosum)*	ZYGOPHYLLACEAE	LC	Dwarf succulent shrub
61.	*Rosenia* cf. *glandulosa*	ASTERACEAE	LC (SA endemic)	Low shrub
62.	*Ruschia intricata*	AIZOACEAE	LC NCNCA, Schedule 2 protected	Small thorny succulent
63.	*Salsola aphylla*	AMARANTHACEAE	LC	Woody shrub
64.	*Salsola kali**	AMARANTHACEAE	Naturalised weed	Herb
65.	*Salsola tuberculata*	AMARANTHACEAE	LC	Dwarf shrub
66.	*Searsia lancea*	ANACARDACEAE	LC	Tree
67.	*Searsia undulata*	ANACARDACEAE	LC	Small Tree
68.	*Tetragonia fruticosa*	AIZOACEAE	LC NCNCA, Schedule 2 protected	Succulent herb
69.	*Tylecodon wallichii*	CRASSULACEAE	LC NCNCA, Schedule 2 protected	Succulent shrub
70.	*Typha capensis*	THYPHACEAE	LC	Hydrophyte herb
71.	*Ursinia nana*	ASTERACEAE	LC	Small herb
72.	*Viscum* cf. *hoolei*	SANTALACEAE	LC	Parasitic shrub
73.	*Willdenowia incurvata*	RESTIONACEAE	LC NCNCA, Schedule 2 protected	Dwarf Restioid

* These species are often seen as disturbance indicators (although they can play a vital role in soil protection through its rapid germination and spread) (Vlok & Schutte-Vlok, 2015).

4.6. THREATENED AND PROTECTED PLANT SPECIES

South Africa has become the first country to fully assess the status of its entire flora. Major threats to the South African flora are identified in terms of the number of plant taxa Red-Listed as threatened with extinction as a result of threats like, habitat loss (e.g. infrastructure development, urban expansion, crop cultivation and mines), invasive alien plant infestation (e.g. outcompeting indigenous plant species), habitat degradation (e.g. overgrazing, inappropriate fire management

etc.), unsustainable harvesting, demographic factors, pollution, loss of pollinators or dispersers, climate change and natural disasters (e.g. such as droughts and floods). South Africa uses the internationally endorsed IUCN Red List Categories and Criteria in the Red List of South African plants. However, due to its strong focus on determining risk of extinction, the IUCN system does not highlight species that are at low risk of extinction, but may nonetheless be of high conservation importance. As a result a SANBI uses an amended system of categories in order to highlight species that may be of low risk of extinction but are still of conservation concern (SANBI, 2015).

In the Northern Cape, species of conservation concern are also protected in terms of national and provincial legislation, namely:

- The National Environmental Management: Biodiversity Act, Act 10 of 2004, provides for the protection of species through the "Lists of critically endangered, endangered, vulnerable and protected species" (GN. R. 152 of 23 February 2007).
- National Forest Act, Act 84 of 1998, provides for the protection of forests as well as specific tree species through the "List of protected tree species" (GN 908 of 21 November 2014).
- Northern Cape Nature Conservation Act, Act of 2009, provides for the protection of "specially protected species" (Schedule 1), "protected species" (Schedule 2) and "common *indigenous species"* (Schedule 3).

4.6.1. Red list of South African plant species

The Red List of South African Plants online provides up to date information on the national conservation status of South Africa's indigenous plants (SANBI, 2015).

- No red-listed species was observed (Refer to Table 3).

4.6.2. NEM: BA protected plant species

The National Environmental Management: Biodiversity Act, Act 10 of 2004, provides for the protection of species through the "Lists of critically endangered, endangered, vulnerable and protected species" (GN. R. 152 of 23 February 2007).

- No NEM: BA protected species was observed (Refer to Table 3).

4.6.3. NFA Protected plant species

The National Forests Act (NFA) of 1998 (Act 84 of 1998) provides for the protection of forests as well as specific tree species (as updated).

- No NFA protected species were observed (Refer to Table 3).

4.6.4. NCNCA protected plant species

The Northern Cape Nature Conservation Act 9 of 2009 (NCNCA) came into effect on the 12th of December 2011, and also provides for the sustainable utilization of wild animals, aquatic biota and plants. Schedule 1 and 2 of the act give extensive lists of specially protected and protected fauna and flora species in accordance with this act. NB. Please note that all indigenous plant species are protected in terms of Schedule 3 of this act (e.g. any work within a road reserve).

- **Twenty seven (27) species protected in terms of the NCNCA were encountered** (Refer to Table 3). Table 4 gives recommendations on impact minimisation with regards to these species.

Table 4: Plant species protected in terms of the NCNCA encountered within the study area

NO.	SPECIES NAME	COMMENTS	RECOMMENDATIONS
1.	*Bulbinella* cf. *elegans* **Schedule 2 protected**	Common bulb, especially along the Klipwerf road.	This plant was not restricted to the road reserve (very common in the adjacent veld). No search & rescue required. Topsoil conservation (top 15 – 20 cm of soils) and re-use for rehabilitation should
2.	*Cheiridopsis namaquensis* **Schedule 2 protected**	A very small plant, occasionally encountered on the remainder of Farm Vlakke Fontein no. 766	**Search & rescue** all plants, and replant to adjacent veld, if the pipeline over the Farm Vlakke Fontein is installed underground; If the pipeline is installed above ground, the impact will be minimal and no search & rescue required.
3.	*Cotyledon orbiculata* **Schedule 2 protected**	Occasionally observed along the Klifpwerf road.	**Search & rescue** all plants. Replant to adjacent veld.
4.	*Crassula subaphylla* **Schedule 2 protected**	Occassionally observed in the Kreitzberg area (the farms Aurets kloof and Vlakke Fontein)	**Search & rescue** all plants, and replant to adjacent veld, where the pipeline is installed underground; If the pipeline is installed above ground, the impact will be minimal and no search & rescue required.
5.	*Drosanthemum* cf. *framesii* **Schedule 2 protected**	Occassionally observed in the Kreitzberg area (the farms Aurets kloof and Vlakke Fontein)	No search & rescue required. Will be protected through topsoil conservation (propagate by seed) where pipelines are installed underground.
6.	*Euphorbia mauritanica* **Schedule 2 protected**	Common along the foothills of the Hantam Mountains	No search & rescue required. Larger plants does not transplant successfully.
7.	*Galenia africana* **Schedule 2 protected**	Common throughout	No search & rescue required. A weedy pioneer species.
8.	*Galenia fruticosa* **Schedule 2 protected**	Occasionally found along the Klipwerf road.	No search & rescue required. Impact will be insignificant on this population.
9.	*Gethyllis lanuginosa* **Schedule 2 protected**	Occasionally observed (only 2 individuals) on the farm Vlakke Fontein, but should be expected in the whole of the Kreitzberg area.	No Search & rescue required as it will be difficult to observe them out of season. Must be protected through topsoil conservation where pipelines are installed underground.
10.	*Lachenalia* cf. *carnosa* **Schedule 2 protected**	Occasionally observed just east of Calvinia.	No Search & rescue required as it will be difficult to observe them out of season. Must be protected through topsoil conservation where pipelines are installed underground.
11.	*Lessertia frutescens* **Schedule 1 protected**	Occasionally observed within the road reserves.	No search & rescue required. Will be protected through topsoil conservation (propagate by seed) where pipelines are installed underground.
12.	*Mesembryanthemum amplectens* **Schedule 2 protected**	Relative common throughout.	No search & rescue required. Will be protected through topsoil conservation (propagate by seed) where pipelines are installed underground.
13.	*Mesembryanthemum cf. nitidum* **Schedule 2 protected**	Occasionally observed.	No search & rescue required. Will be protected through topsoil conservation (propagate by seed) where pipelines are installed

NO.	SPECIES NAME	COMMENTS	RECOMMENDATIONS
			underground.
14.	*Mesembryanthemum dinteri* **Schedule 2 protected**	Common almost throughout (common in disturbed areas)	No search & rescue required. Will be protected through topsoil conservation (propagate by seed) where pipelines are installed underground.
15.	*Mesembryanthemum fastigiatum* **Schedule 2 protected**	Common throughout – a disturbance indicator.	No search & rescue required. A weedy pioneer species.
16.	*Mesembryanthemum guerichianum* **Schedule 2 protected**	Common throughout – a disturbance indicator.	No search & rescue required. A weedy pioneer species.
17.	*Mesembryanthemum junceum* **Schedule 2 protected**	Common almost throughout (common in disturbed areas)	No search & rescue required. Will be protected through topsoil conservation (propagate by seed) where pipelines are installed underground.
18.	*Mesembryanthemum noctiflorum* **Schedule 2 protected**	Common almost throughout (common in disturbed areas)	No search & rescue required. Will be protected through topsoil conservation (propagate by seed) where pipelines are installed underground.
19.	*Mesembryanthemum subnodosum* **Schedule 2 protected**	Common almost throughout (common in disturbed areas)	No search & rescue required. Will be protected through topsoil conservation (propagate by seed) where pipelines are installed underground.
20.	*Microloma sagittatum* **Schedule 2 protected**	Relative common herbaceous climber.	No search & rescue required. Will be protected through topsoil conservation (propagate by seed) where pipelines are installed underground.
21.	*Moraea* cf. *bifida* **Schedule 2 protected**	Occasionally observed.	No Search & rescue required as it will be difficult to observe them out of season. Must be protected through topsoil conservation where pipelines are installed underground.
22.	*Moraea* cf. *pritzeliana* **Schedule 2 protected**	Occasionally observed near Calvinia.	No Search & rescue required as it will be difficult to observe them out of season. Must be protected through topsoil conservation where pipelines are installed underground.
23.	*Pelargonium rapaceum* **Schedule 1 protected**	A very small plant, occasionally encountered on the remainder of Farm Vlakke Fontein no. 766	**Search & rescue** all plants, and replant to adjacent veld, if the pipeline over the Farm Vlakke Fontein is installed underground; If the pipeline is installed above ground, the impact will be minimal and no search & rescue required.
24.	*Ruschia intricata* **Schedule 2 protected**	Very common plant in most Karoo veld	No search & rescue required. Will be protected through topsoil conservation (propagate by seed) where pipelines are installed underground.
25.	*Tetragonia fruticosa* **Schedule 2 protected**	A common plant	No search & rescue required. Will be protected through topsoil conservation (propagate by seed) where pipelines are installed underground.
26.	*Tylecodon wallichii* **Schedule 2 protected**	Relative common (poisounous to livestock)	No search & rescue required. Will be protected through topsoil conservation where pipelines are installed underground.
27.	*Willdenowia incurvata* **Schedule 2 protected**	Only observed at Aurets Kloof next to water course.	No search & rescue required.

4.7. FAUNA AND AVI-FAUNA

Please note that no fauna screening was done as part of this study and the following is based on observations made during the site visit and the general status of the study area.

Because of its aridity the Karoo would have favours free moving herbivores such as ostrich and springbok, nomadic birds and invertebrates with variable dormancy cued by rain. Faunal diversity changes through space and time and are directly influenced by anthropogenic activities, including animal husbandry (i.e. overgrazing by livestock) and human settlements (e.g. transformation of land) (Tilman et al., 1997; Chapin et al., 2000). The major large-scale disturbance to the Karoo ecosystem has been the change in grazing. Since the 19th century the vast herds of migratory ungulates indigenous to this biome have been almost completely replaced by domestic stock. Once farmers started fencing their properties into camps (following the Fencing Act of 1912), stock numbers were dramatically increased with dire consequences to plant diversity. A case in point is the nearby Tankwa Karoo National Park, where larger game had to be reintroduced to the park with the aim of restoring large mammals as a key driver in maintaining biological diversity through trampling and herbivore disturbance (www.sanparks.org/parks/tankwa).

Previously a variety of indigenous migratory ungulates with a broad range of grazing habits would have migrated through the land, but now domestic sheep and goats with much more selective grazing habits are confined within farm boundaries (Skead, 1982). This change in the grazing regime is thought to be responsible for alterations in both plant species composition and cover, which ultimately influence ecosystem functioning (Roux & Theron, 1986). Grazing during and immediately after droughts periods is regarded as a major cause of detrimental change in vegetation composition and were ultimately responsible for the decline of large numbers of palatable plants (Mucina *et. al*., 2006). Heavily disturbed Karoo veld seldom recovers within one lifetime (Esler *et. al*., 2006).

Direct impacts are typically associated with urban land expansion, leading to land cover changes (and consequent loss of natural areas) and edge effects, whereas indirect impacts include impacts associated with the generation of waste (e.g. general or sewage) and its management (McDonald et al., 2020). Edge effects have diverse impacts on biodiversity and ecological functioning.

4.7.1. Mammals

Almost 95% of the pipeline will be located within existing road reserves. In general these road reserves were still covered with natural vegetation in good condition (although the on-going drought had impacted species diversity). The remaining pipelines will all be located on active livestock farms (mainly sheep). The location of the pipe lines (mainly within the road reserves) and the adjacent farming practices (livestock grazing) would all have contributed to a disturbance factor, which have resulted in the replaced of most game species with livestock (mostly sheep). This in turn would have affected the food chain and ultimately the density of tertiary predators, particularly mammals and larger birds of prey, while smaller predators and scavengers such as jackal and caracal would have been eradicated by farmers in fear of their livestock.

Smaller mammals like Aardvark (*Orycteropus afer*), Bat-eared fox (*Otocyon megalotis*), Black-backed jackal (*Canis mesomelas*), Cape hare (*Lepus capensis*), Scrub hare (*Lepus saxatilis*), Four-striped grass

mouse (*Rhabdomys pumilio*), Gerbil mouse (*Malacothrix typica*), House mouse (*Mus domesticus*), Karoo bush rat (*Otomys unisulcatis*), Grey duiker (*Sylvicapra grimmia*), Meerkat (*Suricata suricatta*), Cape porcupine (*Hystrix africaeaustralis*), Small-spotted genet (*Genetta genetta*), Steenbok (*Raphicerus campestris*) and the yellow mongoose (*Cynictis penicillata*) are still expected. However, the construction of the pipeline will only result in a relative short construction period and a temporary impact. Most of the species mentioned above will move to the adjacent natural veld during the construction period. The proposed development is not expected to have any significant or long lasting impact on the remaining natural fauna. Because of the long-term impact of human settlement on the larger areas a comprehensive faunal survey is not deemed necessary.

4.7.2. Reptiles

The Succulent Karoo in general is considered a centre of diversity and endemism for reptiles and many invertebrates (e.g. of the 50 scorpion species, 22 are endemic). Monkey beetles, largely endemic to southern Africa, are concentrated in the Succulent Karoo and are important pollinators of the flora. So, too, are the Hymenoptera and masarine wasps, and colletid, fideliid, and melittid bees (Vernon, 1999). Approximately 15 amphibians are found in this ecoregion, including three endemics. Among the region's 115 reptile species, 48 are endemic. The genus *Cordylus* (spinytail lizards) includes six strict endemics. Other strict endemics are Broadley's lance skink (*Acontias litoralis*), Richtersveld dwarf leaf-toed gecko (*Goggia gemmula*), Smith's sand lizard (*Meroles ctenodactylus*), Calvinia thick-toed gecko (*Pachydactylus labialis*), Namaqua thick-toed gecko (*P. namaqua*), and Meyer's legless skink (*Typhlosaurus meyeri*). The Sperregebiet region is a hotspot for endemic reptiles, including an unusual endemic tortoise, the Namba padloper (*Homopus bergeri*, VU) (Hilton-Taylor 2000).

Apart from the occasional lizard no other reptile or amphibian species were observed during the site survey. The project footprint may provide habitat for a number of reptile species, but they would most likely be terrestrial species adapted to the dry Karoo. Amphibian species within the proposed footprint will be very restricted due to the lack of permanent or semi-permanent wetland habitats.

4.7.3. Avi-fauna

The Akkerendam Nature Reserve (near Calvinia) is also popular with bird watchers and a proclaimed bird sanctuary, containing more than 65 different species of birds including, the Cinnamon-breasted Warbler or Kopje Warbler, Karoo Lark, Dwarf eagle, Black Harrier, Black-headed canary, Malachite Sunbird, Layards Warbler and Fairy Flycatcher.

Because of the overhead power line extensions that will have to be constructed to service the new boreholes, there is a possibility that some of the larger bird species may be impacted by these overhead lines. As a result an Avi-Fauna survey and report was prepared by Watson Africa (Van Driel, 2020). Refer to Appendix 2.

5. IMPACT ASSESSMENT METHOD

The objective of this study was to evaluate the botanical value of the study area in order to identify significant environmental resources that might be impacted as a result of the development. The Ecosystem Guidelines for Environmental Assessment (De Villiers *et. Al*., 2005), were used to evaluate the botanical significance of the property with emphasis on:

- Significant ecosystems
    - Threatened or protected ecosystems
    - Special habitats
    - Corridors and or conservancy networks
- Significant species
    - Threatened or endangered species
    - Protected species

5.1. DETERMINING SIGNIFICANCE

Determining impact significance from predictions of the nature of the impact has been a source of debate and will remain a source of debate. The author used a combination of scaling and weighting methods to determine significance based on a simple formula. The formula used is based on the method proposed by Edwards (2011). However, the criteria used were adjusted to suite its use for botanical assessment. In this document significance rating was evaluated using the following criteria (Refer to Table 5).

Significance = Conservation Value x (Likelihood + Duration + Extent + Severity) (Edwards 2011)

Table 5: Categories and criteria used for the evaluation of the significance of a potential impact

ASPECT / CRITERIA	LOW (1)	MEDIUM/LOW (2)	MEDIUM (3)	MEDIUM/HIGH (4)	HIGH (5)
CONSERVATION VALUE Refers to the intrinsic value of an attribute or its relative importance towards the conservation of an ecosystem or species or even natural aesthetics. Conservation status is based on habitat function, its vulnerability to loss and fragmentation or its value in terms of the protection of habitat or species	The attribute is transformed, degraded not sensitive (e.g. Least threatened), with unlikely possibility of species loss.	The attribute is in good condition but not sensitive (e.g. Least threatened), with unlikely possibility of species loss.	The attribute is in good condition, considered vulnerable (threatened), or falls within an ecological support area or a critical biodiversity area, but with unlikely possibility of species loss.	The attribute is considered endangered or, falls within an ecological support area or a critical biodiversity area, or provides core habitat for endemic or rare & endangered species.	The attribute is considered critically endangered or is part of a proclaimed provincial or national protected area.
LIKELIHOOD Refers to the probability of the specific impact occurring as a result of the proposed activity	Under normal circumstances it is almost certain that the impact will not occur.	The possibility of the impact occurring is very low, but there is a small likelihood under normal circumstances.	The likelihood of the impact occurring, under normal circumstances is 50/50, it may or it may not occur.	It is very likely that the impact will occur under normal circumstances.	The proposed activity is of such a nature that it is certain that the impact will occur under normal circumstances.
DURATION Refers to the length in time during which the activity is expected to impact on the environment.	Impact is temporary and easily reversible through natural process or with mitigation. Rehabilitation time is expected to be short (1-2 years).	Impact is temporary and reversible through natural process or with mitigation. Rehabilitation time is expected to be relative short (2-5 years).	Impact is medium-term and reversible with mitigation, but will last for some time after construction and may require on-going mitigation. Rehabilitation time is expected to be longer (5-15 years).	Impact is long-term and reversible but only with long term mitigation. It will last for a long time after construction and is likely to require on-going mitigation. Rehabilitation time is expected to be longer (15-50 years).	The impact is expected to be permanent.
EXTENT Refers to the spatial area that is likely to be impacted or over which the impact will have influence, should it occur.	Under normal circumstances the impact will be contained within the construction footprint.	Under normal circumstances the impact might extent outside of the construction site (e.g. within a 2 km radius), but will not affect surrounding properties.	Under normal circumstances the impact might extent outside of the property boundaries and will affect surrounding land owners or –users, but still within the local area (e.g. within a 50 km radius).	Under normal circumstances the impact might extent to the surrounding region (e.g. within a 200 km radius), and will regional land owners or –users.	Under normal circumstances the effects of the impact might extent to a large geographical area (>200 km radius).
SEVERITY Refers to the direct physical or biophysical impact of the activity on the surrounding environment should it occur.	It is expected that the impact will have little or no affect (barely perceptible) on the integrity of the surrounding environment. Rehabilitation not needed or easily achieved.	It is expected that the impact will have a perceptible impact on the surrounding environment, but it will maintain its function, even if slightly modified (overall integrity not compromised). Rehabilitation easily achieved.	It is expected that the impact will have an impact on the surrounding environment, but it will maintain its function, even if moderately modified (overall integrity not compromised). Rehabilitation easily achieved.	It is expected that the impact will have a severe impact on the surrounding environment. Functioning may be severely impaired and may temporarily cease. Rehabilitation will be needed to restore system integrity.	It is expected that the impact will have a very severe to permanent impact on the surrounding environment. Functioning irreversibly impaired. Rehabilitation often impossible or unfeasible due to cost.

5.2. SIGNIFICANCE CATEGORIES

The formal NEMA EIA application process was developed to assess the significance of impacts on the surrounding environment (including socio-economic factors), associated with any specific development proposal in order to allow the competent authority to make informed decisions. Specialist studies must advise the environmental assessment practitioner (EAP) on the significance of impacts in his field of specialty. In order to do this, the specialist must identify all potentially significant environmental impacts, predict the nature of the impact and evaluate the significance of that impact should it occur. Potential significant impacts are evaluated, using the method described above, in order to determine its potential significance. The potential significance is then described in terms of the categories given in Table 6.

Table 6: Categories used to describe significance rating (adjusted from DEAT, 2002)

SIGNIFICANCE	DESCRIPTION
Insignificant or Positive (4-22)	There is no impact or the impact is insignificant in scale or magnitude as a result of low sensitivity to change or low intrinsic value of the site, or the impact may be positive.
Low (23-36)	An impact barely noticeable in scale or magnitude as a result of low sensitivity to change or low intrinsic value of the site, or will be of very short-term or is unlikely to occur. Impact is unlikely to have any real effect and no or little mitigation is required.
Medium Low (37-45)	Impact is of a low order and therefore likely to have little real effect. Mitigation is either easily achieved. Social, cultural and economic activities can continue unchanged, or impacts may have medium to short term effects on the social and/or natural environment within site boundaries.
Medium (46-55)	Impact is real, but not substantial. Mitigation is both feasible and fairly easily possible, but may require modification of the project design or layout. Social, cultural and economic activities of communities may be impacted, but can continue (albeit in a different form). These impacts will usually result in medium to long term effect on the social and/or natural environment, within site boundary.
Medium high (56-63)	Impact is real, substantial and undesirable, but mitigation is feasible. Modification of the project design or layout may be required. Social, cultural and economic activities may be impacted, but can continue (albeit in a different form). These impacts will usually result in medium to long-term effect on the social and/or natural environment, beyond site boundary within local area.
High (64-79)	An impact of high order. Mitigation is difficult, expensive, time-consuming or some combination of these. Social, cultural and economic activities of communities are disrupted and may come to a halt. These impacts will usually result in long-term change to the social and/or natural environment, beyond site boundaries, regional or widespread.
Unacceptable (80-100)	An impact of the highest order possible. There is no possible mitigation that could offset the impact. Social, cultural and economic activities of communities are disrupted to such an extent that these come to a halt. The impact will result in permanent change. Very often these impacts cannot be mitigated and usually result in very severe effects, beyond site boundaries, national or international.

6. DISCUSSING BOTANICAL SENSITIVITY

The aim is to determine the vulnerability of a habitat to a specific impact. In order to do so, the sensitivity of the habitat should be determined by identifying and assessing the most significant environmental aspects of the site against the potential impact(s). For this development the following biodiversity aspects were considered:

- **Location**: Almost 95% of the approximate 100 km pipeline will be located within existing road reserves. In general these road reserves were still covered with natural vegetation in good condition (although the on-going drought had impacted species diversity). Because of the lack of irrigation water intensive farming is not a common practice (apart from the small holdings next to Calvinia) and the farms adjacent to these road reserves are all still covered in natural vegetation in fair to good condition. The main agricultural practice is livestock (mainly sheep) farming. Although over-grazing might have impacted some of these farms, the remaining natural vegetation on these farms are generally in similar or better condition than the vegetation within the road reserves. By placing the proposed pipelines within the road reserves, the environmental impact is already reduced significantly (especially since additional serves roads will not be needed – or minimised).
- **Activity**: The development of the boreholes will result in relative small localised concrete structures to protect and house the pumping & telemetry equipment. The construction of the connecting pipelines will result in a temporary disturbance within various road reserves (a total pipeline length of approximately 85 -90 km) as well as about 5.5 km on private properties (livestock farms). Further potential impact minimisation options discussed with the engineers, would be to place the pipeline above ground on some of these private properties (by placing the pipeline above ground, the physical excavation impact is almost negated).
- **Geology & Soils**: In general the soils were relatively similar, apart from the more salty and clayey soils of the "salt pans" or "vloere" encountered on the farms Spitskop and Rietfontein.
- **Land use and cover**: 95% of the approximate 100 km pipeline will be located within existing road reserves. About 5.5 km will be located on active livestock farms. The temporary nature of the construction should result in a temporary impact on these activities, which can be significantly reduced (or managed) with good communications with the land-owner.
- **Vegetation status**: The proposed footprint(s) will only impact on one broad vegetation type, namely Hantam Karoo, which is considered "Least Threatened". Hantam Karoo is a subtype of the Succulent Karoo Biome with a low winter rainfall and hot and dry summers. Globally there are few other places than can claim to be as biologically distinct as the Succulent Karoo Biome. At the time of the study the area was still in the grips of a severe dry spell, which had lasted almost seven years. This reflected in the species composition and the condition of the plants (e.g. very few annual-, herbaceous- or bulbaceous plants were observed). The vegetation was relatively similar over most of the study area, but differences in soil, variation in altitude and rainfall (dryer areas) influenced species composition. The vegetation to the north of Calvinia (Loeriesfontein-, Toren and Klipwerf roads) were generally much dryer. The soils in the lower lying areas at Calvinia and its surrounds were generally more clayey and probably more prone to being waterlogged. Historic and on-going agricultural practices and urban associated disturbances near the town of Calvinia meant that the vegetation surrounding the town was generally in poor condition and most often dominated by hardy pioneer and weedy species.

- **Conservation priority areas**: According to the NCCBA (Figure 14), portions of the pipeline route will impact on both ESA's and CBA's. Fortunately, the pipeline will be located within the road reserve wherever possible. Road reserves can be very good ecological corridors, but can are also mostly slightly more disturbed as a result of road maintenance actions and the edge effect of the road itself (coupled with impacts from the road users). It was taken into account that the placement of the pipeline (underground) will only result in a short to medium term temporary impact, while locating it in the road reserve (rather than in the adjacent remaining natural veld), will also minimise the impact.

  According to Van Wyk & Smith (2001), the proposed infrastructure falls within the Hantam-Roggeveld Centre (HRC) of endemism (Figure 15**Error! Reference source not found.**). However, the more recent Northern Cape Critical Biodiversity Areas map (2016), aims at the conservation of important corridors and local priority areas. As such the finer scale maps given in the NCCBA were used as basis to identify priority conservation areas within the study area.
- **Connectivity**: 95% of the pipeline will be located within existing road reserves and the impact will be temporary or nature. In general connectivity is still very good across most of the footprint and the proposed development is not expected to have any significant additional (long lasting) impact on connectivity.
- **Watercourses and wetlands**: A freshwater specialist was appointed to address this aspect.
- **Protected or endangered plant species**: The Succulent Karoo Biome is unrivalled in its status as the world's only entirely arid region diversity hotspot and has a high diversity of dwarf leaf-succulent shrubs. However, endemism species diversity is less pronounced in the Hantam Karoo (which is part of the Succulent Karoo). Seventy three (73) plant species where identified of which a number is South African endemics, and three (3) are naturalised weeds. No red-listed, NEMBA or NFA protected species were observed, but 27 NCNCA protected species were encountered (a number of which were weedy/pioneer species often viewed as disturbance indicator species).
- **Alien and Invasive Plant species**: The presence of a number of the invasive alien *Prosopis* tree is concerning. At present it is almost only found near water courses. However, care will have to be taken to ensure that this plant does not become a serious invader in this area.

Conservation value or habitat sensitivity is based on the irreplaceability of the habitat unit, on observations of the abundance and diversity of floral and faunal species present at the time of the assessment, on the presence of endangered or protected species within the habitat units, on the presence of Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) and on the degree of disturbance encountered as a result of historical and current activities.

The terrestrial habitat associated with this project is considered to be of a moderate sensitivity based on the following factors:

- The vegetation type is classified as least threatened;
- However, the project footprint overlaps CBA's & ESA's;
- The floral habitat and natural systems have been impacted, by grazing and urban related activities, but still functions well over most of the study area;
- The floral diversity is medium and no special habitats were observed, apart from the clayey soils of the salt pans or "vloere" at Rietfontein;
- No red-list or nationally protected plant species were observed, but 27 provincially protected plant species were encountered.

6.1. IMPACT ASSESSMENT

Table 7 rates the significance of environmental impacts associated with the proposed development. For each aspect, the worst case scenario (of the combined sites) were taken as "*without mitigation*" with reference to specific mitigation actions given for the specific site mitigation actions required when scoring "*with mitigation*". It also evaluates the expected accumulative effect of the proposed development as well as the No-Go option.

Table 7: Impact assessment associated with the proposed development

Impact assessment								
Aspect	**Mitigation**	**CV**	**Lik**	**Dur**	**Ext**	**Sev**	**Significance**	Short discussion
Geology & soils: Potential impact on special habitats (e.g. true quartz or "heuweltjies")	Without mitigation	2	2	2	2	1	14	No special habitats observed, apart from the salt pans or "vloere" on the Farm Spitskop & Rietfontein.
	With mitigation	2	1	1	1	1	8	Minimising of construction footprint through good environmental control.
Landuse and cover: Potential impact on socio-economic activities.	Without mitigation	3	3	2	2	1	24	95% of the approximate 100 km pipeline will be located within existing road reserves. About 5.5 km will be located on active livestock farms.
	With mitigation	3	1	2	1	1	15	Consider the viability of placing the pipeline above ground on the farms in the Kreitzberg area.
Vegetation status: Loss of vulnerable or endangered vegetation and associated habitat.	Without mitigation	4	3	3	2	2	40	A temporary impact on vegetation within the road reserve (90-95 km in length) and a number of private farms (5 - 7 km in length).
	With mitigation	4	2	2	1	1	24	Consider the viability of placing the pipeline above ground on the farms in the Kreitzberg area.
Conservation priority: Potential impact on protected areas, CBA's, ESA's or Centre's of Endemism.	Without mitigation	4	3	3	2	2	40	The proposed project will impact on both CBA and ESA areas. However, the impact will be temporary and by utilizing the road reserves, the impact is minimised.
	With mitigation	4	2	2	1	1	24	Minimising of construction footprint through good environmental control.
Connectivity: Potential loss of ecological migration corridors.	Without mitigation	4	2	2	2	2	32	Connectivity is still good across most of the footprint and the proposed development is not expected to have any long lasting impact on connectivity.
	With mitigation	4	2	2	1	1	24	Minimising of construction footprint through good environmental control.
Watercourses and wetlands: Potential impact on natural water courses and it's ecological support areas.	Without mitigation						0	N/a (Refer to the Freshwater specialist report).
	With mitigation						0	
Protected & endangered plant species:	Without mitigation	4	5	2	2	2	44	27 Provinitially protected species were observed, but not nationally protected or red listed species.

Impact assessment								
Aspect	**Mitigation**	**CV**	**Lik**	**Dur**	**Ext**	**Sev**	**Significance**	Short discussion
Potential impact on threatened or protected plant species.	With mitigation	4	4	2	1	1	32	Implement impact minimisations practices described for each protected species (Refer to Table 4).
Invasive alien plant species: Potential invasive plant infestation as a result of the activities.	Without mitigation	4	3	2	2	2	36	Prosopis and other alien species densities are generally low. However, indiscriminate construction can led to Prosopis distribution.
	With mitigation	4	2	1	1	1	20	Special care must be taken during alien control (in order to avoid re-sprouting).
Veld fire risk: Potential risk of veld fires as a result of the activities.	Without mitigation	4	2	3	3	2	40	Veld fire risk low.
	With mitigation	4	1	1	1	1	16	Address fire danger throughout construction.
Cumulative impacts: Cumulative impact associated with proposed activity.	Without mitigation	4	5	3	2	2	48	Temporary impact on an portion of land located within a CBA and which might result in impact on a number of NCNCA protected plant species.
	With mitigation	4	4	2	1	1	32	Refer to all the mitigation recommendations above.
The "No-Go" option: Potential impact associated with the No-Go alternative.	Without mitigation	3	3	4	2	2	33	The status quo will be maintained, but veld will still be impacted by urban and agricultural related activities. Water is a basic right an all communities should have access to drinking water.
	With mitigation						0	

According Table 7, the main impacts associated with the proposed development will be:

- The impact on NCNCA protected plant species (a definite, but temporary impact);
- The impact on CBA and ESA areas (a definite, but temporary impact);
- The impact on remaining natural vegetation (a definite, but temporary impact on vegetation classified as of Least Concern);

The No-Go option is not likely to result in a “no-impact” scenario, for it will have a negative socio-economic impact (and slow degradation may still continue).

The cumulative impact (without mitigation) is expected to be **Medium**, mainly as a result of the potential impact on protected plant species and CBA and ESA’s, but can be reduced to **Low** through simple and very viable mitigation options.

7. IMPACT MINIMISATION RECOMMENDATIONS

The proposed development will result in a temporary impact on natural vegetation along an approximate 100 km footprint. Only one vegetation type is expected, namely Hantam Karoo vegetation, which is not considered vulnerable. However, it will impact on CBA's and ESA's (some of which are also disturbed). However, 95% of the pipeline will be placed within existing road reserves and pipelines on private land can potentially be located above ground (which will result in a long term visual impact, but a very low construction related impact).

Probably the most significant botanical observations made relates to a number of protected plant species observed (refer to Table 4). In terms of vegetation, the Kreitzberg area was by far the most interesting in terms of species diversity, but all the water courses were also taken as areas of special significance.

According to the impact assessment given in Table 7 the development (without mitigation) is expected to result in a **Medium** impact, but can be reduced to **Low** through simple and very viable mitigation options.

With the correct mitigation it is unlikely that the development will contribute significantly to any of the following:

- Significant loss of vegetation type and associated habitat.
- Loss of ecological processes (e.g. migration patterns, pollinators, river function etc.) due to construction and operational activities.
- Loss of local biodiversity and threatened plant species.
- Loss of ecosystem connectivity.

7.1. SITE SPECIFIC RECOMMENDATIONS

Figure 16 (underneath) gives a sensitivity map for the Calvinia BWS. It shows the important Akkerendam Nature Reserve in green (just north of Calvinia) the slightly more sensitive Kreitzberg area also in green (to the south of Calvinia) and the disturbed or transformed areas, next to or within the Calvinia urban edge. The following site specific recommendations were made to minimise impact within the more sensitive areas:

- **Kreitzberg Area (aboveground pipelines)**: In the Kreitzberg area on the Farms Aurets Kloof & Vlakke Fontein, consideration should be given to place the pipelines above ground. The reasoning being that the potential impact on natural vegetation can be negated to a very large degree. In dry semi-desert areas, rehabilitation can take a long time. However, this will lead to a long term visual impact and may impact on the

free movement of livestock on the property (land-owner approval should be obtained – whichever option is taken).

- **Akkerendam Nature Reserve (Routes)**: Figure 13 shows two potential pipeline route options for linking the pipeline from the northwest of Calvinia to the existing water treatment works (WTW). The red route (which should be the preferred route), will follow the outer edge of the existing build footprint of Calvinia and could link up with the southern and eastern pipeline (existing) to enter the WTW from the east. This route will NOT impact on the Akkerendam NR and will have only a small impact on remaining natural veld (<200 m). The proposed yellow route will run along the existing entrance route to the WTW through the Akkerendam NR (for about 3.5 km). This will mean the pipeline will have an impact on remaining natural veld for almost the whole of the 3.5 km, which is not preferable, especially within a Nature Reserve in a semi-desert region where rehabilitation will be very slow.

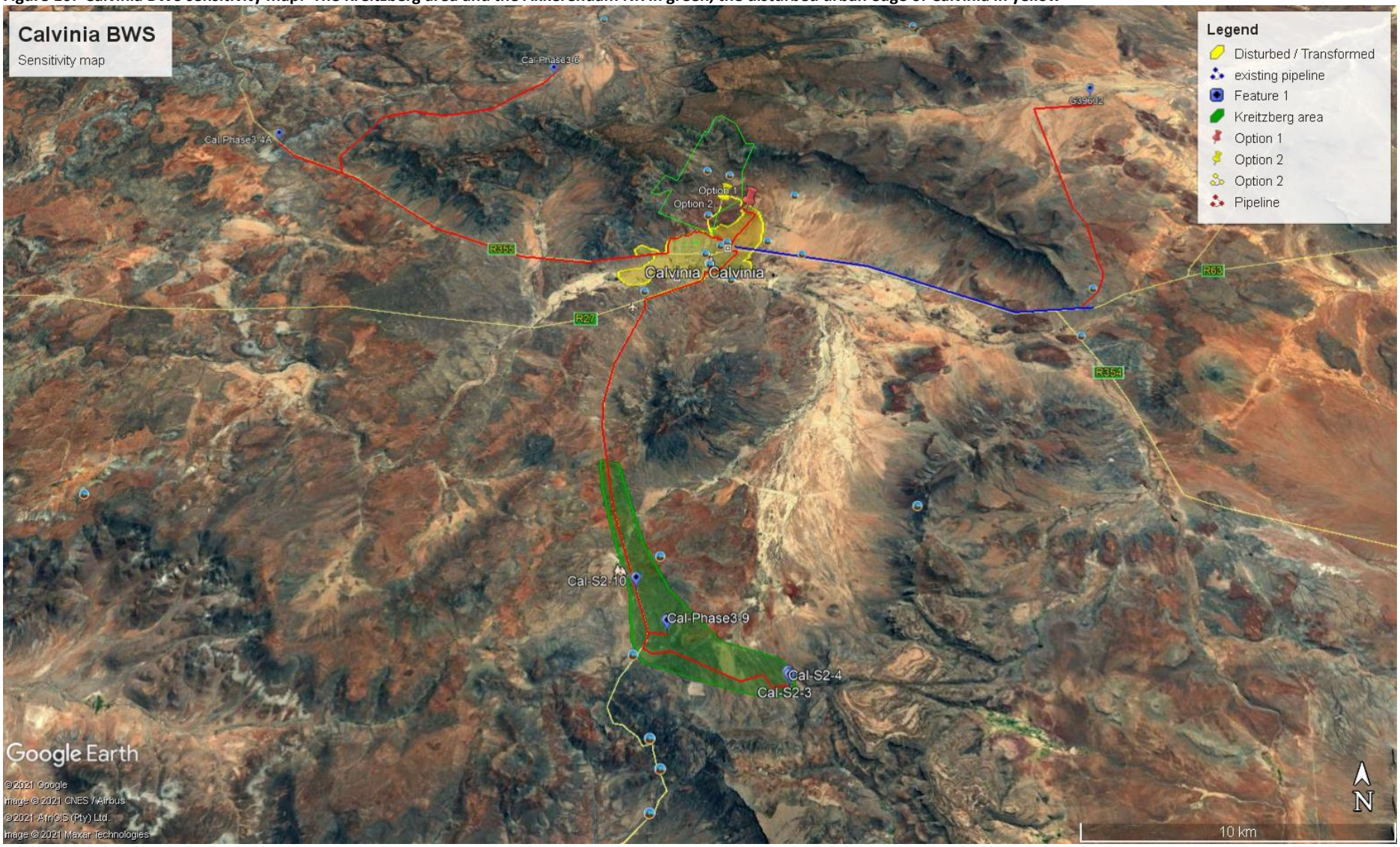
- Larger **water courses along the Toren Road**: A number of water courses cross this road from south (the Hantam Mountains) across the road into the valley below (to the north). A number of larger trees (most notably *Searsia lancea*) have established itself (mostly in the downslope riparian corridor) along these streams. The main objective should be to minimise the impact on larger indigenous trees (next to the water courses). They are mostly on the downslope (or northern side of the road verge). Unfortunately, the southern or upper slope is in places very narrow and steep, which might result in future erosion problems. The location of the pipeline should thus be a careful consideration between the protection of larger indigenous trees and the minimisation of future erosion problems.

7.2. GENERAL MITIGATION ACTIONS

The following general mitigation actions should also be implemented:

- All construction must be done in accordance with an approved construction and operational phase Environmental Management Plan (EMP), which must include the recommendations made in this report.
- A suitably qualified Environmental Control Officer must be appointed to monitor the construction phase in terms of the EMP and any other conditions pertaining to specialist studies.
- The layout of the development footprint should take the sensitivity map (Figure 16, next page) into account.
- Search & rescue as described in Table 4, must be done before construction may commence;
- Lay-down areas or construction sites must be located on areas already disturbed;
- No unnecessary clearing of any area outside of the construction footprint may be allowed.
- An integrated waste management approach must be implemented during construction.
    - Construction related general and hazardous waste may only be disposed of at suitably approved waste disposal sites.

Figure 16: Calvinia BWS sensitivity map: The Kreitzberg area and the Akkerendam NR in green, the disturbed urban edge of Calvinia in yellow



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Curriculum Vitae: Peet JJ Botes

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Nationality:	South African
ID No.:	670329 5028 081
Language:	Afrikaans / English
Profession:	Environmental Consultant & Auditing
Specializations:	Botanical & Biodiversity Impact Assessments
	Environmental Compliance Audits
	Environmental Impact Assessment
	Environmental Management Systems
Qualifications:	**BSc** (Botany & Zoology), with Nature Conservation III & IV as extra subjects; Dept. of Natural Sciences, Stellenbosch University 1989.
	Hons. BSc (Plant Ecology), Stellenbosch University, 1989
	More than 20 years of experience in the Environmental Management Field (Since 1997 to present).
Professional affiliation:	Registered Professional Botanical, Environmental and Ecological Scientist at SACNASP (South African Council for Natural Scientific Professions) since 2005.
SACNAP Reg. No.:	400184/05

BRIEF RESUME OF RELEVANT EXPERIENCE

1997-2005: Employed by the Overberg Test Range (a Division of Denel), responsible for managing the environmental department of OTB, developing and implementing an ISO14001 environmental management system, ensuring environmental compliance, performing environmental risk assessments with regards to missile tests and planning the management of the 26 000 ha of natural veld, working closely with CapeNature (De Hoop Nature Reserve).

2005-2010: Joined Enviroscientific, as an independent environmental consultant specializing in wastewater management, botanical and biodiversity assessments, developing environmental management plans and

strategies, environmental control work as well as doing environmental compliance audits and was also responsible for helping develop the biodiversity part of the Farming for the Future audit system implemented by Woolworths. During his time with Enviroscientific he performed more than 400 biodiversity and environmental legal compliance audits.

2010-2017: Joined EnviroAfrica, as an independent Environmental Assessment Practitioner and Biodiversity Specialist, responsible for Environmental Impact Assessments, Biodiversity & Botanical specialist reports and Environmental Compliance Audits. During this time Mr Botes compiled more than 70 specialist Biodiversity & Botanical impact assessment reports ranging from agricultural-, infrastructure pipelines- and solar developments.

2017-Present: Establish a small independent consultancy (PB Consult) specialising in Environmental Audits, Biodiversity and Botanical specialist studies as well as Environmental Impact Assessment.

LIST OF MOST RELEVANT BOTANICAL & BIODIVERSITY STUDIES

Botes. P. 2007: Botanical assessment. Schaapkraal, Erf 644, Mitchell's Plain. A preliminary assessment of the vegetation in terms of the Fynbos Forum: Ecosystem guidelines. 13 November 2007.

Botes. P. 2008: Botanical assessment. Schaapkraal Erf 1129, Cape Town. A preliminary assessment of the vegetation using the Fynbos Forum Terms of Reference: Ecosystem guidelines for environmental Assessment in the Northern Cape. 20 July 2008.

Botes, P. 2010(a): Botanical assessment. Proposed subdivision of Erf 902, 34 Eskom Street, Napier. A Botanical scan and an assessment of the natural vegetation of the site to assess to what degree the site contributes towards conservation targets for the ecosystem. 15 September 2010.

Botes, P. 2010(b): Botanical assessment. Proposed Loeriesfontein low cost housing project. A preliminary Botanical Assessment of the natural veld with regards to the proposed low cost housing project in/adjacent to Loeriesfontein, taking into consideration the National Spatial Biodiversity Assessment of South Africa. 10 August 2010.

Botes, P. 2010(c): Botanical assessment: Proposed Sparrenberg dam, on Sparrenberg Farm, Ceres. . A Botanical scan and an assessment of the natural vegetation of the site. 15 September 2010.

Botes, P. 2011: Botanical scan. Proposed Cathbert development on the Farm Wolfe Kloof, Paarl (Revised). A botanical scan of Portion 2 of the Farm Wolfe Kloof No. 966 (Cathbert) with regards to the proposed Cathbert Development, taking into consideration the National Spatial Biodiversity Assessment of South Africa. 28 September 2011.

Botes, P. 2012(a): Proposed Danielskuil Keren Energy Holdings Solar Facility on Erf 753, Danielskuil. A Biodiversity Assessment (with botanical input) taking into consideration the findings of the National Spatial Biodiversity Assessment of South Africa. 17 March 2012.

Botes, P. 2012(b): Proposed Disselfontein Keren Energy Holdings Solar Facility on Farm Disselfontein no. 77, Hopetown. A Biodiversity Assessment (with botanical input) taking into consideration the findings of the National Spatial Biodiversity Assessment of South Africa. 28 March 2012.

Botes, P. 2012(c): Proposed Kakamas Keren Energy Holdings Solar Facility on Remainder of the Farm 666, Kakamas. A Biodiversity Assessment (with botanical input) taking into consideration the findings of the National Spatial Biodiversity Assessment of South Africa. 13 March 2012.

Botes, P. 2012(d): Proposed Keimoes Keren Energy Holdings Solar Facility at Keimoes. A Biodiversity Assessment (with botanical input) taking into consideration the findings of the National Spatial Biodiversity Assessment of South Africa. 9 March 2012.

Botes, P. 2012(e): Proposed Leeu-Gamka Keren Energy Holdings Solar Facility on Portion 40 of the Farm Kruidfontein no. 33, Prince Albert. A Biodiversity Assessment (with botanical input) taking into consideration the findings of the National Spatial Biodiversity Assessment of South Africa. 27 March 2012.

Botes, P. 2012(f): Proposed Mount Roper Keren Energy Holdings Solar Facility on Farm 321, Kuruman. A Biodiversity Assessment (with botanical input) taking into consideration the findings of the National Spatial Biodiversity Assessment of South Africa. 28 March 2012.

Botes, P. 2012(g): Proposed Whitebank Keren Energy Holdings Solar Facility on Farm no. 379, Kuruman. A Biodiversity Assessment (with botanical input) taking into consideration the findings of the National Spatial Biodiversity Assessment of South Africa. 27 March 2012.

Botes, P. 2012(h): Proposed Vanrhynsdorp Keren Energy Holdings Solar Facility on Farm Duinen Farm no. 258, Vanrhynsdorp. A Biodiversity Assessment (with botanical input) taking into consideration the findings of the National Spatial Biodiversity Assessment of South Africa. 13 April 2012.

Botes, P. 2012(i): Askham (Kameelduin) proposed low cost housing, Mier Municipality Residential Project, Northern Cape. A preliminary Biodiversity & Botanical scan in order to identify significant environmental features (and to identify the need for additional studies if required. 1 November 2012.

Botes, P. 2013(a): Groot Mier proposed low cost housing, Mier Municipality Residential Project, Northern Cape. A preliminary Biodiversity & Botanical scan in order to identify significant environmental features (and to identify the need for additional studies if required. January 2013.

Botes, P. 2013(b): Loubos proposed low cost housing, Mier Municipality Residential Project, Northern Cape. A preliminary Biodiversity & Botanical scan in order to identify significant environmental features (and to identify the need for additional studies if required. January 2013.

Botes, P. 2013(c): Noenieput proposed low cost housing, Mier Municipality Residential Project, Northern Cape. A preliminary Biodiversity & Botanical scan in order to identify significant environmental features (and to identify the need for additional studies if required. January 2013.

Botes, P. 2013(d): Rietfontein proposed low cost housing, Mier Municipality Residential Project, Northern Cape. A preliminary Biodiversity & Botanical scan in order to identify significant environmental features (and to identify the need for additional studies if required. January 2013.

Botes, P. 2013(e): Welkom proposed low cost housing, Mier Municipality Residential Project, Northern Cape. A preliminary Biodiversity & Botanical scan in order to identify significant environmental features (and to identify the need for additional studies if required. January 2013.

Botes, P. 2013(f): Zypherfontein Dam Biodiversity & Botanical Scan. Proposed construction of a new irrigation dam on Portions 1, 3, 5 & 6 of the Farm Zypherfontein No. 66, Vanrhynsdorp (Northern Cape) and a scan of the proposed associated agricultural enlargement. September 2013.

Botes, P. 2013(g): Onseepkans Canal: Repair and upgrade of the Onseepkans Water Supply and Flood Protection Infrastructure, Northern Cape. A Biodiversity & Botanical scan in order to identify significant environmental features (and to identify the need for additional studies if required). August 2013.

Botes, P. 2013(h): Biodiversity scoping assessment with regards to a Jetty Construction On Erf 327, Malagas (Matjiespoort). 24 October 2013.

Botes, P. 2013(i): Jacobsbaai pump station and rising main (Saldanha Bay Municipality). A Botanical Scan of the area that will be impacted by the proposed Jacobsbaai pump station and rising main. 30 October 2013.

Botes, P. 2014(a): Brandvlei Bulk Water Supply: Proposed construction of a 51 km new bulk water supply pipeline (replacing the existing pipeline) from Romanskolk Reservoir to the Brandvlei

Reservoir, Brandvlei (Northern Cape Province). A preliminary Biodiversity & Botanical scan in order to identify significant environmental features (and to identify the need for additional studies if required). 24 February 2014.

Botes, P. & McDonald Dr. D. 2014: Loeriesfontein Bulk Water Supply: Proposed construction of a new bulk water supply pipeline and associated infrastructure from the farm Rheeboksfontein to Loeriesfontein Reservoir, Loeriesfontein. Botanical scan of the proposed route to determine the possible impact on vegetation and plant species. 30 May 2014.

Botes, P. 2014(b): Kalahari-East Water Supply Scheme Extension: Phase 1. Proposed extension of the Kalahari-East Water Supply Scheme and associated infrastructure to the Mier Municipality, ZF Mgcawu District Municipality, Mier Local Municipality (Northern Cape Province). Biodiversity & Botanical scan of the proposed route to determine the possible impact on biodiversity with emphasis on vegetation and plant species. 1 July 2014.

Botes, P. 2014(c): The proposed Freudenberg Farm Homestead, Farm no. 419/0, Tulbagh (Wolseley Area). A Botanical scan of possible remaining natural veld on the property. 26 August 2014.

Botes, P. 2014(d): Postmasburg WWTW: Proposed relocation of the Postmasburg wastewater treatment works and associated infrastructure, ZF Mgcawu District Municipality, Tsantsabane Local Municipality (Northern Cape Province). Biodiversity and botanical scan of the proposed pipeline route and WWTW site. 30 October 2014.

Botes, P. 2015(a): Jacobsbaai pump station and rising main (Saldanha Bay Municipality) (Revision). A Botanical Scan of the area that will be impacted by the proposed Jacobsbaai pump station and rising main. 21 January 2015.

Botes, P. 2015(b): Steenkampspan proving ground. Proposed establishment of a high speed proving (& associated infrastructure) on the farm Steenkampspan (No. 419/6), Upington, ZF Mgcawu (Siyanda) District Municipality, Northern Cape Province. Biodiversity and Botanical Scan of the proposed footprint. 20 February 2015.

Botes, P 2015(c): Proposed Bredasdorp Feedlot, Portion 10 of Farm 159, Bredasdorp, Cape Agulhas Municipality, Northern Cape Province. A Botanical scan of the area that will be impacted. 28 July 2015.

Botes, P. 2016(a): OWK Raisin processing facility, Kuruman, Erf 151, Kenhardt, Northern Cape Province. A Botanical scan of the proposed footprint. 26 May 2016.

Botes, P. 2016(b): Onseepkans Agricultural development. The proposed development of ±250 ha of new agricultural land at Onseepkans, Northern Cape Province. Biodiversity and Botanical Scan. January 2016.

Botes, P. 2016(c): Henkries Mega-Agripark development. The proposed development of ±150 ha of high potential agricultural land at Henkries, Northern Cape Province. Biodiversity and Botanical Scan of the proposed footprint. 28 February 2016.

Botes, P. 2016(d): Proposed Namaqualand Regional Water Supply Scheme high priority bulk water supply infrastructure upgrades from Okiep to Concordia and Corolusberg. Biodiversity Assessment of the proposed footprint. March 2016.

Botes, P. 2017: The proposed new Namaqua N7 Truck Stop on Portion 62 of the Farm Biesjesfontein No. 218, Springbok, Northern Cape Province. Botanical scan of the proposed footprint. 10 July 2017.

Botes, P. 2018(a): Kuruman Bulk Water Supply – Ground water desalination, borehole- and reservoir development, Kamiesberg, Northern Cape Province. Botanical scan of the proposed footprint. 20 February 2018

Botes, P. 2018(b): Rooifontein Bulk Water Supply – Ground water desalination, borehole- and reservoir development, Rooifontein, Northern Cape Province. Botanical scan of the proposed footprint. 23 February 2018

Botes, P. 2018(c): Paulshoek Bulk Water Supply – Ground water desalination, borehole- and reservoir development, Paulshoek, Northern Cape Province. Botanical scan of the proposed footprint. 27 March 2018.

Botes, P. 2018(d): Kakamas Waste Water Treatment Works Upgrade – Construction of a new WWTW and rising main, Khai !Garib Local Municipality, Northern Cape Province. Botanical assessment of the proposed footprint. 1 August 2018.

Botes, P. 2018(e): Kakamas Bulk Water Supply – New bulk water supply line for Kakamas, Lutzburg & Cillie, Khai !Garib Local Municipality, Northern Cape Province. Botanical assessment of the proposed footprint. 4 August 2018.

Botes, P. 2018(f): Wagenboom Weir & Pipeline – Construction of a new pipeline and weir with the Snel River, Breede River Local Municipality, Northern Cape Province. Botanical assessment of the proposed footprint. 7 August 2018.

Botes, P. 2018(g): Steynville (Hopetown) outfall sewer pipeline – Proposed development of a new sewer outfall pipeline, Hopetown, Northern Cape Province. Botanical assessment of the proposed footprint. 8 October 2018.

Botes, P. 2018(h): Tripple D farm agricultural development – Development of a further 60 ha of vineyards, Erf 1178, Kakamas, Northern Cape Province. Botanical assessment of the proposed footprint. 8 October 2018.

Botes, P. 2018(i): Steynville (Hopetown) outfall sewer pipeline – Proposed development of a new sewer outfall pipeline, Hopetown, Northern Cape Province. Botanical assessment of the proposed footprint. 8 October 2018.

Botes, P. 2019(a): Lethabo Park Extension – Proposed extension of Lethabo Park (Housing Development) on the remainder of the Farm Roodepan No. 70, Erf 17725 and Erf 15089, Roodepan Kimberley. Sol Plaaitje Local Municipality, Northern Cape Province. Botanical assessment of the proposed footprint (with biodiversity inputs). 15 May 2019.

Botes, P. 2019(b): Verneujkpan Trust agricultural development – The proposed development of an additional ±250 ha of agricultural land on Farms 1763, 2372 & 2363, Kakamas, Northern Cape Province. 27 June 2019.

Botes, P. 2020(a): Gamakor & Noodkamp Low cost housing – Botanical Assessment of the proposed formalization of the Gamakor and Noodkamp housing development on the remainder and portion 128 of the Farm Kousas No. 459 and Ervin 1470, 1474 and 1480, Gordonia road, Keimoes. Kai !Gariep Local Municipality, Northern Cape Province. 6 February 2020.

Botes, P. 2020(b): Feldspar Prospecting & Mining, Farm Rozynen Bosch 104, Kakamas. Botanical assessment of the proposed prospecting and mining activities on Portion 5 of The Farm Rozynen Bosch No. 104, Kakamas, Khai !Garib Local Municipality, Northern Cape Province. 12 February 2020.

Botes, P. 2020(c): Boegoeberg housing project – Botanical assessment of the proposed formalization and development of 550 new erven on the remainders of farms 142 & 144 and Plot 1890, Boegoeberg settlement, !Kheis Local Municipality, Northern Cape Province. 1 July 2020.

Botes, P. 2020(d): Komaggas Bulk Water supply upgrade – Botanical assessment of the proposed upgrade of the existing Buffelsrivier to Komaggas BWS system, Rem. of Farm 200, Nama Khoi Local Municipality, Northern Cape Province. 8 July 2020.

Botes, P. 2020(e): Grootdrink housing project – Botanical assessment of the proposed formalization and development of 370 new erven on Erf 131, Grootdrink and Plot 2627, Boegoeberg Settlement, next to Grootdrink, !Kheis Local Municipality, Northern Cape Province. 14 July 2020.

Botes, P. 2020(f): Opwag housing project – Botanical assessment of the proposed formalization and development of 730 new erven on Plot 2642, Boegoeberg Settlement and Farm Boegoeberg Settlement NO.48/16, Opwag, !Kheis Local Municipality, Northern Cape Province. 16 July 2020.

Botes, P. 2020(g): Wegdraai housing project – Botanical assessment of the Proposed formalization and development of 360 new erven on Erven 1, 45 & 47, Wegdraai, !Kheis Local Municipality, Northern Cape Province. 17 July 2020.

Botes, P. 2020(h): Topline (Saalskop) housing project – Botanical assessment of the pproposed formalization and development of 248 new erven on Erven 1, 16, 87, Saalskop & Plot 2777, Boegoeberg Settlement, Topline, !Kheis Local Municipality, Northern Cape Province. 18 July 2020.

Botes, P. 2020(i): Gariep housing project – Botanical assessment of the proposed formalization and development of 135 new erven on Plot 113, Gariep Settlement, !Kheis Local Municipality, Northern Cape Province. 20 July 2020.

APPENDIX 2: BIODIVERSITY REPORT - BIRDS