BIODIVERSITY ASSESSMENT

PROPOSED NAMAQUALAND REGIONAL WATER SUPPLY SCHEME

A Biodiversity Assessment of the area impacted by the proposed Namaqualand regional water supply scheme refurbishment (from Henkries Pump Station to Vaalhoek Reservoir, Okiep), taking into consideration the NSBA of South Africa.

June, 2012

PREPARED BY: PB Consult

PREPARED FOR: ENVIROAFRICA CC

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SUMMARY - MAIN CONCLUSIONS

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MAIN VEGETATION TYPES	**EASTERN GARIEP ROCKY DESERT**: Least Threatened; Not Protected; Remaining 99.7% **EASTERN GARIEP PLAINS DESERT**: Least Threatened; Not Protected; Remaining (Text) **BUSHMANLAND ARID GRASSLAND**: Least Threatened; Not Protected; Remaining 99.5% **BUSHMANLAND SANDY GRASSLAND**: Least Threatened; Hardly Protected; Remaining 99.4% **EENRIET PLAINS SUCCULENT SHRUBLAND**: Least Threatened; Not Protected; Remaining 99.5% **NAMAQUALAND BLOMVELD**: Least Threatened; Hardly Protected; Remaining 94% **NAMAQUALAND KLIPKOPPE SHRUBLAND**: Least Threatened; Poorly Protected; Remaining 95%
CRITICAL BIODIVERSITY AREAS (NAMAKWA DISTRICT BIODIVERSITY SECTOR PLAN)	The Terrestrial Critical Biodiversity Areas (CBA) map for the Namaqualand District Municipality shows that the existing pipeline (and thus the proposed refurbishment) crosses various areas identified as CBA's or CBA support areas within the sector plan (Refer to Figure 8). Care will have to taken when any work is done within or near any of the identified CBA areas, especially CBA1 areas (near Eenriet Reservoir). However, the impact could be negated and minimised through good environmental control. In fact if the old spoil (left during the original excavation) could be removed and the area cleaned up and suitably rehabilitated it might be possible that the project could improve the status of the area as a whole, and also the CBA areas
LAND USE AND COVER	Land use in the majority of the NDM is defined by livestock grazing and mining. Most of the study area is covered by natural vegetation with the Doring- and Skaap River and tributaries also present. Apart from the N7, smaller 2-spoor tracks and the Power lines, no other major infrastructure or land-use has been observed. . No intensive agricultural practices (excluding grazing) have been observed (apart from small areas in the vicinity of Henkries). The surrounding areas show the same largely natural veld extending in almost all directions (refer to the national Landcover map.
RED DATA PLANT SPECIES	*Aloe dichotoma* var. *dichotoma* (Kokerboom) is prominent in some areas, especially in the vicinity of the Bulletrap – Okiep area. The possibility exists that more red data species might be encountered within the study area (especially with regards to annual and geophytes plants). However, since the impact will be very localized and associated with existing disturbed areas, the changes of irreparable or irreversible lost is considered very low. A botanical scan of the final route will further minimise possible impacts (recommendations at the end of this report).
IMPACT ASSESSMENT	No-Go Alternative: Significance = 31.5% Refurbishment: Significance = 48.5% (No mitigation) Significance = **12.4%** (With mitigation) Where values of ≤15% indicate an insignificant environmental impact and values >15% constitute ever increasing environmental impact.

RECOMMENDATION	The fact that the replacement pipeline will be placed in the same trench (previously disturbed) in which the original pipeline is located will reduce the impact significantly, since the area was already impacted during the original installation of the pipeline. The current activity (when replacing the old pipeline with the new) will be of a temporary nature. It is also presumed that Environmental Control will be applicable (in the form of an ECO) during the construction phase (which was not the case during the original installation). From the study it is clear that care will have to taken when any work is done within or near any of the identified CBA areas, especially CBA1 areas (near Eenriet Reservoir). However, the impact could be negated and minimised through good environmental control. In fact if the old spoil (left during the original excavation) could be removed and the area cleaned up and suitably rehabilitated it might be possible that the project could improve the status of the area as a whole, and also the CBA areas. **With the available information to the author's disposal it is recommended that project be approved since it is not associated with irreversible environmental impact, provided that mitigation is adequately addresses.**

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 OTB 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 EIA applications, biodiversity assessment, botanical assessment, environmental compliance audits and environmental control work.

Mr. Botes is also a registered Professional 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.

Yours sincerely,

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CONTENTS

INTRODUCTION

Namakwa Water Board is a bulk supplier of water to the Nama Khoi Municipal jurisdiction area. The communities that are served are: Steinkop, Okiep, Concordia, Nababeep, Bulletrap, Carolusberg, Springbok and Kleinzee with an estimate population of ±50 000. The Namakwa water scheme was constructed during the 1970's and the Namakwa Water Board came into being in 1982. The scheme exist of an extraction point on the Orange River at Henkries mond, purification works at Henkries, a booster pump station at Doringwater and round about 130 km's of pipeline to Springbok. The water is pumped from Henkries to Eenrietberg from where it gravitates to Springbok. From Springbok to Kleinzee is another 120 km's of pipeline. As a result age and weathering the pipeline is subject to consistent breakages, resulting in significant water losses which again results in inconsistent water supply, leaving various communities and towns without potable water on an ever increasing frequency. All of the current pipelines have been in use well over its design period and needs to be replaced as a matter of urgency. The main cause for the deterioration of the pipeline was that the mortar lining at various points detached from the inner wall which led to water seeping behind the pipeline causing rust as well as the friction caused by lose pieces of mortar within the pipeline. As a result the upgrading and maintenance of the Namakwa water scheme is regarded as a very high priority. Since no other sources of potable water are locally available it means that the current pipelines need to be in operation while the replacement is done. A phased refurbishment has been proposed. The proposed project comprises the second phase of this refurbishment, and entails the replacement of approximately 100 km of pipeline between Henkries extraction point to Okiep (Vaalhoek Reservoir). Please note that the replacement of a portion of this pipeline, approximately 6 km of the old pipeline, just north of Okiep (the portion between 10 km – 16 km north of Okiep) where the most frequent failures occur (at the lowest point where the pressure is at its highest) has already been approved by DENC and is known as phase 1 of the project (Refer to Environmental Authorization Ref. No. NNO 25/19 (NC/BA/NAM/NAB3/2011) issued on the 16th of February 2012).

It is proposed that the existing pipeline is to be removed and that the new pipeline will be placed in the same trench/location as the original pipeline (within the existing servitude). Water must remain available during the refurbishment period. The engineers thus proposes to install the new pipeline in sections (in a leap-frog exercise) during which a temporary pipeline will be placed next to the existing pipe to ensure continual water supply (while being replaced). Since the natural vegetation over the pipeline has re-established itself, a biodiversity scan was commissioned to evaluate the environmental impact of the proposed activity.

TERMS OF REFERENCE

BVi Consulting Engineers (Pty) Ltd has been appointed to handle the project management and planning for the construction and refurbishment of the proposed project. EnviroAfrica (Pty) Ltd was appointed by BVi Consulting Engineers (Pty) Ltd as the independent Environmental Assessment Practitioner (EAP) to undertake the Scoping/Environmental Impact Assessment (EIA) Process for the proposed development. PB Consult was

appointed by EnviroAfrica to perform a Biodiversity Assessment of the proposed development area on recommendation by the EAP.

PB Consult was appointed within the following terms of reference:

- The study must consider short- to long-term implications of impacts on biodiversity and highlight irreversible impacts or irreplaceable loss of species.

INDIPENDENCE & CONDITIONS

PB Consult is an independent consultant to BVi Consulting Engineers and has 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.

DEFINITIONS & ABBREVIATIONS

DEFINITIONS

Environmental Aspect: Any element of any activity, product or services that can interact with the environment.

Environmental Impact: Any change to the environment, whether adverse or beneficial, wholly or partially resulting from any activity, product or services.

No-Go Area(s): Means an area of such (environmental/aesthetical) importance that no person or activity is allowed within a designated boundary surrounding this area.

ABBREVIATIONS

DEA	Department of Environmental Affairs
EAP	Environmental assessment practitioner
EIA	Environmental impact assessment
EMP	Environmental management plan
IUCN	International Union for Conservation of Nature
NDM	Namaqualand District Municipality
NSBA	National Spatial Biodiversity Assessment
SKEP	Succulent Karoo Ecosystem Project

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PROJECT DESCRIBTION

Water is being abstracted from the Orange River at a point near Goodhouse. The raw water abstracted is delivered to the purification and treatment works at Henkries and after treatment, the potable water is distributed via pipelines to the towns of Steinkopf, Bulletrap, Nababeep, Okiep, Carolusberg, Concordia, Springbok and the De Beers Mining operation and settlement of Kleinzee. The total population in the area supplied with potable water is approximately 55 000 people.

The current network consists of an extracting facility at the Orange River, a primary flocculation facility at Henkriesmond, a purification plant at Henkries and 4 pumping stations. The network also consists of a number of concrete reservoirs of which the main distribution reservoirs are Eenriet near Steinkopf and Vaalhoek in Okiep. The approximately 200 km of distribution pipes have an average age is 38 years. The pipeline varies in size from 520 mm steel to 150 mm asbestos pipeline.

Urgent infrastructure replacements and repairs should be carried out to insure continues supply. Currently supply is interrupted on a frequent basis leaving large portions of the population without potable water. As Springbok is the main town in the region it have a hospital prison various old age homes and schools with hostel this situation is compounded by the interrupted supply of bulk water services (BVi, August 2011).

PROPOSED REFURBISHMENT

All current pipeline needs to be replace as a matter of urgency due to the pipeline have been used well over its design period and due to the condition of the pipeline. As no other sources of potable water are locally available the current pipelines need to be in operation while the replacement is done. As a result the propose replacement of pipelines will be done in phases to insure the continuation of services.

This report is applicable to the second phase of this refurbishment, and entails the replacement of approximately 100 km of pipeline between Henkries extraction point to Okiep (Vaalhoek Reservoir). Please note that the replacement of a portion of this pipeline, approximately 6 km of the old pipeline, just north of Okiep (the portion between 10 km – 16 km north of Okiep) where the most frequent failures occur (at the lowest point where the pressure is at its highest) has already been approved by DENC and is known as phase 1 of the project (Refer to Environmental Authorization Ref. No. NNO 25/19 (NC/BA/NAM/NAB3/2011) issued on the 16th of February 2012)..

METHOD OF REFURBISHMENT

It is proposed that the existing pipeline is to be removed and that the new pipeline will be placed in the same trench/location as the original pipeline (within the existing servitude). The supply of water to the communities during the construction phase will be insured by a temporary pipeline is installed within the servitude of the

current pipeline. The engineers thus proposes to install the new pipeline in sections (in a leap-frog exercise) during which a temporary pipeline will be placed next to the existing pipe to ensure continual water supply (while being replaced).

The new pipeline will be of similar size to insure that the gravitational feed of the current pipeline is kept. The pipeline will be at least 1 meter under ground level and at least 1 meter under the river bed where crossings of rivers or streams might be encountered. The only visible part of the pipeline will be the current air vents and scoure valves that were erected when the pipeline was originally installed. The feasibility of replacing the old pipeline in the same trench will not only limit the cost of construction but will also insure the no new area is been disturbed (BVi, August 2011).

METHODS USED DURING THE ASSESSMENT

Biological diversity, or biodiversity, refers to the variety of life on Earth. As defined by the United Nations Convention on Biological Diversity, it includes diversity of ecosystems, species and genes, and the ecological processes that support them. Natural diversity in ecosystems provides essential economic benefits and services to human society—such as food, clothing, shelter, fuel and medicines—as well as ecological, recreational, cultural and aesthetic values, and thus plays an important role in sustainable development. Biodiversity is under threat in many areas of the world. Concern about global biodiversity loss has emerged as a prominent and widespread public issue.

The objective of this study was to evaluate the biological diversity associated with the study area in order to identify significant environmental features which should be avoided during development activities and or to evaluate short and long term impact and possible mitigation actions in context of the proposed development.

As such the report aim to evaluate the biological diversity of the area using the Ecosystem Guidelines for Environmental Assessment (De Villiers *et. al*., 2005), with emphasis on:

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

SITE VISIT

Apart from the desktop study, a site visit was conducted, one on the 2nd of June 2011. The site visit compromises visiting the proposed pipeline route and its immediate surroundings. During the site visit and subsequent desktop studies, a fairly good understanding of the environment was achieved. The timing of the site visit was also reasonable in that essentially all perennial plants where identifiable and although the possibility remains that a few species may have been missed, the author is confident that a fairly good understanding of the biodiversity status in the area was obtained.

The survey was conducted by driving and walking the pipeline route and examining and photographing any area of interest. Confidence in the findings is high.

The aim of site visit and subsequent desktop studies was to put the study area in perspective with regards to all probable significant biodiversity features which were encountered within the study area. During the desktop study possible significant biodiversity features associated with the larger surroundings was identified, and were taken into account. The desktop study taking into consideration and evaluating the location in terms of the:

- SANBI: Biodiversity GIS Home. http://bgis.sanbi.org (as updated);
- Vegetation map of South Africa, Lesotho and Swaziland (Mucina & Rutherford, 2006);
- National Spatial Biodiversity Assessment 2004;
- The Namakwa District Critical Biodiversity Areas Sector Map
- Fynbos Forum Ecosystem Guidelines for Environmental Assessment (De Villiers, 2005);
- The National list of ecosystems that are threatened and in need of protection (GN 1002, December 2011), promulgated in terms of the National Environmental Management Biodiversity Act (NEM: BA), Act 10 of 2004.

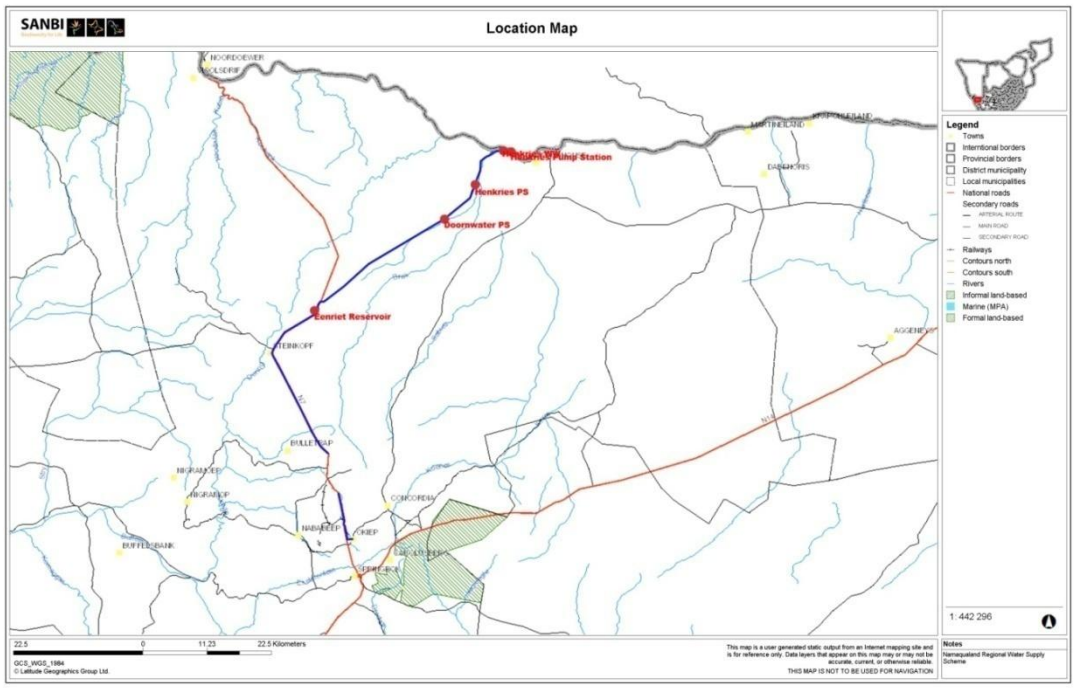
DESCRIBTION OF ENVIRONMENT

The aim of this description is to put the study area in perspective with regards to all probable significant biodiversity features which might be encountered within the study area. The study area has been taken as the two proposed routes and its immediate surroundings. During the desktop study significant biodiversity features associated with the larger surroundings was also identified (as far as possible), which was then also taken into account. The desktop study also informs as to the biodiversity status of such features as classified in the National Spatial Biodiversity Assessment (2004) as well as in the more recent updated Draft Threatened Ecosystems of South Africa (GG No. 32689, 2009 & SANBI & DEAT, 2009) and particularly to draft biodiversity sector plan for the Namaqualand District Municipality (Critical Biodiversity Areas Map).

LOCATION & LAYOUT

This report to the second phase of the pipeline refurbishment, which includes the replacement of approximately 100 km of pipeline between Henkries extraction point to Okiep (Vaalhoek Reservoir) (Refer to Figure 1). Please note that the replacement of a portion of this pipeline, approximately 6 km of the old pipeline, just north of Okiep (the portion between 10 km – 16 km north of Okiep) has already been approved by DENC and is known as phase 1 of the project (Refer to Environmental Authorization Ref. No. NNO 25/19 (NC/BA/NAM/NAB3/2011), issued on the 16th of February 2012). The town of Okiep is situated just north of Springbok in the Namakwa District Municipality.

Figure 1: Overview of the Namakwa Water Scheme, indicating the location of the proposed refurbishment (in blue)



The following waypoints (WGS 84 format) can be used as reference:

Phase 2:

- Henkries extraction point: S28 54 06.8 E18 10 01.9

- Henkries treatment works: S28 54 03.6 E18 08 14.8
- Henkries purification plant: S28 58 33.4 E18 05 43.6
- Doornwater pump station: S29 04 54.5 E17 56 45.3
- Eenriet Reservoir: S29 11 14.9 E17 48 49.9

Phase 1 (already completed)

- Gravity Starts: S29 27 14.0 E17 50 23.0
- Gravity End: S29 31 01.0 E17 51 34.0

Phase 2 continue

- Vaalhoek Reservoir (Okiep): S29 35 33.2 E17 53 13.4

TOPOGRAPHY

The pipeline starts at the Henkries extraction point (elevation ± 200 m) next to the Orange River. It then follows the base of the Rocky outcrops next to the Orange River to the Henkries Treatment Works (elevation ± 208 m). From there it is follows the road to Henkries (between the rocky outcrops) and on to the Henkries Purification Plant (elevation ± 413 m). From there it follows the road connecting Henkries with the N7, through the open plains, to the Doornwater Pump station (elevation ± 745 m). From the pump station the pipeline again follows the road between Henkries and the N7 southwards, still running through the open Bushmanland plains towards the Eenriet Reservoir situated on a small koppie (elevation ± 1 094 m) next to the N7. From Eenriet it follows along the N7 (to the west) towards Steinkopf and from there all the way along the N7 towards the Vaalhoek Reservoir next to Okiep (elevation ± 956 m). It crosses the N7 just before Okiep from where it follows along the eastern side of the N7. Just south of Steinkopf the pipeline crosses the first of two small rivers/streams which drains into the Doring River. The Skaap River is also crossed just north of Okiep.

CLIMATE

All regions with a rainfall of less than 400 mm per year are regarded as arid. This area normally receives about 106 mm of rain per year (the climate is therefore regarded as arid to very arid) and because it receives most of its rainfall during winter it has a Mediterranean climate.

Figure 2: Average monthly precipitation over the year (www.weather-and-climate.com)

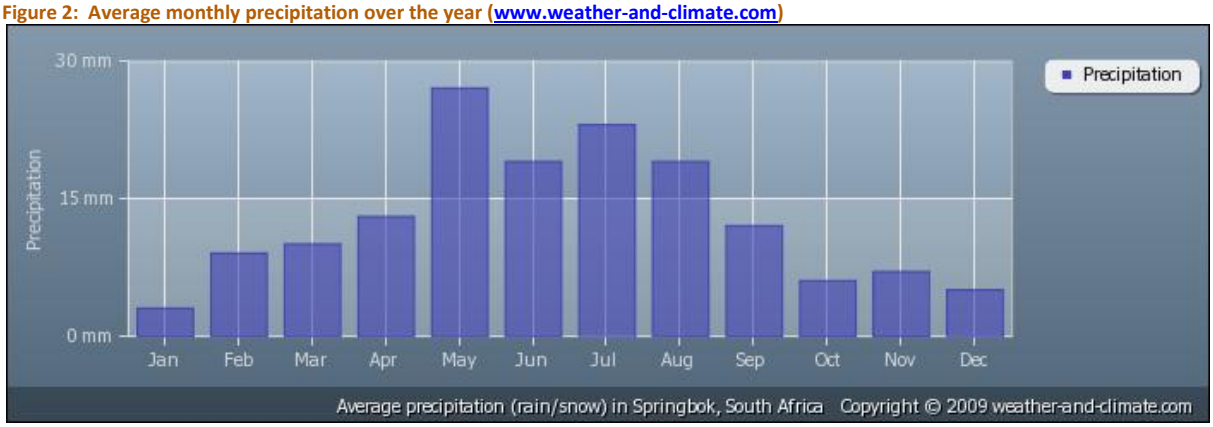


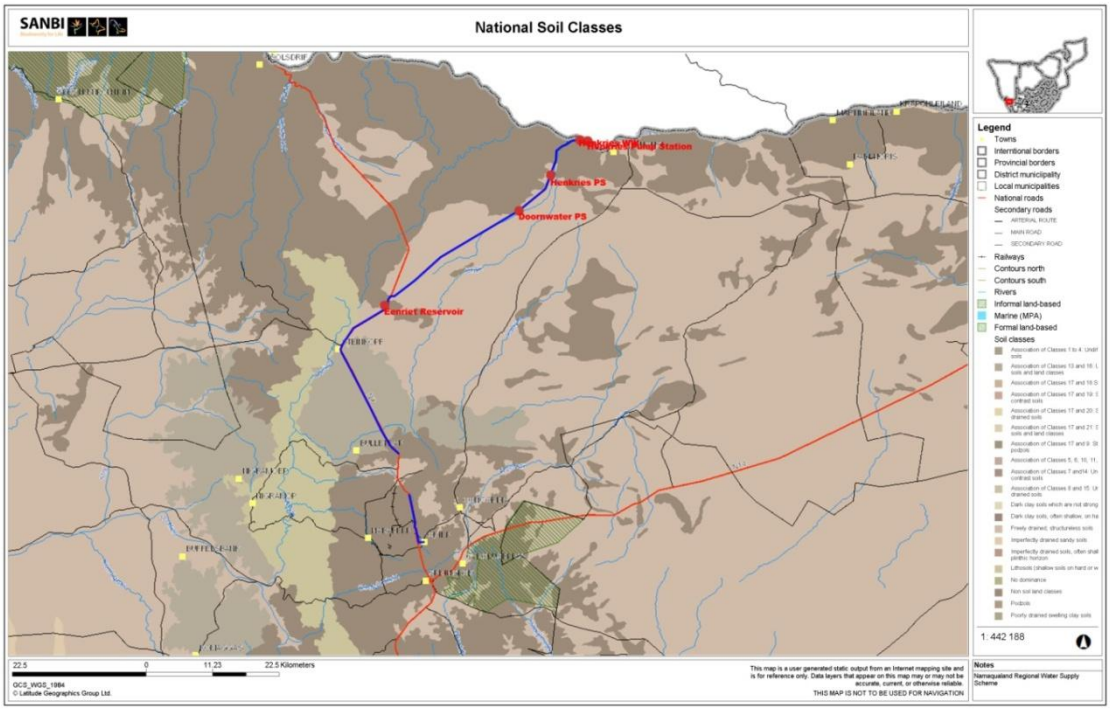
Figure 2 shows the average rainfall values for Springbok per month. It receives the lowest rainfall in January and the highest May to June. The monthly distribution of average daily maximum temperatures shows that the average midday temperatures for Springbok range from 16.5°C in July to 28.3°C in February. The region is the coldest during July when the mercury drops to 3.8°C on average during the night. Figure 3 gives the average monthly hours of sunshine over the year (www.weather-and-climate.com)

Figure 3: Average monthly hours of sunshine over the year (www.weather-and-climate.com)

SOILS

Soils are described as 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. In some areas it may have restricted soil depth, excessive drainage, high erodibility, low natural fertility. May be water-intake areas, but generally with restricted land use options (refer to Figure 4).

Figure 4: General soils expected in the study area

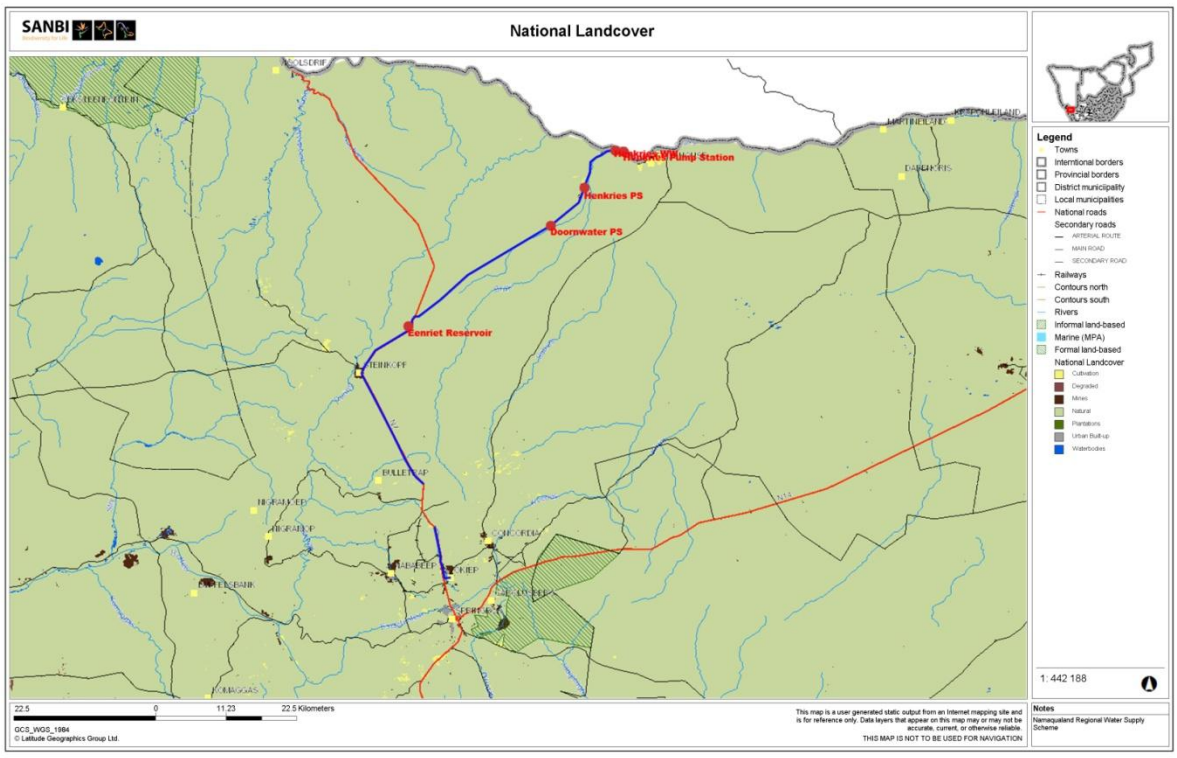


LANDUSE AND COVER

Land use in the majority of the NDM is defined by livestock grazing and mining – the two major economic drivers in the region. Some agriculture in the form of wheat and grape cultivation occurs in areas under irrigation and dryland rooibos tea production occurs on the Bokkeveld Escarpment. Another significant economic factor for the NDM's economy is "flower" tourism that is based on Namaqualand's fantastic annual wildflower displays that cover regions in a kaleidoscope of colour each spring. This is a distinctly seasonal aspect of the economy, lasting only eight to ten weeks, and being highly dependent on the timing and duration of the previous winter rains. However, there are indications that in recent years the regional ecotourism industry is diversifying (e.g. 4x4 and nature tourism) with greater numbers of tourists arriving throughout the year. River rafting is also a big industry on the Orange and Doring Rivers (Namakwa District Sector Plan, 2008).

Google images of the area, confirmed by the site visit, shows that the area is still almost completely natural (apart from the N7 which bisects the study area from north to south, smaller 2-spoor tracks found in the area and the Power lines running almost parallel to the N7). No other infrastructure or land-use has been observed. Most of the study area is covered by natural vegetation with the Doring- and Skaap River and tributaries also present. No intensive agricultural practices (apart from possible grazing) have been observed (apart from small areas in the vicinity of Henkries). The surrounding areas show the same largely natural veld extending in almost all directions (refer to the national Landcover map in Figure5).

Figure 5: National Landcover map indicating landuse and cover in the vicinity of the pipeline



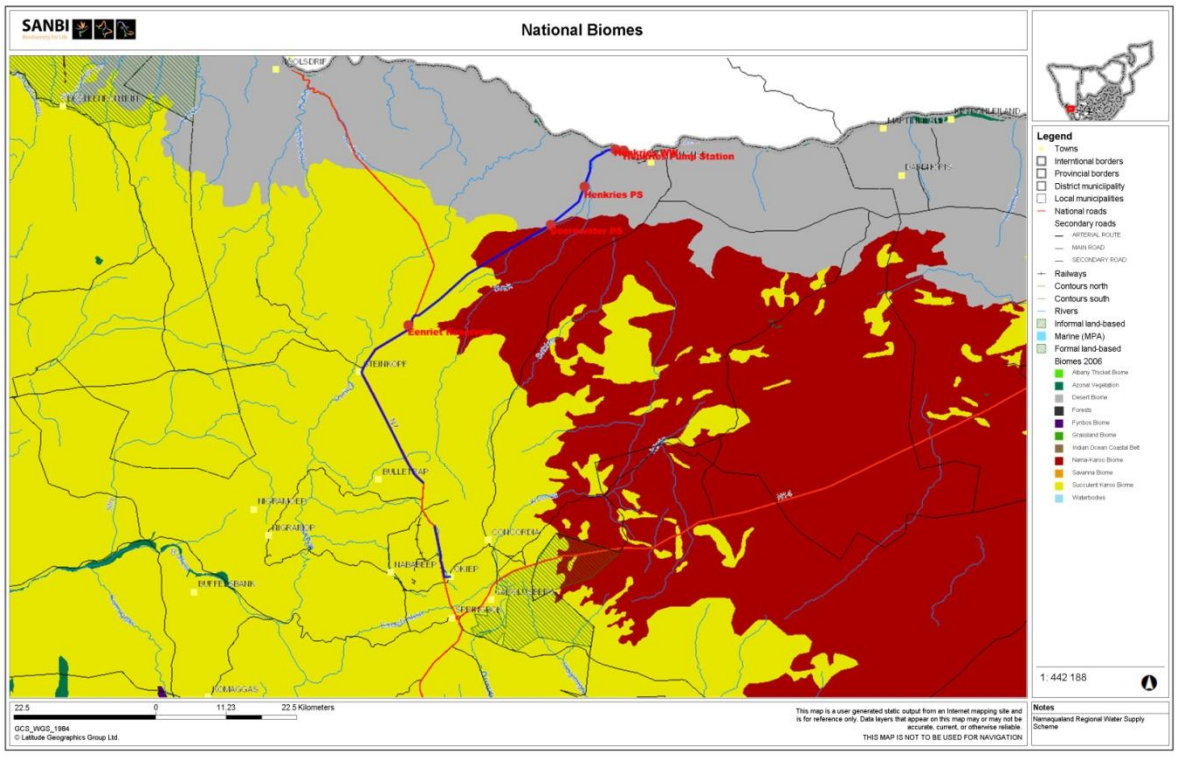
BIOMES

The pipeline route transverse three Biomes namely the Desert Biome (next to the Orange River) then the Nama-Karoo Biome in the vicinity of the Doornwater pump station and then into the Succulent Karoo Biome for the remaining (and larger) part of the pipeline route (Refer to Figure 6).

DESERT BIOME

True desert is found under very harsh environmental conditions which are more extreme than those found in the Succulent Karoo Biome and Nama-Karoo Biome. The climate is characterized by summer rainfall, but high levels of summer aridity. Mean annual rainfall is from approximately 10mm in the west, to 70 or 80mm on the inland margin of the desert. In reality, the rainfall is highly variable from year to year. Most true desert in southern Africa is found in Namibia, although an outlier does occur in a small part of South Africa, mainly in the Springbokvlakte area of the Richtersveld in the lower Orange River valley.

Figure 6: National biomes o South Africa, indicating the location of the pipeline route



The vegetation of the Desert Biome is characterized by dominance of annual plants (often annual grasses). This means that after a season with rarely abundant rains, the desert plains can be covered with a sea of short annual grass. Whereas in more normal years, the plains can appear bare with the annual plants persisting in the form of seed. Perennial plants are usually encountered in specialized habitats associated with local concentrations of water. Common examples of these are broad drainage lines or washes. The well-known shrub, *Welwitschia mirabilis*, of the Namib Desert, occurs in such areas. The perennial grass, *Stipagrostis*

sabulicola, occurs sporadically on large dunes which contain substantial stores of water. Nearer the coast in Namibia, the role of coastal fog also governs distribution of certain species commonly associated with the desert. The Desert Biome includes an abundant insect fauna which includes many tenebrionid beetles, some of which can utilize fog water (www.plantzafrica.com).

NAMA-KAROO BIOME

The Nama Karoo Biome occurs on the central plateau of the western half of South Africa, at altitudes between 500 and 2000m, with most of the biome failing between 1000 and 1400m. It is the second-largest biome in the region. The geology underlying the biome is varied, as the distribution of this biome is determined primarily by rainfall. The rain falls in summer, and varies between 100 and 520mm per year. This also determines the predominant soil type - over 80% of the area is covered by a lime-rich, weakly developed soil over rock. Although less than 5% of rain reaches the rivers, the high erodibility of soils poses a major problem where overgrazing occurs.

The dominant vegetation is a grassy, dwarf shrubland. Grasses tend to be more common in depressions and on sandy soils, and less abundant on clayey soils. Grazing rapidly increases the relative abundance of shrubs. Most of the grasses are of the C4 type and, like the shrubs, are deciduous in response to rainfall events. The amount and nature of the fuel load is insufficient to carry fires and fires are rare within the biome. The large historical herds of Springbok and other game no longer exist. Like the many bird species in the area - mainly larks - the game was probably nomadic between patches of rainfall events within the biome. The Brown Locust and Karoo Caterpillar exhibit eruptions under similarly favourable, local rainfall events, and attract large numbers of bird and mammal predators.

Less than 1% of the biome is conserved in formal areas. The Prickly Pear *Opuntia aurantiaca* and Mesquite *Prosopis glandulosa* are the major alien invader species. Urbanization and agriculture are minimal, and irrigation is confined to the Orange River valley and some pans. Most of the land is used for grazing, by sheep (for mutton, wool and pelts) and goats, which can be commensurate with conservation. However, under conditions of overgrazing, many indigenous species may proliferate, including Three thorn *Rhigozum trichotomum*, Bitterbos *Chrysocoma ciliata* and Sweet Thorn *Acacia karroo*, and many grasses and other palatable species may be lost.

There are very few rare or Red Data Book plant species in the Nama Karoo Biome (www.plantzafrica.com).

SUCCULENT KAROO BIOME

The Succulent Karoo Biome has an equal status to the other biomes in South Africa - it is not a subtype of "a Karoo Biome." Most of the biome covers a flat to gently undulating plain, with some hilly and "broken" veld,

mostly situated to the west and south of the escarpment, and north of the Cape Fold Belt. The altitude is mostly below 800 m, but in the east it may reach 1 500 m. A variety of geological units occur in the region. There is little difference between the soils of the Succulent Karoo and Nama Karoo Biomes - both are lime-rich, weakly developed soils on rock. The Olifants and Doring Rivers are the major drainage systems in the west, with the Gouritz River in the south-east of the biome. 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 are cyclonic, and not due to thunderstorms, the erosive power is far less than of the summer rainfall biomes. During summer, temperatures in excess of 40°C are common. Fog is common nearer the coast. Frost is infrequent. Desiccating, hot, Berg Winds may occur throughout the year.

The vegetation is dominated by dwarf, succulent shrubs, of which the Vygies (Mesembryanthemaceae) and Stonecrops (Crassulaceae) are particularly prominent. 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.

Little data are available for the fauna of the Succulent Karoo. Of importance in the area are heuweltjies, raised mounds of calcium-rich soil, thought to have been created by termites. These often support distinctive plant communities. The area has little agricultural potential due to the lack of water. The paucity of grasses limits grazing, and the low carrying capacity requires extensive supplementary feeds. Much soil has been lost from the biome, through sheet erosion, as a consequence of nearly 200 years of grazing. Ostrich farming, with considerable supplementary feeding, is practised in the Little Karoo in the south of the biome. In areas adjoining the Fynbos Biome, wine grapes, fruit and other crops are cultivated using the Fynbos water catchments. Tourism is a major industry: both the coastal scenery and the spring mass flower displays are draw cards. Mining is important, especially in the north.

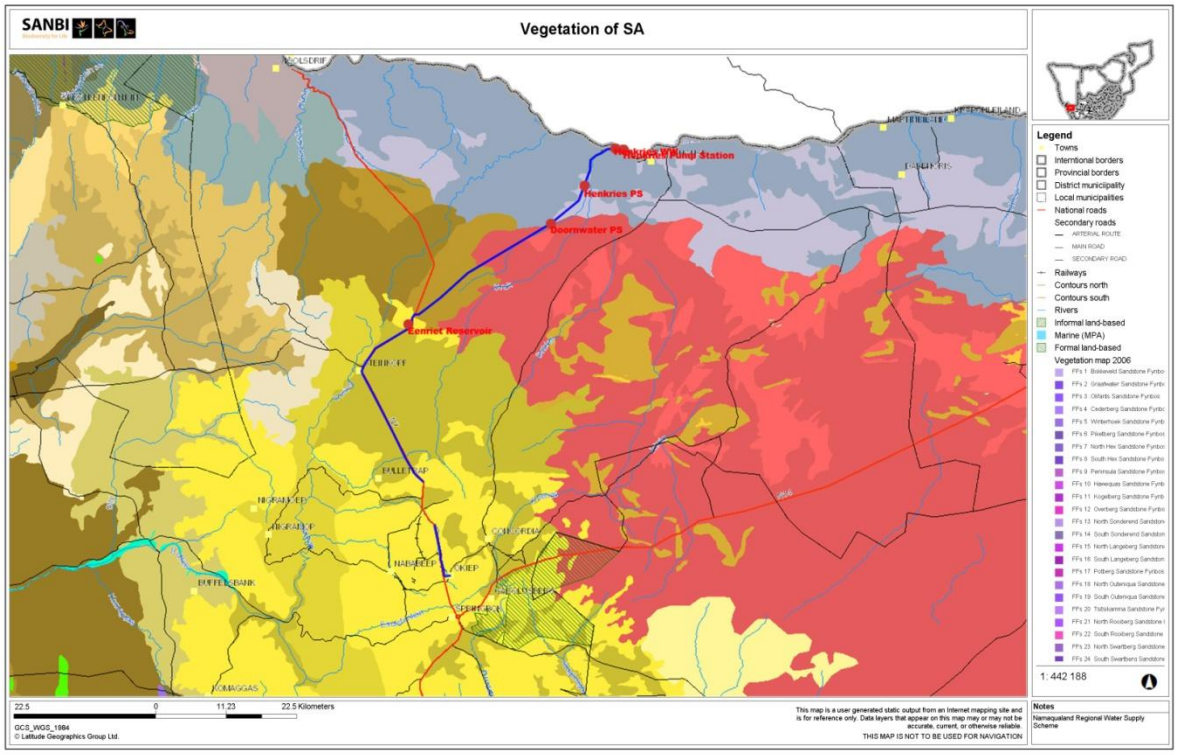
Less than 0.5% of the area of the Succulent Karoo Biome has been formally conserved. The biome has a high number of rare and Red Data Book plant species. The high species richness and unique global status of the biome require urgent conservation attention. Fortunately, there are few invasive alien plants, with only Rooikrans *Acacia cyclops* a major problem in the southern coastal regions. Strip-mining for diamonds is destructive in the northern coastal regions, and legislation requiring revegetation of these areas is inadequate for near-desert conditions.

VEGETATION TYPES

In accordance with the 2006 Vegetation map of South Africa, Lesotho and Swaziland (Mucina & Rutherford, 2006) seven broad vegetation types are expected in the study area (Refer to Figure 7), namely:

VEGETATION TYPE	BIOME	STATUS	REMAINING	FORMALLY CONSERVED	CONSERVATION TARGET
Eastern Gariep Rocky Desert (Darker blue Figure 7)	Desert	Least Threatened Not Protected	99.7%	0%	34%
Eastern Gariep Plains Desert (Lighter blue Figure 7)	Desert	Least Threatened Not Protected		0%	34%
Bushmanland Arid Grassland (Darker red Figure 7)	Nama-Karoo	Least Threatened Not Protected	99.5%	0%	21%
Bushmanland Sandy Grassland (Lighter red Figure 7)	Nama-Karoo	Least Threatened Hardly Protected	99.4%	0.4%	21%
Eenriet Plains Succulent Shrubland (Yellow Figure 7)	Succulent Karoo	Least Threatened Not Protected	99.5%	0%	28%
Namaqualand Blomveld (Darker mustard in Figure 7)	Succulent Karoo	Least Threatened Hardly Protected	94%	1.5%	28%
Namaqualand Klipkoppe Shrubland (Lighter mustard in Figure 7)	Succulent Karoo	Least Threatened Poorly Protected	95%	5.8%	28%

Figure 7: Vegetation map of SA, Lesotho and Swaziland (2006)



It is clear to see that although all of these vegetation types were classified as "Least Threatened" during the National Spatial Biodiversity Assessment (NSBA), 2004, they are also all considered to be at least "Poorly Protected" given the fact that very little of these two vegetation types are formally protected. Note that the status of these vegetation types remained "Least Threatened" as listed in the recently promulgated National list of ecosystems that are threatened and in need of protection (GN 1002, December 2011), promulgated in terms of the National Environmental Management Biodiversity Act (NEM: BA), Act 10 of 2004.

Fortunately, more than 95% of most of these vegetation types are still found in a relative natural state. In addition the pipeline would be situated in the same area (previously disturbed) as which the original pipeline is located, which will reduce the impact significantly.

EASTERN GARIEP ROCKY DESERT

Eastern Gariep Rocky Desert is described as a landscape of hills and mountains (up to 650 m), mostly with bare rocky outcrops and covered with very sparse shrubby vegetation in crevices. Habitats are mainly controlled by topography, aspect, local climate and lithology. On the higher southern slopes *Justicia orchioides* is often dominant, with localised grassland directly below steep cliffs (*Enneapogon scaber*, *Triraphis ramosissima* and *Danthoniopsis ramose*). The south-facing quartzite cliffs and steep slopes support chasmophytes such as *Ficus lilcina*, *Aloe dabenorisana* and *Bowiea pariepensis*. On the summits and higher northern slopes there is much higher preponderance of succulent plants including *Euphorbia avasmontana*, *Aloe dichotoma*, *A. microstigma* subsp. *microstigma*, *Pelargonium aridum* and *Kleinia longiflora*. Succulent plants are also important on the northern foothills and also include *Aloe dichotoma*, *Euphorbia avasmontana*, *Sarcostemma viminale* and the diminutive *Lapidaria margarethae* (Mucina & Rutherford, 2006).

BUSHMANLAND ARID GRASSLAND

Bushmanland Arid Grassland is described as located on extensive to irregular plains on a slightly sloping plateau sparsely vegetated by grassland dominated by white grasses (e.g. *Stipagrostis* species) giving the vegetation type the character of semi-desert “steppe”. In places low shrubs of *Salsola* change the vegetation structure. In years of abundant rainfall rich displays of annual herbs can be expected (Mucina & Rutherford, 2006).

EASTERN GARIEP PLAINS DESERT

Eastern Gariep Plains Desert is described as a landscape of often sloping plains, sharply contrasting with the surrounding rocky hills and mountains. Typical was vegetation in the breaks between the mountains to the Orange River. Grassland dominated by "white grasses", some spinescent (Stipagrostis species), on much of the flats with additional shrubs and herbs in the drainage lines or on more gravelly or loamy soil next to the mountains (Mucina & Rutherford, 2006).

BUSHMANLAND SANDY GRASSLAND

Bushmanland Sandy Grassland is described as dense, sandy grassland plains with dominating "white grasses" (e.g. *Stipagrostis* and *Schmidtia* species) and abundant drought-resistant shrubs. After rainy winters, rich displays of ephemeral spring flora (e.g. *Grielum humifusum* and *Gazania lichtensteinii*) can occur (Mucina & Rutherford, 2006).

EENRIET PLAINS SUCCULENT SHRUBLAND

Eenriet Plains Succulent Shrubland is described as located on wide plains tilting towards the north, with few inselbergs. The extensive plains often resemble sheet wash plains. The deep loamy-sandy soils support mostly dense shrubby vegetation dominated by *Ruschia paucipetala*, *Prenia tetragona* or *Brownanthus pseudoschlichtianus*. *Stomatium alboroseum* and *Polymita albiflora* are found on calcrete or quartz patches. On the inselbergs rocky outcrops numerous isolated populations of some Crassulaceae (e.g. *Crassula macowaniana* and *Tylecodon racemosus*) are found (Mucina & Rutherford, 2006). Endemic taxa include the geophytic herb *Ornithogalum unifoliatum*.

NAMAQUALAND BLOMVELD

Namaqualand Blommeveld is found in valleys and flat areas between granitic rocky hills of the Namaqualand Escarpment. Usually on level to slightly undulating sedimentary surfaces between rocky granitic hills and mountains, such as wide plains and broad valleys with dry channels of intermittent water courses. Sparse dwarf shrubs with succulent or ericoid leaves dominate these shrublands. Geophytes and ephemeral herbs and in places also low, spreading, leaf-succulents show spectacular flower displays in wet years (Mucina &Rutherford, 2006). Endemic taxon associated with this veld type includes (Mucina & Rutherford, 2006) – Herbs: *Lessertia capitata, Lotononis arenicola*. Succulent Herbs: *Dorotheanthus bellidiformis* subsp. *hestermalensis. D. rourkei*.

NAMAQUALAND KLIPKOPPE SHRUBLAND

Namaqualand Klipkoppe Shrubland is described as a dramatic landscape of huge granite and gneiss domes, smooth glacis and disintegrating boulder koppies supporting open shrubland up to 1 m tall, dominated by shrubs of dwarf to medium stature and with ericoid or succulent leaves. A few scattered pachycaul Kokerboom trees (*Aloe dichotoma* var. *dichotoma*) are found mostly on north-facing slopes. Flat or gentle sloping rock sheets (the dominant feature of this unit) support dwarf or prostrate succulents in shallow pockets with soil or in cracks. Fringe vegetation at the bottom of steep rock sheets (collecting run-off water) could house 1-3 m tall shrubs with non-succulent leaves and canopy cover reaching 40-100% (Mucina & Rutherford, 2006). Endemic taxon associated with this veld type includes (Mucina & Rutherford, 2006) - Succulent Shrubs: *Ottosonderia montincola, Tylecodon nigricaulis*. Low Shrubs: *Lotononis benthamiana, L. longiflora, L. quinata, Wiborgia incurvata*. Herbs: *Tripteris spathulata, Zaluzianskya collina*. Geophytic Herbs: *Ornithogalum leeupoortense, O. Louisae, Xysmalobium pearsonii*. Succulent Herbs: *Quagua bayeriana, Q pallens, Stapeliopsis khamiesbergensis*.

RED DATA OR PROTECTED PLANT SPECIES

Aloe dichotoma var. *dichotoma* (Kokerboom) is prominently on display on the north and north-western facing mountain slopes within the study area. Quite a number of these trees has been observed in the vicinity of the proposed pipeline (must be protected during construction), especially in the Bulletrap – Okiep area. The possibility exists that more red data species might be encountered within the study area (especially with regards to annual and geophytes plants). However, since the impact will be very localized and associated with existing disturbed areas, the changes of irreparable or irreversible lost is considered very low.

The following protected tree species in terms of the National Forest Act of 1998 (Act 84 of 1998) have a geographical distribution that may overlap with the study area.

SPECIES NAME	COMMON NAME	TREE NO.	DISTRIBUTION
Acacia erioloba	Camel Thorn Kameeldoring	168	In dry woodlands next to water courses, in arid areas with underground water and on deep Kalahari sand
Boscia albitrunca	Shepherds-tree Witgat/Matopie	130	Occurs in semi-desert and bushveld, often on termitaria, but is common on sandy to loamy soils and calcrete soils.

RIVERS AND WETLANDS

Rivers maintain unique biotic resources and provide critical water supplies to people. South Africa's limited supplies of fresh water and irreplaceable biodiversity are very vulnerable to human mismanagement. Multiple environmental stressors, such as agricultural runoff, pollution and invasive species, threaten rivers that serve the world's population. River corridors are important channels for plant and animal species movement, because they link different valleys and mountain ranges.

The health of the world's freshwater ecosystems has declined by 50% in the last 30 years, and up to 35% of the world's freshwater fish are now endangered, threatened or extinct. The deterioration of rivers not only results in a loss of freshwater species but also degrades the ability of the systems to provide the goods and services that people depend on. Estimates are that freshwater use is growing at 2.5 times the rate of the human population growth rate, with water demand in developing countries increasing by 50% in the next 25 years. Water resource managers and water users alike will have to alter their practices if we are to ensure that rivers continue to support both freshwater biodiversity and human life. The scarcity of water resources is a defining feature of this arid environment. The two main river systems – the Orange River on the northern boundary, and the Oliphant's/Doring River system that flows in a north-westerly direction through the Hantam and Karoo Hoogland Municipalities – are both under pressure from the clearing of land for agriculture and the encroachment of alien vegetation along river banks. Similarly, the high yielding water catchment areas of the high mountain areas – some of which provide a significant amount of fresh water to surrounding towns – are also demonstrating lower yields because of a lack of efficient water management strategies. In order to maintain ecosystem health and thereby ensure the sustainability of existing towns and land use practices it is critical for each municipality to safeguard these areas (NDM, 2008).

The currently pipeline location crosses the Brak-, the Doring- and the Skaap Rivers or tributaries thereof.

- Near Henkries the pipeline crosses the non-perennial Brak River (Classified as an Endangered, Class B or Largely Natural river system).
- Just south of Steinkopf the pipeline crosses two a small non-perennial tributary of the Doring River (Classified as an Endangered, Class C –Moderately Modified river system).
- The non-perennial Skaap River (and smaller tributaries thereof are also crossed in more than one location in the vicinity of Bulletrap, north of Okiep (Classified as an Endangered, Class C or Moderately Modified river system).

Although all of these rivers are regarded as slightly too moderately impacted they are still classified as endangered and in need of protection. River crossing must thus be seen as significant aspects of the proposed project .

INVASIVE ALIEN INFESTATION

Most probably because of the aridity of the area, invasive alien rates are generally very low for most of this area. Problem areas are usually associated with river systems and other wetland areas. Very few invasive alien trees have been observed within the study area (mostly associated with the river systems).

MAMMAL AND BIRD SPECIES

Mammal and bird species was not regarded as the proposed activity should have very little permanent impact on these species.

The Desert Biome includes an abundant insect fauna which includes many tenebrionid beetles, some of which can utilize fog water. The large historical herds of Springbok and other game no longer exist in the Nama-Karoo Biome. Like the many bird species in the area - mainly larks - the game was probably nomadic between patches of rainfall events within the biome. The Brown Locust and Karoo Caterpillar exhibit eruptions under similarly favourable, local rainfall events, and attract large numbers of bird and mammal predators. Little data are available for the fauna of the Succulent Karoo. Of importance in the area are heuweltjies, raised mounds of calcium-rich soil, thought to have been created by termites. These often support distinctive plant communities. (www.plantzafrica.com).

It is known that the Namaqua Dune Mole Rat (*Bathyergus janetta*), a species of rodent, is found in the Springbok area. Its natural habitats are subtropical or tropical dry shrubland, caves, and sandy shores. The IUCN assessment states that : Although the extent of occurrence is less than 20,000 km², and the potential impact of diamond mining remains to be quantified, at present there is no reason to believe that the species is declining, and its presence in areas entirely restricted to public access (and with extremely high protection) suggest it should be Least Concern.

NAMAKWA DISTRICT BIODIVERSITY SECTOR PLAN

The Namakwa District Biodiversity Sector Plan with its associated Terrestrial Critical Biodiversity Areas maps was created with three main land-use planning and decision-making avenues in mind:

1) Reactive decision-making, such as environmental impact assessment (EIA) agricultural land-use decisions, water-use licensing and other development control decisions through the Land Use Planning Ordinance (LUPO) or other land-use legislation,
2) Proactive forward planning, such as Integrated Development Plans (IDP's), Spatial Development Frameworks (SDF's) & Zoning Schemes, and
3) Proactive conservation, such as stewardship, land acquisition & easements.

The importance of these functions is described within the NDM (2008) Sector plan as follows:

Terrestrial (or land) ecosystems provide valuable ecosystem services that contribute to human well-being. For example they can provide:

- buffers against natural hazards such as fire and floods
- carbon sequestration (storage), important for reducing the impacts of climate change
- regulation of water supply grazing for wild animals and livestock
- natural spaces for recreation &tourism
- the air we breathe
- spiritual, ritual and ceremonies
- horticultural & wild flower industries
- natural heritage
- food, fibre and medicinal plants

Rivers are central to human welfare and economic development. They provide:

- water for agricultural, industrial and domestic uses
- flood attenuation and regulation
- food and medicinal plants
- transport and/or purification of biodegradable wastes
- tourism, recreational and cultural use
- enhanced property values

Ecological corridors provide valuable ecosystem services that are often impossible or very costly to replicate or offset. For example they:

- support the migration (movement) and long-term survival of plant and animal species and their ecological processes (e.g. fire, pollination, seed dispersal), in response to global climate change.
- are important areas for storing carbon to reduce the impacts of global climate change.
- are important areas for regulating water supply (e.g. filtering and storing drinking water, keeping excess nutrients out of wetlands and rivers, ensuring a high water yield from mountain catchments).
- supply good quality water from mountain catchment areas, both surface and groundwater.
- the supply of water quality and quantity is not only for human consumption but for ensuring the survival of downstream estuaries, wetlands (vleis) and streams (which in turn provide us with other ecosystem services).
- are of important scenic value, contributing to tourism and the 'sense of place'.

CBA CATEGORIES WITHIN THE NDM SECTOR PLAN

The use of CBA's in the NDM follows the definition laid out in the guideline for publishing bioregional plans (Anon, 2008):

- 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).

The table underneath gives the framework for linking spatial planning categories (CBA's) to land-use planning and decision-making guidelines based on a set of high-level land biodiversity management objectives (as used within the NDM, 2008).

Table 1: Linking CBA categories to land management objectives within the Namaqualand District Municipality

CBA CATEGORY	LAND MANAGEMENT OBJECTIVE
PA & CBA 1	*Natural landscapes*: • Ecosystems and species fully intact and undisturbed • These are areas with high irreplaceability or low flexibility in terms of meeting biodiversity pattern targets. If the biodiversity features targeted in these areas are lost then targets will not be met. • These are landscape that are at or past their limits of acceptable change
CBA 2	*Near-natural landscapes*: • Ecosystems and species largely intact and undisturbed. • Areas with intermediate irreplaceability or some flexibility in terms of area required

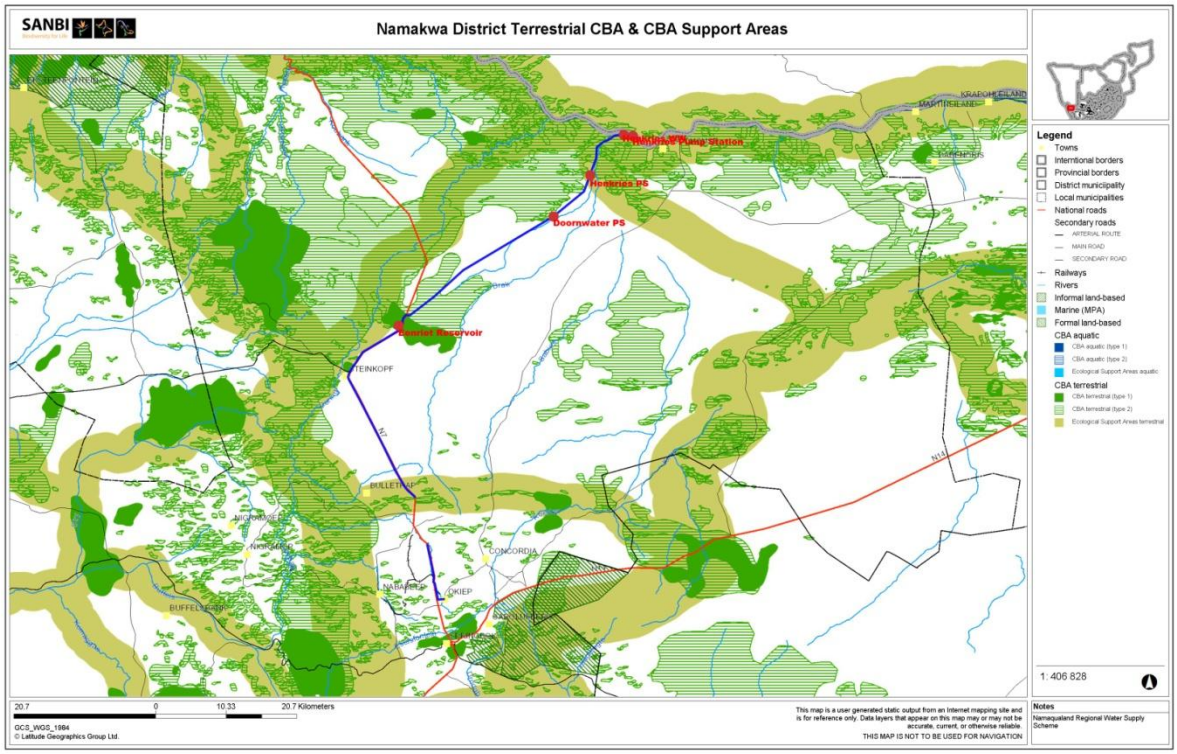
	to meet biodiversity targets. There are options for loss of some components of biodiversity in these landscapes without compromising our ability to achieve targets. • These are landscapes that are approaching but have not passed their limits of acceptable change.
Ecological Support Areas (ESA)	*Functional landscapes*: • Ecosystems moderately to significantly disturbed but still able to maintain basic functionality. • Individual species or other biodiversity indicators may be severely disturbed or reduced. • These are areas with low irreplaceability with respect to biodiversity pattern targets only.
ONA and Transformed	*Production landscapes*: • manage land to optimize sustainable utilization of natural.

* PA = Protected Areas, ESA = Ecological Support Area, ONA = Other Natural Areas

CRITICAL BIODIVERSITY AREAS ENCOUNTERED

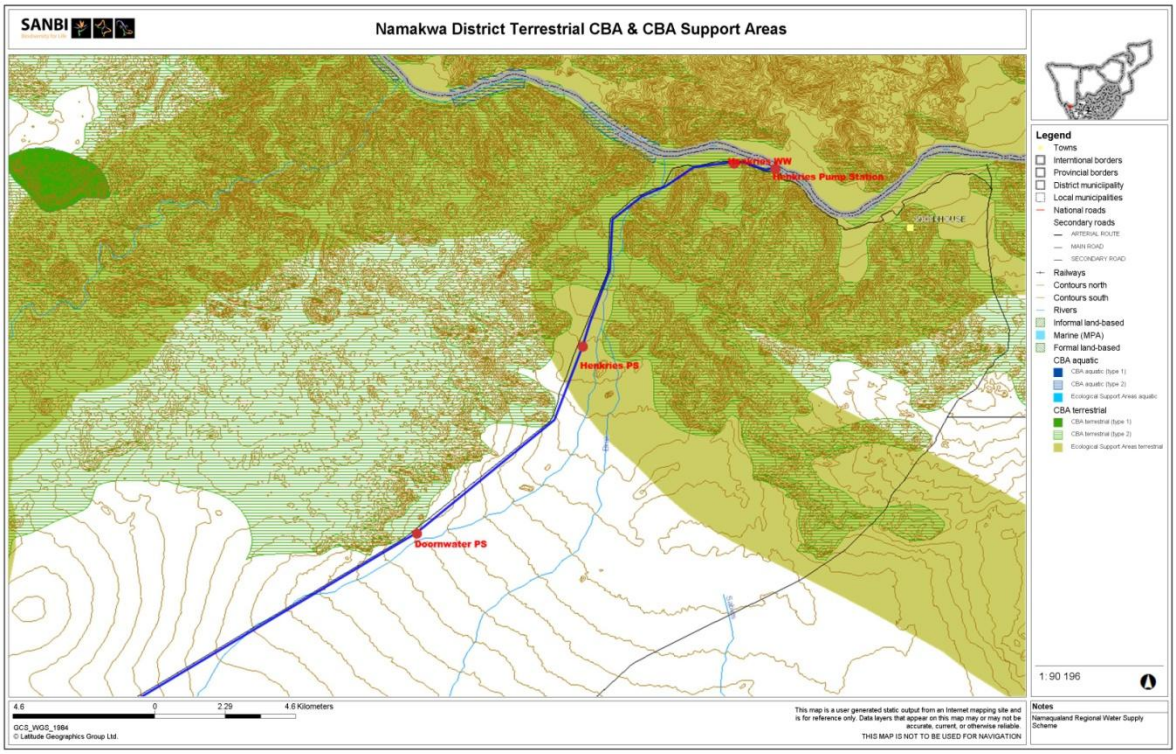
The Terrestrial Critical Biodiversity Areas (CBA) map for the Namaqualand District Municipality shows that the existing pipeline (and thus the proposed refurbishment) crosses various areas identified as CBA's or CBA support areas within the sector plan (Refer to Figure 8).

Figure 8: An overview of the NDM critical biodiversity areas map for the area impacted by the proposed project



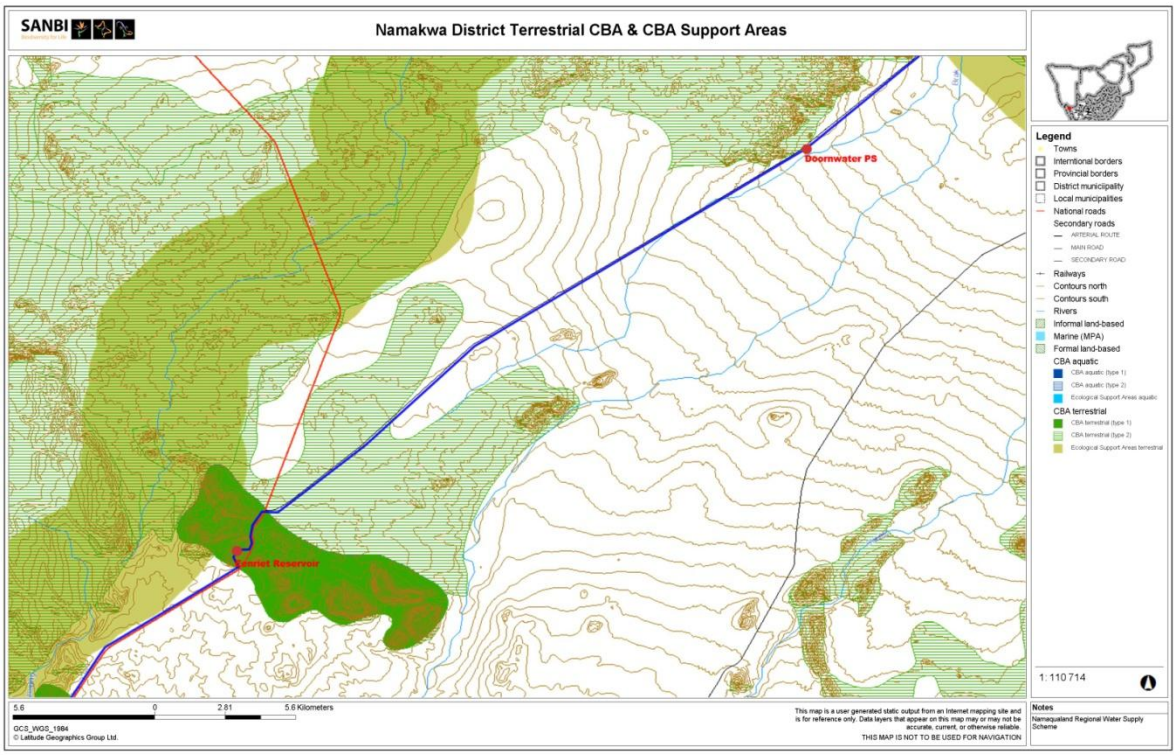
When looking at the map above in more detail, it shows that the existing pipeline (and thus the proposed new pipeline) will cross CBA1, CBA2 and ESA areas (Refer to Figure 9-12). Figure 9 indicate that, next to the Orange River the pipeline is located within a CBA 2 (expert important terrestrial area) as well as an ESA (Terrestrial migration corridor).

Figure 9: CBA map indicating the pipeline route from Henkries extraction point to Doornwater Pump Station



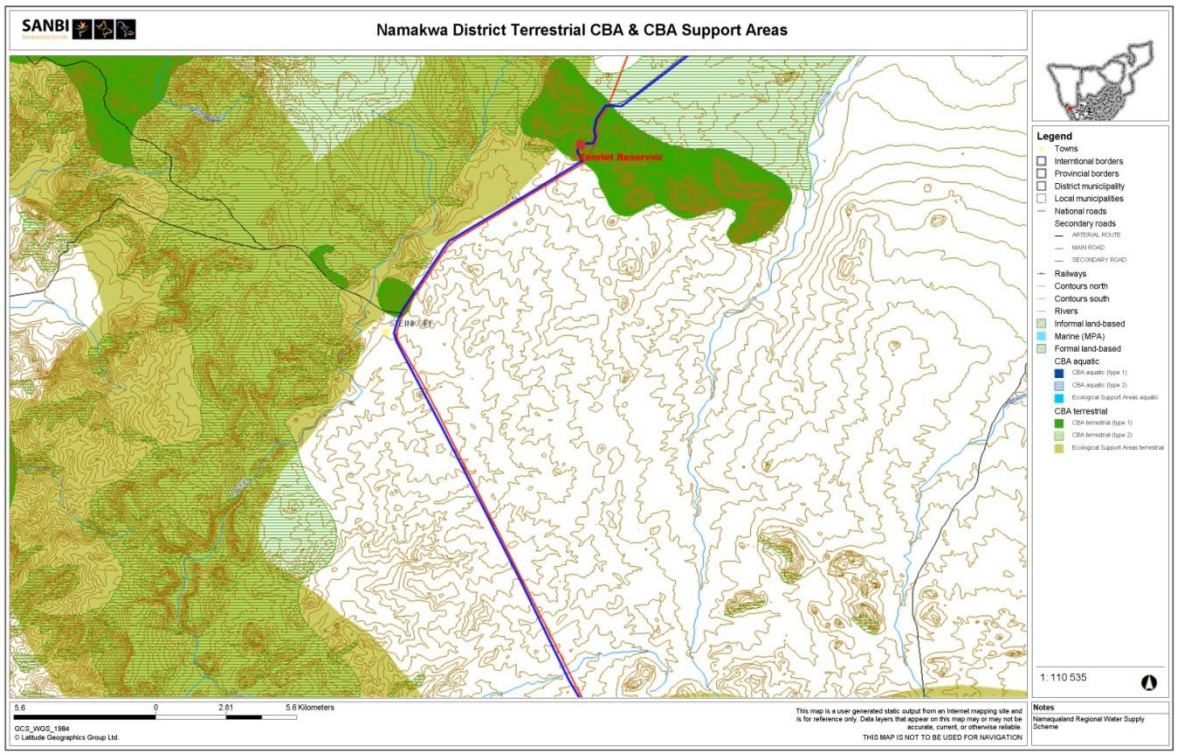
From just south of Henkries until about 8 km north of the Eenriet Reservoir the pipeline is not located in an identified CBA area. Approximately 8 km north-east of Eenriet the pipeline again enters a CBA2 (Expert important Terrestrial area), and then enters the CBA1 area which encompasses the area around Eenriet (Expert critical Terrestrial area). The CBA1 status most probably based on the quartz patches present.

Figure 10: CBA map indicating the pipeline route from Doornwater PS to Eenriet Reservoir



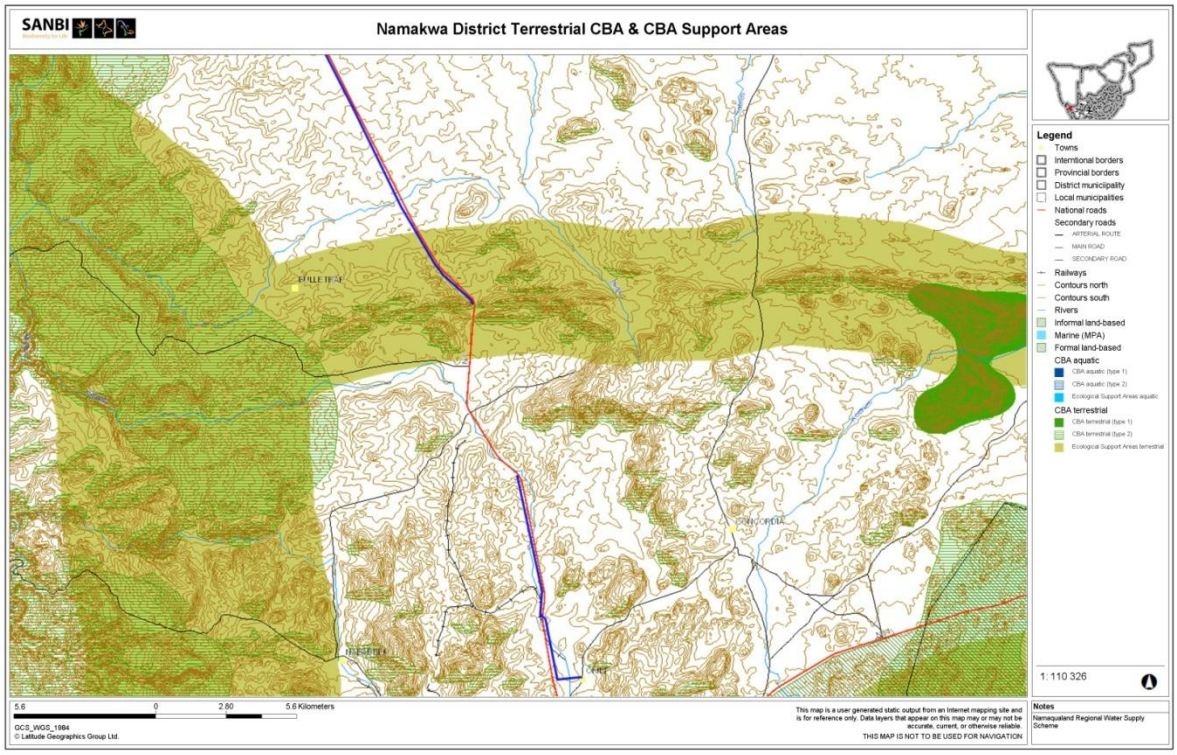
The pipeline then run next to identified CBA areas, but only enters the next CBA near Bulletrap (Figure 12).

Figure 11: CBA map indicating the pipeline route from Eenriet reservoir towards Bulletrap



Near Bulletrap (Figure 12), the pipeline again enters an ESA area (Terrestrial migration corridor) before it crosses between two CBA2 areas (Slopes).

Figure 12: CBA map indicating the pipeline route from Bulletrap to Okiep



It was taken into account that the original pipeline route was already disturbed during the installation of this pipeline. In fact along most of the pipeline route a twee spoor track was established for maintenance purposes. This area in the immediate vicinity of the pipeline was thus already disturbed. Secondly the disturbance (when replacing the old pipeline with the new) will be of a temporary nature. It was also presumed that Environmental Control will be applicable (in the form of an ECO) during the construction phase.

Taking the above into consideration it is evident that care will have to taken when any work is done within or near any of the identified CBA areas, especially CBA1 areas (near Eenriet Reservoir). However, the impact could be negated and minimised through good environmental control. In fact if the old spoil (left during the original excavation) could be removed and the area cleaned up and suitably rehabilitated it might be possible that the project could improve the status of the area as a whole, and also the CBA areas.

IMPACT ASSESSMENT

The "No-Go alternative" and the two alternative routes would have been assessed. The alternative routes are described in the previous sections of this report. Since Springbok and the surrounding towns is absolutely dependant on the pipeline for potable water the "No-Go alternative" is of particular significance in this instance.

METHOD USED

During May 2001, Van Schoor published a formula for prioritizing and quantifying potential environmental impacts. This formula has been successfully used in various applications for determining the significance of environmental aspects and their possible impacts, especially in environmental management systems (e.g. ISO 14001 EMS's). By adapting this formula slightly it can also be used successfully to compare/evaluate various environmental scenario's/options with each other using a scoring system of 0-100%, where any value of 15% or less indicate an insignificant environmental impact while any value above 15% constitute ever increasing environmental impact.

Using Van Schoor's formula (adapted for construction with specific regards to environmental constraints and sensitivity) and the information gathered during the site evaluation the possible negative environmental impact of the activity was evaluated.

Underneath follow a short description of Van Schoor's formula. In the formula the following entities and values are used in order to quantify environmental impact.

***S* = [(*fd* + *int* + *sev* + *ext* + *loc*) x (*leg* + *gcp* + *pol* +*ia* + *str*) x *P*]** (as adapted for construction activities)

Where

S = Significance value

fd = frequency and duration of the impact

int = intensity of the impact

sev = severity of the impact

ext = extent of the impact

loc = sensitivity of locality

leg = compliance with legal requirements

gcp = conformance to good environmental practices

pol = covered by company policy/method statement

ia = impact on interested and affected parties

str = strategy to solve issue

P = probability of occurrence of impact

CRITERIA

The following numerical criteria for the above-mentioned parameters are used in the formula.

fd = frequency and duration of the impact					
low frequency ; low duration	1	medium frequency; low duration	1.5	high frequency ; low duration	2
low frequency; medium duration	1.5	medium frequency ; medium duration	2	high frequency ; medium duration	2.5
low frequency ; high duration	2	medium frequency ; high duration	2.5	high frequency ; high duration	3

int = intensity of the impact					
low probability of species loss; low physical disturbance	1	medium probability of species loss; low physical disturbance	1.5	high probability of species loss; low physical disturbance	2
low probability of species loss; medium physical disturbance	1.5	medium probability of species loss; medium physical disturbance	2	high probability of species loss; medium physical disturbance	2.5
low probability of species loss; high physical disturbance	2	medium probability of species loss; high physical disturbance	2.5	high probability of species loss; high physical disturbance	3

sev = severity of the impact	
changes immediately reversible	1
changes medium/long-term reversible	2
changes not reversible	3

ext = extent of the impact	
locally (on-site)	1
regionally (or natural/critical habitat affected)	2
globally (e.g. critical habitat or species loss)	3

loc = sensitivity of location	
not sensitive	1
moderate (e.g. natural habitat)	2
sensitive (e.g. critical habitat or species)	3

leg = compliance with legal requirements	
compliance	0
non-compliance	1

gcp = good conservation practices	
conformance	0
non-conformance	1

pol = covered by company policy	
covered in policy	0
not covered/no policy	1

ia = impact on interested and affected parties	
not affected	1
partially affected	2
totally affected	3

str = strategy to solve issue	
strategy in place	0
strategy to address issue partially	0.5
no strategy present	1

P = probability of occurrence of impact	
not possible (0% chance))	0
not likely, but possible (1 - 25% chance)	0.25
likely (26 - 50% chance)	0.50
very likely (51 - 75% chance)	0.75
certain (75 - 100% chance)	0.95

RATIONALE BEHIND IMPACT EVALUATION

It is a fact that most of the existing Namakwa pipeline needs to be replaced as a matter of urgency due to the due to the condition of the pipeline and the fact that it has been used well over its design period. As no other sources of potable water are locally available the current pipelines need to be in operation.

PLACEMENT AND CONSTRUCTION METHOD

It is very important to note that the "No-Go Alternative" will not result in a *status quo* or no impact, since this portion of the pipeline has already been identified as the portion subject to the most frequent failures. As a result the continual disturbance over time (when taking the cumulative effect into consideration) may have a more significant impact than any of the proposed alternatives. Each failure will result in excavations, vehicle access and possibly even temporary pipeline routes. Eventually the pipeline will have to be replaced.

The preferred alternative is to locate the replacement pipeline within the old pipeline trench. This will entail the placement and installation of a temporary pipeline (to ensure continual water supply during the construction of the new pipeline), the excavation and removal of the original pipeline, the placement of the new pipeline and rehabilitation of the construction area (as well as the removal and rehabilitation of the temporary pipeline and its route). In theory this should result in the lowest impact, since the pipeline will be placed within an already disturbed area and service access has already been established along this route. The duration of the impact is considered to be short term (coupled with the construction period). With mitigation, almost all significant impacts could be negated.

DIRECT IMPACTS

As the name suggest, direct impacts refers to those impacts with a direct impact on biodiversity features and in this case was considered for the four potentially most significant associated impacts which are:

- Direct loss of vegetation type and associated habitat due to construction and operational activities.
- 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

LOSS OF VEGETATION AND ASSOCIATED HABITAT

The broad vegetation types expected in the study area, were classified as "Least Threatened" during the 2004 National Spatial Biodiversity Assessment, but are also considered to be "Poorly or Hardly Protected". Fortunately, more than 95% of most of these vegetation types are still found in a relative natural state. The

vegetation along most of the route is still in good condition with only the occasional track spoiling small portions of the natural features.

The "No-Go Alternative": Continual disturbance over time (when taking the cumulative effect into consideration) may have a more significant impact than any of the proposed alternatives. Each failure will result in excavations, vehicle access and possibly even temporary pipeline routes. Eventually the pipeline will have to be replaced.

Direct impact to vegetation would be moderate to low, due to the fact that this area was previously disturbed in combination with the status of the vegetation itself. Furthermore, the duration of the impact is considered to be temporary since the construction period will be relative short. With mitigation, almost all significant impacts could be negated.

Mitigation: There are numerous possibilities for mitigation measures to lessen the direct impact of the pipeline construction phase. The construction areas should be clearly demarcated and should aim for the absolute minimum disturbance footprint. Only existing access routes should be used where-ever possible.
Prior to construction, the vegetation the vegetation and topsoil along the excavation route should be removed and stored separately from the subsoil (to be re-used during rehabilitation after construction). The topsoil and vegetation should be replaced over the disturbed soil to provide a source of seed and a seed bed to encourage re-growth of the species removed during construction. All indications show that the natural vegetation should re-establish itself on the disturbed areas, which will lessen the overall impact significantly. Once the pipeline has been constructed all further movement must be confined to the access tracks to allow the vegetation to re-establish over the excavated areas.

LOSS OF ECOLOGICAL PROCESSES

Ecological processes in the study area operate over a wide extent. Since a pipe-line is a linear structure it is expected to have a very limited lateral impact on ecological processes (in most cases). Since the N7 also runs along the same North-South direction as the pipeline, the road itself has already impacted ecological processes. The pipeline is not expected to add significantly to the impact.

Impact to ecological processes is expected to be low to very low, and restricted to the short construction period (open trench period). Once construction is completed and rehabilitation effected, the impact should be almost negligible.

Mitigation: Apart from rehabilitation after construction no further mitigation is possible.

LOSS OF LOCAL BIODIVERSITY AND THREATENED SPECIES

Both *Acacia erioloba* (Camel Thorn) and *Boscia albitrunca* (Witgat Tree) can be expected along the lower lying areas in and around the Skaap River area. *Aloe dichotoma* var. *dichotoma* (Kokerboom) is also prominent in certain areas in the vicinity of the study area (must be protected during construction). The possibility exists that more red data species might be encountered within the study area (especially with regards to annual and geophytes plants). However, since the impact will be very localized and associated with existing disturbed areas, the changes of irreparable or irreversible lost is considered very low.

Since excavation is needed there will be a possible impact on loss of biodiversity and threatened species. This will be negated to a certain extent by placing the pipeline within the original trench line and due to the relative local effect of the excavation. As such the impact is expected to be medium to low, but the impact could be significantly negated through good mitigation.

Mitigation: A botanical scan of the approved route should be done by a botanist, during which all significant plant species should be identified. Where encountered important species as well as other viable species such as geophytes can be saved through a search & rescue project before construction of the pipe-line starts. Such species can be relocated to unaffected areas in the same habitat nearby or kept in cultivation for re-establishment in the disturbed areas once construction of the pipeline is completed.

LOSS OF ECOSYSTEM CONNECTIVITY

Ecological gradient often operate from the mountains to the lower lying areas and *vice versa*. In the study area this gradient also supports the River ecosystems (including its tributaries). The River ecosystems have been classified as an endangered ecosystem during the 2004 National Spatial Biodiversity Assessment. The construction of the pipeline can have a significant impact on ecosystem connectivity with regards to river flow. However, with the necessary mitigation the impact could be negated, especially since the major part of the impact will be associated with the short term construction phase.

Impact to ecosystem connectivity is expected to be medium, and restricted to the short construction period (open trench period). However, with the correct mitigation the impact can be much reduced and almost negligible.

Mitigation: There are numerous possibilities for mitigation measures to lessen the direct impact of the pipeline construction along both routes. The construction areas should be clearly demarcated and should aim for the absolute minimum disturbance footprint. Only existing access routes should be used where-ever possible.
Prior to construction, the vegetation the vegetation and topsoil along the excavation route should be removed and stored separately from the subsoil (to be re-used during rehabilitation after construction). The topsoil and vegetation should be replaced over the disturbed soil to provide a source of seed and a seed bed to encourage

re-growth of the species removed during construction. All indications show that the natural vegetation should re-establish itself on the disturbed areas, which will lessen the overall impact significantly. Once the pipeline has been constructed all further movement must be confined to the access tracks to allow the vegetation to re-establish over the excavated areas. All areas should be re-shaped to represent its original shape. Especial care must be taken to ensure normal river flow (where applicable) and to prevent erosion.

INDIRECT IMPACTS

Indirect impacts are impacts that are not a direct result of the main activity (construction of the pipeline), but are impacts still associated or resulting from the main activity (e.g. access routes).

No indirect impacts have been identified. Access routes are already established since this is also the current pipeline route.

Mitigation: Existing tracks or routes should be used where-ever possible. New routes should only be considered if all alternatives have been investigated. Routes should also be placed to minimize the visual impact thereof. All construction spoil and rubble must be removed.

CUMULATIVE IMPACTS

The vegetation types expected in the study area have a conservation rating of Least Threatened, which imply that at present this vegetation types are not under immediate threat. In order to comprehend the cumulative impact one has to understand to what extend the proposed activity will contribute to the cumulative loss of this vegetation type and other biodiversity features on a regional basis. Fortunately, more than 95% of most of these vegetation types are still found in a relative natural state.

The impact is expected to be low to very low, associated mostly with the short construction phase.

Mitigation: All the mitigations discussed in the previous sections are applicable (with regards to the applicable route chosen).

QUANTIFICATION OF ENVIRONMENTAL IMPACTS

Using the Van Schoor formula the impacts can be quantified as follows.

THE NO-GO ALTERNATIVE

It is very important to note that the "No-Go Alternative" will not result in a *status quo* or no impact, since this portion of the pipeline has already been identified as the portion subject to the most frequent failures. As a result the continual disturbance over time (when taking the cumulative effect into consideration) may have a more significant impact than any of the proposed alternatives. Each failure will result in excavations, vehicle access and possibly even temporary pipeline routes. Eventually the pipeline will have to be replaced.

***S* = [(*fd* + *int* + *sev* + *ext* + *loc*) x (*leg* + *gcp* + *pol* +*ia* + *str*) x *P*]** (as adapted)

S = [(1 + 1 + 2 + 1 + 2) x (1 + 1 +1 + 2 +1) x 0.75] = 31.5 %

REFURBISHMENT

The preferred alternative is to locate the replacement pipeline within the old pipeline trench. This will entail the placement and installation of a temporary pipeline (to ensure continual water supply during the construction of the new pipeline), the excavation and removal of the original pipeline, the placement of the new pipeline and rehabilitation of the construction area (as well as the removal and rehabilitation of the temporary pipeline and its route). The duration of the impact is considered to be short term (coupled with the construction period). However, the proposed route includes crossing the ecological sensitive Rivers and its tributaries on more than one occasion.

Without mitigation: (River crossings and major excavations)

***S* = [(*fd* + *int* + *sev* + *ext* + *loc*) x (*leg* + *gcp* + *pol* +*ia* + *str*) x *P*]** (as adapted)

S = [(1 + 1.5 + 2 + 2 + 2) x (1 + 1 +1 + 2 +1) x 0.95] = 48.5 %

With mitigation (almost all significant impacts could be negated)

***S* = [(*fd* + *int* + *sev* + *ext* + *loc*) x (*leg* + *gcp* + *pol* +*ia* + *str*) x *P*]** (as adapted)

S = [(1 + 1.5 + 1 + 1 + 2) x (0 + 0 +0 + 2 +0) x 0.95] = 12.4 %

RECOMMENDATIONS & IMPACT MINIMIZATION

Considering the No-Go alternatives against the proposed project shows that the No-Go alternative is not viable and might even result in more disturbances over time. When taken into account that such maintenance work is mostly done without the supervision of an experienced environmental control officer, the cumulative impact over time can be even more significant.

Having evaluated and discussed the various biodiversity aspects associated with the project it is clear that the most significant impacts are associated with the impact (even temporary) on ecological sensitive areas (e.g. river system & CBA's). The fact that the underground placement proposed in this project can be seen as a short term impact and almost all significant impacts associated with the construction phase can be negated, should indicated that the proposed method of construction is viable and should be open for consideration.

With the available information to the author's disposal it is recommended that project be approved since it is not associated with irreversible environmental impact, provided that mitigation is adequately addresses.

IMPACT MINIMIZATION

- Before any work is done the route must be clearly demarcated (with the aim at minimal width/smallest footprint). The demarcation must include the total footprint necessary to execute the work, but must aim at minimum disturbance.
- All significant biodiversity features must be identified and mapped on the site plans. This includes all areas falling within Ecological support areas, Critical Biodiversity Areas (CBA1 & CBA2) as well as any river crossing. Special care must be taken when working in any of these areas, which include that a suitably experienced ECO or Botanist must first walk the route in these areas to establish whether any significant features will be irreversibly impacted by the proposed activity.
- Special care must be taken when work is done within the Eenriet Plains Succulent Shrubland. In this area a suitably qualified ECO or botanist must first walk the route and identify any significant biodiversity features (such as quartz patches) along the route and then decide whether search and rescue are to be done before construction starts.
- In addition the total route must be scanned by a suitably experienced ECO or botanist in order to identify any significant plant species (e.g. Protected trees or other significant Rare & Endangered species, including Geophytes where applicable). If any such features are encountered the Botanist must advise on the best way to minimise the impact (e.g. through Search & Rescue).
- Before any excavation is allowed all significant plant species identified during the botanical scan must be rescued in a search and rescue operation supervised by a suitably qualified ECO or Botanist.
- Only existing access routes may be used (if additional access is required it must be cleared with the ECO).

- All topsoil (the top 20 cm) should be removed and stored separately to be re-used during the rehabilitation after construction (the purpose being to re-use as much of the seed and bulb stock within the topsoil layer for re-establishing these species in the disturbed areas).
- The integrity of all the River system must be protected throughout the construction and operation phase of the pipeline.
- Adequate measures must be implemented to ensure against erosion.
- All alien vegetation encountered within 15 m of the route must be removed, as is legally required.
- All rubble and rubbish should be collected and removed from the site to a suitable registered waste disposal site.
- All legal requirements must be adhered to (e.g. General Authorization from the Department of Water Affairs with regards to river crossings).
- All construction areas must be suitably rehabilitated on completion of the project. This includes the removal of all excavated material, spoil and rocks, all construction related material and all waste material. It also included replacing the topsoil back on top of the excavation as well as shaping the area to represent the original shape of the environment.