BOTANICAL INPUTS FOR THE ATLANTIS WATER RESOURCE MANAGEMENT SCHEME ENVIRONMENTAL MAINTENANCE MANAGEMENT PLAN, CITY OF CAPE TOWN

CAPENSIS

PAUL EMMS

DECEMBER 2024

REPORT PREPARED FOR
ZUTARI (PTY) LTD

DETAILS OF THE SPECIALIST

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Expertise

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- Has conducted over 300 specialist botanical studies.

THE SPECIALIST

I, Paul Ivor Emms, as the appointed specialist hereby declare/affirm the correctness of the information provided or to be provided as part of the application, and that I:

- in terms of the general requirement to be independent:
- other than fair remuneration for work performed/to be performed in terms of this application, have no business, financial, personal or other interest in the activity or application and that there are no circumstances that may compromise my objectivity; or
- in terms of the remainder of the general requirements for a specialist, am fully aware of and meet all of the requirements and that failure to comply with any the requirements may result in disqualification;
- have disclosed/will disclose, to the applicant all material information that have or may have the potential to influence the decision of the Department or the objectivity of any report, plan or document prepared or to be prepared as part of the application;
- have ensured/will ensure that information containing all relevant facts in respect of the application was/will be distributed or was/will be made available to interested and affected parties and the public and that participation by interested and affected parties was/will be facilitated in such a manner that all interested and affected parties were/will be provided with a reasonable opportunity to participate and to provide comments;
- have ensured/will ensure that the comments of all interested and affected parties were/will be considered, recorded and submitted to the Department in respect of the application;
- have ensured/will ensure the inclusion of inputs and recommendations from the specialist reports in respect of the application, where relevant;
- have kept/will keep a register of all interested and affected parties that participate/d in the public participation process; and
- am aware that a false declaration is an offence in terms of regulation 48 of the 2014 NEMA EIA Regulations.
  Note: The terms of reference of the review specialist must be attached.

Signature of the specialist:

Paul Emms
Name of company: Capensis Ecological Consulting (Pty) Ltd
Date: 13 December 2024

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Table of abbreviations and acronyms

ASF	Atlantis Sand Fynbos
CFDS	Cape Flats Dune Strandveld
CFSF	Cape Flats Sand Fynbos
CR	Critically Endangered
CWCBR	Cape West Coast Biosphere Reserve
EN	Endangered
NT	Near Threatened
RNLETNP	The Revised National List of Ecosystems that are Threatened and in Need of Protection
SCC	Species of Conservation Concern
SSR	Swartland Shale Renosterveld
VU	Vulnerable

1. INTRODUCTION

1.1. BACKGROUND

The City of Cape Town (CCT) is compiling an Environmental Maintenance Management Plan (EMMP) for the Atlantis Water Resource Management Scheme (AWRMS) in line with the New Water Programme (NWP), which was developed under Section 41(1) of the Disaster Management Act, 2002 (No. 57 of 2002). The AWRMS includes new infrastructure associated with groundwater development but also incorporates older infrastructure constructed in the 1970s.

A Section 30A Directive in terms of the National Environmental Management Act (NEMA) (No. 107 of 1998) was issued to the CCT by the Department of Forestry, Fisheries, and the Environment (DFFE) in April 2018 and June 2020, and by the Provincial Department of Environmental Affairs and Development Planning (DEA&DP) in May 2017. These directives meant that the conventional Environmental Impact Assessment (EIA) process was not required for specific Listed Activities under NEMA. The groundwater development infrastructure associated with the AWRMS falls within this directive but still requires compliance with certain conditions, including:

- Sensitivity screening of project areas
- Development of detailed environmental method statements
- On-site Environmental Control Officers
- Oversight by specialist ecologists
- Stakeholder engagement throughout the project lifecycle (Zutari, 2023).
- Compliance with the DEA&DP accepted Water Resilience Projects Environmental Management Programmes (City of Cape Town)

As part of the environmental inputs, botanical and freshwater surveys were carried out to address the identified impacts associated with the maintenance of infrastructure and to provide best-practice mitigation recommendations aimed at reducing associated impacts. Capensis Ecological Consulting (Pty) Ltd (trading as Capensis) was commissioned by Zutari (Pty) Ltd to provide the botanical inputs for the EMMP.

The EMMP will be compiled by Zutari (Pty) Ltd and will include:

1. Background and strategic overview
2. The objectives of the EMMP
3. The project description and location
4. Relevant legislation and policies
5. Site context including specialist studies and input

6. Implementation of the EMMP
7. Environmental management requirements and mitigations for maintenance and repair activities
8. Monitoring and reporting requirements,

The information provided in this report will be incorporated into the EMMP and is not intended to serve as a standalone botanical assessment report.

1.2. METHOD OF PLANNED MAINTENANCE ACTIVITIES

The maintenance activities include:

1. Repair of damaged water crossing infrastructure:

This would include the replacement of broken culverts, redirecting of culverts which are located against the natural flow of a river, dredging inside the watercourse to obtain access to infrastructure, removal of flood debris and silt and the infilling of material for stabilisation and support of new infrastructure.

2. Replacement of damaged road and infrastructure after large storm events:

In most instances after large storm events there is some degree of damage, including erosion of banks, gravel roads and bridge approaches. Some flood debris could also cause damage to the infrastructure itself which would need to be fixed or replaced if damaged extensively. This could entail dredging, excavating and infilling in a stream.

3. Repair of pipeline and cable infrastructure:

Over time some damage could occur to the installed pipeline, electrical and communication infrastructure, which would result in machinery needing to access the pipe or cables over / underneath the stream and would entail dredging, excavating and potentially infilling inside a watercourse. More than 300 square metres of indigenous vegetation could be cleared for maintenance of below ground linear infrastructure (e.g. pipelines, powerlines, telemetry etc.) where the linear infrastructure would need to be excavated and repaired.

4. Clearing of silt or flood debris from infrastructure (e.g., culverts, weir and basins) and watercourses:

Over time, material such as silt, dead vegetation and litter will accumulate along, under, downstream of, behind and within infrastructure, and in rivers and wetlands. These need to be cleared regularly to ensure proper functioning of the infrastructure and ecosystems and prevent flooding and associated

damage within these areas. The clearing would entail the dredging or excavating of debris, silt and other flooded material from the crossings.

5. Clearing of alien invasive vegetation from watercourses, weirs and basins:

Large alien invasives will be cleared using chainsaws. Smaller plants will be removed by hand using hand tools to remove the roots from the beds and banks of watercourses. Excavators may be needed to clear alien invasives in areas where access is limited, such as within saturated basins and abstraction ponds above weirs. All plant material will be removed and disposed of at a licenced WDF, with proof thereof retained.

6. Clearing of indigenous vegetation around the borehole sites in case of borehole maintenance or drilling activities:

More than 300 square metres of indigenous vegetation could be cleared during redrilling or maintenance activities (e.g., borehole cleaning) needed at any of the borehole sites for the establishment of drill rigs and/or other equipment.

7. Replacement of eroded stream crossing approaches:

Over time some of the gravel road approaches alongside the stream crossings could erode and cause the need for replacement or installation of erosion control measures. This would entail the infilling of material within close proximity of watercourses or within wetlands.

8. Replacement and maintenance of erosion control measures:

Where erosion control measures are already installed, maintenance would have to be done to ensure these remain in good working order or that areas that become prone to erosion is secured to protect infrastructure and prevent downstream impacts to the aquatic ecosystems. This would entail the potential excavation and infilling of material within watercourses or wetlands and activities such as gabion basket installations

9. Maintenance of firebreaks and fencing

Where firebreaks align with pipeline infrastructure regular brush-cutting is required. Fencing may also need to be either repaired or replaced around infrastructure, requiring clearing of indigenous and/or alien vegetation in some instances.

2. TERMS OF REFERENCE

The following Terms of Reference were provided:

- Carry out a survey of AWRMS infrastructure sites and provide a description of the vegetation (type, condition, sensitivity). Record any Species of Conservation Concern (SCC).
- Provide a report which contains an overview of the study area in terms of the ecological context.
- Assess the likely impacts of all the listed maintenance activities
- List appropriate mitigation measures to ensure no unnecessary loss of indigenous vegetation or degradation of habitat occurs (mitigation).

3. STUDY AREA

3.1. Locality and survey area

The AWRMS encompasses an area of 180 km², extending from the northeastern side of Atlantis near Mamre, southwards to the Atlantis Industrial Area, west to Silverstroom and the Koeberg Nature Reserve, and south to the Blouberg Reservoir (Figure 1). The infrastructure includes retention and discharge basins, access roads, boreholes, pipelines, electricity cables, manholes, culverts, and above-ground water transfer and storage systems.

Most of the infrastructure consists of a below-ground pipeline network, with the visible components being:

1. The borehole sites and associated roads
2. The retention and discharge basins
3. Treatment works
4. Pumpstations
5. Reservoirs

In most instances, the original disturbance footprint (trenching and installation) of the below-ground pipeline is not obvious since the vegetation has recovered exceptionally well.

3.2. Landscape and geology

The landscape and topography vary across the extensive study area and have the following features associated with the main areas:

- **Silwerstroom Wellfield**: Sand-dominated, vegetated (stable) dunes with gently undulating to flat topography.
- **Witsands Wellfield within Witsands Aquifer Nature Reserve and Koeberg Nature Reserve (including the Coastal Recharge Basins)**: Vegetated (stable) dunes.
- **Atlantis Industrial and outskirts**: Sandy, gently undulating to flat topography.
- **R27**: Sandy, gently undulating to flat topography.
- **Blouberg Hill lower slopes**: Sandy flats and lower slopes of Blouberg Hills with sandy, slightly loamy soils containing a small clay content but predominantly sandy.

Soil types include alkaline sands of marine origin associated with strandveld vegetation and grey regic acid sands associated with fynbos (Rebelo et al., 2006, in Mucina & Rutherford, 2006). The slightly loamy soils on the lower slopes of Blouberg Hill are most likely in the neutral pH range

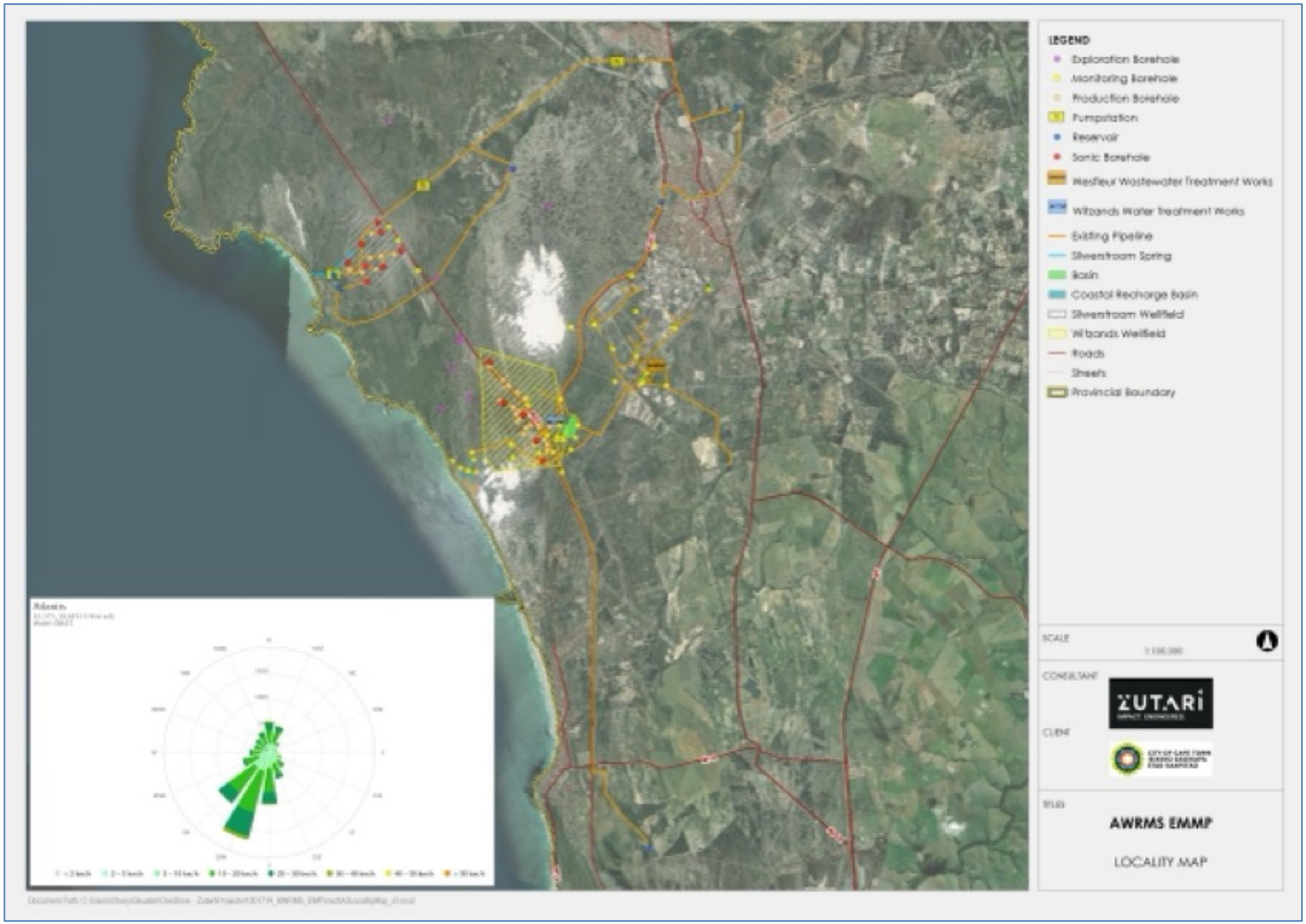

Figure 1. Overview of the AWRMS.

4. METHODOLOGY, LIMITATIONS AND ASSUMPTIONS

The study area was visited between the 29th October and 19th of November 2024 and surveyed by vehicle with periodic stops to assess the vegetation. Sample waypoints were collected using a Garmin GPSmap 62. Photographs were taken with a Sony Cyber-Shot DSC-HX90V and georeferenced.

The following sources have been used to inform this study:

Site boundaries: The spatial files of the AWRMS were provided by Zutari.

Vegetation Types: Based on The Vegetation of South Africa, Lesotho and Swaziland (VEGMAP)(Mucina & Rutherford, 2006). The South African National Biodiversity Institute (SANBI) has updated the VEGMAP (2024 Beta Version). These latest shapefiles have been used.

Ecosystem threat status: Informed by (1) Revised National List of Ecosystems that are Threatened and in Need of Protection (Government Gazette, 2022).

Biodiversity planning: The City of Cape Town Biodiversity Network GIS (Geographical Information System) shapefiles (City of Cape Town, 2024) and main report (Holmes and Pugnalin, 2016) is important for determining the conservation importance of the designated habitat.

Important species: The presence or absence of threatened (i.e. SCC) and ecologically important species informs the ecological condition and sensitivity of the site. The latest conservation status of species was checked in the Red List of South African Plants (Raimondo et al. 2009) (www.redlist.sanbi.org). A list of sensitive species generated by the National Web-based Screening Tool (screening.enviornment.gov.za) was used. Observations from iNaturalist (inaturalist.org) at and in the vicinity of the study area were also noted.

Previous studies: Previous botanical studies at a local scale, if available, are consulted to provide additional information regarding the botanical attributes of the site.

The site visit was carried out after the peak flowering period for the region, which extends from August to October. The timing of the survey is thus regarded as suboptimal for accurately assessing the flora of the site; however, the overall sensitivity could be determined based on the vegetation condition. A few sections of the pipeline were not visited due to a combination of dumping within the road and safety concerns. These areas were mapped by interpreting aerial imagery based on the condition of nearby surveyed areas. Overall, the limitations to the study are not regarded as significant enough to influence the overall mapping and determination of sensitivity.

5. NATIONAL VEGETATION TYPES AND ECOSYSTEM THREAT STATUS

5.1. Vegetation type

According to the Vegetation Map of South Africa, Lesotho and Swaziland (SANBI, 2024 Beta Version) (VEGMAP) four vegetation types occur within the study area, namely Atlantis Sand Fynbos,

Cape Flats Dune Strandveld, Cape Flats Sand Fynbos and Swartland Shale Renosterveld (Figure 2). The latter two vegetation types are purported to occur at the southern portion of the study area on the lower slopes to flats of Blouberg Hill. The landscape and vegetation of the vegetation types or ecosystems is described by Rebelo et al. (in Mucina and Rutherford, 2006) below:

Atlantis Sand Fynbos

> "a dense, moderately tall, ericoid shrubland dotted with emergent, tall sclerophyllous shrubs with an open, short restioid stratum. Restioid and proteoid fynbos are dominant, with asteraceous fynbos and patches of ericaceous fynbos in seepages."

Swartland Shale Renosterveld

> "Moderately undulating plains and valleys supporting low to moderately tall leptophyllous shrubland of varying canopy cover as well as low, open shrubland dominated by renosterbos. Heuweltjies are a very prominent local feature of the environment, forming 'hummockveld' near Piketberg and giving the Tygerberg Hills their name. Stunted trees and thicket are often associated with the heuweltjies. Disturbed areas are dominated by Athanasia trifurcata and Otholobium hirtum. Patches of Cynodon dactylon grazing lawns' also occur in abundance."

Cape Flats Sand Fynbos

> "Moderately undulating and flat plains, with dense, moderately tall, ericoid shrubland containing scattered emergent tall shrubs. Proteoid and restioid fynbos are dominant, with asteraceous and ericaceous fynbos occurring in drier and wetter areas, respectively."

Cape Flats Dune Strandveld

> "Flats to undulating (dune fields) landscape covered by tall evergreen shrub, hard-leaved shrubland with abundant grasses and annual herbs in gaps"(Rebelo et al. in Mucina and Rutherford, 2006).

Cape Flats Dune Strandveld has been divided into two sub-types: False Bay and West Coast Cape Flats Dune Strandveld (Holmes et al. 2012). The unit extends across the Cape Flats and along the West Coast where the difference between the West Coast and False Bay Coast forms of the vegetation unit become more discernible with increased distance apart. As a general rule, the West Coast form of the unit has a higher number of succulent species than the False Bay form. The West Coast sub-type is located in proximity to the site.

Ecological drivers

The key ecological drivers in lowland fynbos ecosystems according to Cadman et al. (2016) include (1) the natural fire frequency, (2) diversity of habitat and environmental gradients, (3) regional and local natural water drainage patterns and (4) natural grazing and physical soil disturbance.

The key ecological drivers in renosterveld ecosystems according to Cadman et al. (2016) include (1) fire and grazing patterns, (2) variations in edaphic conditions and water availability, (3) edaphic boundaries, (4) underlying geology, (5) specialised plant-pollinator interactions, (6) plant-plant interactions and (7) living (biogenic) soil crust.

The key ecological drivers in strandveld ecosystems include: (1) variation in soil type, (2) variations the amount and seasonality of rainfall, (3) dispersal of berries and seed by frugivorous bird species (4) fire, (5) drainage patterns and (6) corridors for faunal movement.

5.2. Ecosystem threat status

Ecosystem threat status is informed by The Revised National List of Ecosystems that are Threatened and in Need of Protection (RNLETNP)(Government Gazette, 2022). Species information is not provided in the RNLETNP and is thus taken from The National List of Ecosystems that are Threatened and in Need of Protection (Government Gazette, 2011). Table 1 provides a summary of (a) the original (national) extent of each vegetation type, (b) the proportion of ecosystem target protected, (c) the known number of species of conservation concern and (d) the national conservation target from the three most relevant information sources.

Note that of the four vegetation types occurring within the study area, two are listed as Endangered (Cape Flats Dune Strandveld and Atlantis Sand Fynbos) whereas the remaining two are listed as Critically Endangered (Swartland Shale Renosterveld and Cape Flats Sand Fynbos).

Table 1. Ecosystem threat status derived from SANBI (bgis.sanbi.org)

Ecosystem threat status	**The National List of Threatened Terrestrial Ecosystems**
Atlantis Sand Fynbos	Endangered
Reason	Criterion B (Rate of loss of natural habitat)
Original area	68 905 ha
Remaining area	49%
Protected area	4.6%
*Species of Conservation Concern	84 Red Data plant species (EX, EW, CR, EN & VU excl VU D2) and 6 endemic plant species.
Pressures & threats:	"Agriculture, mainly small holdings and pastures have been a key pressure to this ecosystem with 180.1 km^2 consisting of croplands and a further 146.91 km^2 of old fields.

	Threatened plant species data indicate that alien species, overgrazing and altered fire regimes are important pressures (Red list of species 2018). Specifically, invasions by Acacia saligna, A. cyclops and various species of Eucalyptus and Pinus (Rebelo et al. 2006)."
Notes	"Trigger Sub-Criteria: B1(iii) - Atlantis Sand Fynbos is narrowly distributed with evidence of ongoing biotic disruption from invasive species and overgrazing. Scope: Global & national status (global extent assessed)."
Cape Flats Dune Strandveld	Endangered
Reason	Criterion B (Rate of loss of natural habitat)
Original area	39 864 ha
Remaining area	50%
Protected area	19%
*Species of Conservation Concern	66 Red Data plant species (EX, EW, CR, EN & VU excl VU D2) and 1 endemic plant species.
Pressures & threats:	"This ecosystem has experienced a loss in natural habitat of approximately 69.01 km^2 in the last 28 years (1990-2018). These spatial declines have been primarily driven by urban and rural development with built-up areas increasing by 9.19 km^2 in the last 28 years (1990-2018) to cover 153.17 km^2 of the ecosystem (Rebelo et al. 2006). Agriculture is also a pressure to this ecosystem with 7.89 km^2 covered by croplands and 26.97 km^2 of old fields. Mines cover 4.86 km^2 of the ecosystem. Threatened plant species data indicate that alien invasive species, overgrazing and altered fire regimes are important pressures (Red list of Species 2018). Specifically, invasions by Acacia, Eucalyptus and Pinus species (Rebelo et al. 2006)."
Notes	"Trigger Sub-Criteria: B1(i), B2(i), B1(iii), B2(iii) - Cape Flats Dune Strandveld is narrowly distributed with high rates of habitat loss in the past 28 years (1990-2018), and evidence of ongoing biotic disruption from invasive species. Scope: Global & national status (global extent assessed)."
Swartland Shale Renosterveld	Critically Endangered
Reason	A (Criterion A)
Original area	49 6374 ha
Remaining area	10%
Protected area	0.7%
*Species of Conservation Concern	151 Red Data plant species (EX, EW, CR, EN & VU excl VU D2) and 35 endemic plant species.
Pressures & threats:	"This ecosystem has experienced a loss in natural habitat of approximately 296.62 km^2 in the last 28 years (1990-2018). These spatial declines have been primarily driven by agriculture, with croplands now covering 3861 km^2 of the ecosystem and a further 429.42 km^2 of old fields. The ecosystem is further transformed by urban development, with 95.67 km^2 of built areas, as well as 36.82 km^2 of artificial water bodies. Threatened plant species data indicate that alien invasive species, overgrazing and altered fire regimes are important pressures (Red list of Species 2018). The remnants of this ecosystem are found in isolated pockets, usually on steeper ground where alien annual grasses of the genera Avena, Briza, Bromus, Lolium, Phalaris and Vulpia are a primary concern (Rebelo et al. 2006). Other aliens include Acacia saligna (very scattered), A. mearnsii (very scattered), several species of Prosopis and Eucalyptus, as well as herbs including Erodium cicutarium, E. moschatum, Echium plantagineum and Petrorhagia prolifera (Rebelo et al. 2006)."
Notes	"Trigger Sub-Criteria: A3 - National land cover and supplementary provincial and metropolitan land cover data show that Swartland Shale Renosterveld has experienced extensive spatial declines of approximately 90 % % (sic) since 1750. Scope: Global & national status (global extent assessed)."
Cape Flats Sand Fynbos	Critically Endangered
Reason	Criterion B (Rate of loss of natural habitat)

Original area	55697 (ha)
Remaining area	18 %
Protected area	1.6 %
*Species of Conservation Concern	95 Red Data plant species (EX, EW, CR, EN & VU excl VU D2) and 16 endemic plant species.
Pressures & threats:	This ecosystem has experienced a loss in natural habitat of approximately 69.98 km^2 in the last 28 years (1990-2018), has been driven by a broad range of pressures. Urban development has been a primary pressure to this ecosystem causing severe transformation of this ecosystem with built-up areas now covering 262.09 km^2 (Rebelo et al. 2006). Agriculture has also been a key pressure, with 62.94 km^2 of the ecosystem consisting of croplands and a further 117.24 km^2 of old fields. Cape Flats Sand Fynbos is heavily degraded in the remaining fragments due to mismanagement by mowing, fire protection, bush encroachment especially by Carpobrotus edulis, Chrysanthemoides monilifera, and alien plant invasion (Rebelo et al. 2006). Mowing eliminates serotinous and taller species and altered fire regimes, like complete fire protection, results in a few common thicket species replacing the rich fynbos species (Rebelo et al. 2006). Threatened plant species data indicate that alien species, overgrazing and altered fire regimes are important pressures (Red list of species 2018).
Notes	Trigger Sub-Criteria: B1(i), B1(iii) - Cape Flats Sand Fynbos is narrowly distributed with high rates of habitat loss in the past 28 years (1990-2018), and evidence of ongoing biotic disruption from invasive species. Scope: Global & national status (global extent assessed).

* National List of Ecosystems that are Threatened and in Need of Protection (Government Gazette, 2011).

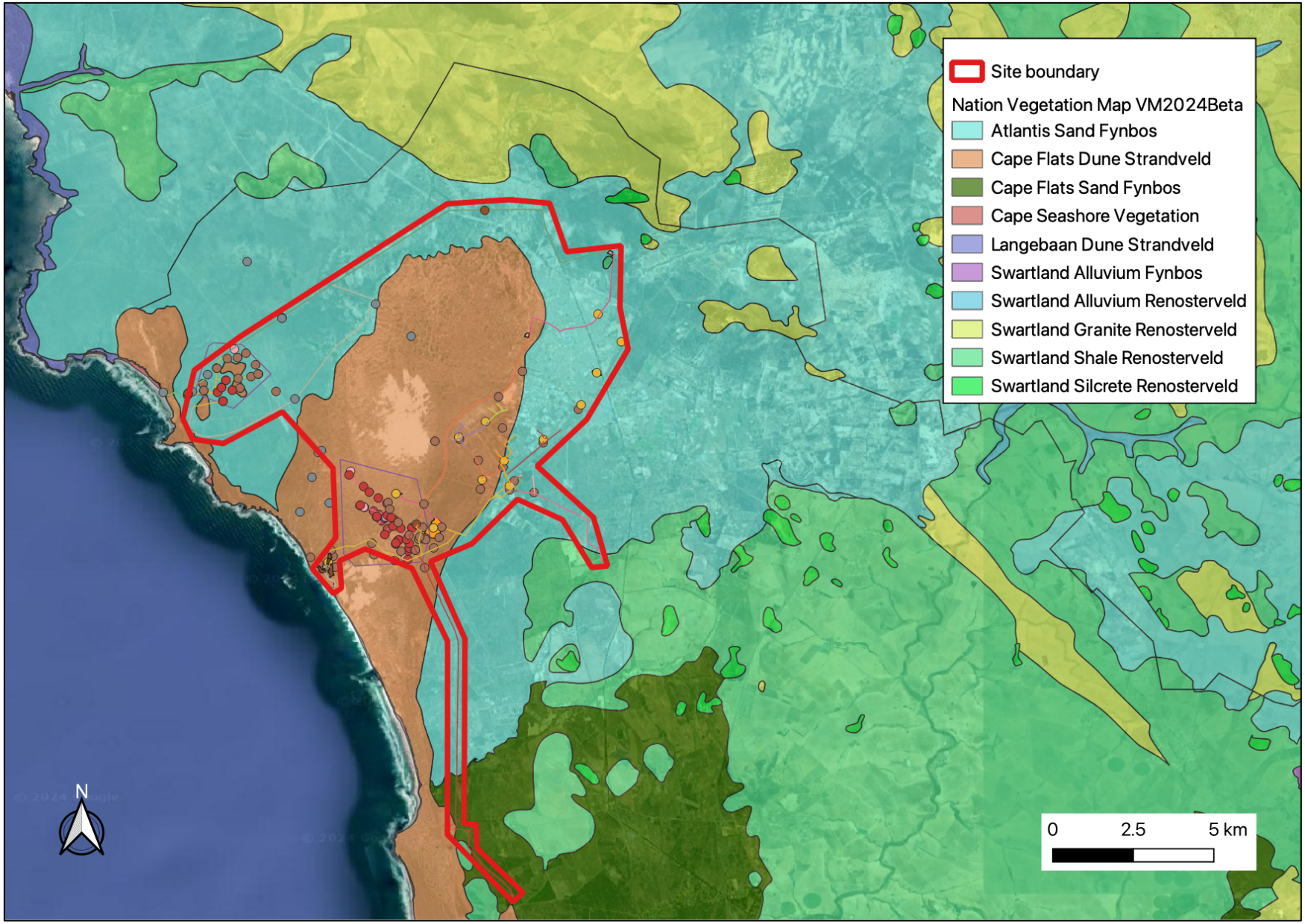

Figure 2. VEGETATION MAP: The vegetation types within the western side of the study area according to *The Vegetation Map of South Africa, Lesotho and Swaziland* (SANBI, 2024 Beta Version) overlaid on a Google Maps ™ aerial image.

3.3. Conservation areas

The study area falls within the City of Cape Town Biodiversity Network (City of Cape Town, 2024) which indicates that portions of the AWRMS are located in two conservation areas. These are the Atlantis Aquifer Nature Reserve and Koeberg Nature Reserve (Figure 3). The AWRMS also falls within the Cape West Coast Biosphere Reserve (CWCBR), which encompasses the entire coastal region from St. Helena Bay in the north to Melkbosstrand in the south, including inland areas of Hopefield and Malmesbury.

Significance of the Cape West Coast Biosphere Reserve

The CWCBR is recognized as a UNESCO-designated biosphere reserve, established to promote sustainable development while conserving biodiversity and cultural heritage. It serves as a framework for balancing ecological conservation with human activities, such as agriculture, tourism, and urban development. The region is home to diverse ecosystems, including fynbos, wetlands, and coastal habitats, which support numerous endemic and threatened species. The reserve also plays a critical role in environmental education, research, and fostering a harmonious coexistence between nature and local communities. Its inclusion in the AWRMS highlights the importance of aligning infrastructure projects with conservation goals.

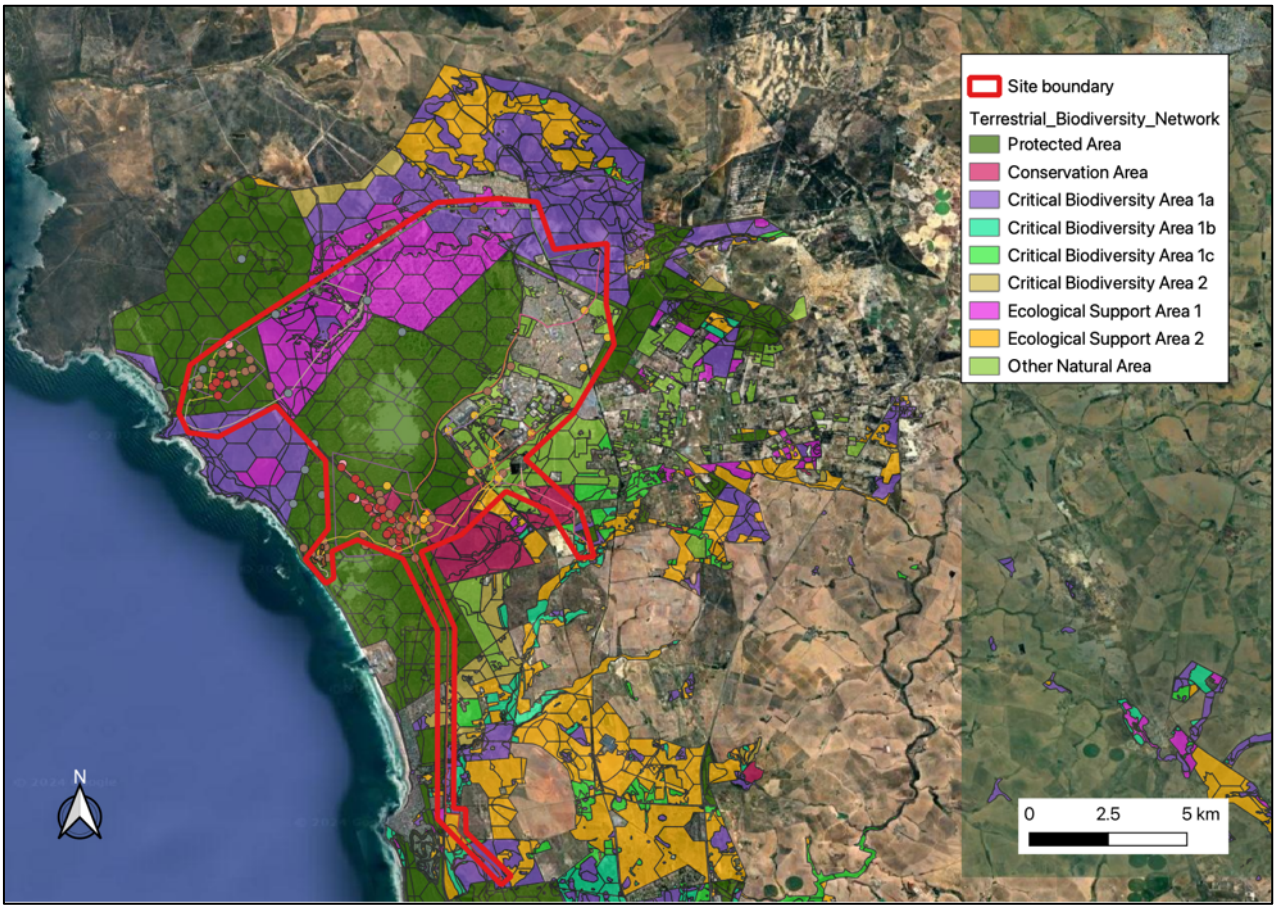

Figure 3. The study aera in relation to the City of Cape Town Biodiversity Network (2024 Beta version, City of Cape Town) overlaid on a Google Earth ™ aerial image.

4. VEGETATION OF THE STUDY AREA

4.1. Habitat condition

The main vegetation types are described below according to habitat condition. The two dominant vegetation types mapped in the VEGMAP, namely Atlantis Sand Fynbos and Cape Flats Dune Strandveld, were verified as the dominant vegetation types. No pure remnants of Cape Flats Sand Fynbos or Swartland Shale Renosterveld were found. Transitional vegetation, comprising a mix of these two vegetation types, was identified close to the Blouberg Reservoir. However, the condition of the vegetation was severely modified (Degraded to Highly Degraded).

The habitat condition categories used to describe the vegetation are indicated in Table 2. All habitats have been mapped according to these condition categories and are provided in the Google Earth (.kmz) spatial file. A separate section is provided for Species of Conservation Concern (SCC) observed during the site visits. These are listed in this section and are also provided as a spatial (.kmz) file.

Table 2. The habitat condition descriptions used for the vegetation on the site.

Habitat condition	Description
Intact vegetation	A true representation of the original vegetation type in terms of structure and species makeup. Minimal soil disturbance. Unlikely to have ever been ploughed. Disturbance may be evident.
Semi-intact	Closely resembles the original vegetation type in terms of structure and species makeup but has undergone some form of current or historical disturbance. Restoration potential is high.
Degraded	Only a few species representative of the original vegetation type are present. The vegetation has undergone heavy disturbance. Restoration potential is either low or moderate.
Highly degraded	The original vegetation is usually absent and has been removed in the past. Only a few remnant or pioneer species are present. Soils usually ploughed in the past. Restoration potential is very low.
Transformed	No remnant species exist anymore. The landscape is altered irreversibly with no restoration potential. Examples include cultivated farmland and the built environment.

As stated earlier, the pipeline footprint is difficult to determine within the aforementioned intact sites since the vegetation has recovered remarkably well in most instances. The areas where recovery has been exemplary are due to the immediate reinstatement of the topsoil after construction. On the opposite end of the spectrum, areas with the highest degree of habitat transformation are a result of the introduction of foreign material, such as gravel.

Disturbed vegetation occurs at the sites along the edges of roads and around the borehole sites. The disturbance footprint associated with roads and borehole sites has led to a proliferation of exotic weeds, which are most prevalent at the borehole sites. The introduction of weeds seems to be linked to the establishment of gravel roads. A list of commonly occurring weeds is provided below. The introduction of exotic weeds is a concern in the protected areas, as these sites would not have contained weeds prior to the infrastructure development in what were previously pristine to near-pristine environments.

Commonly occurring weeds around roads and borehole sites:

- Wild oats (*Avena fatua*)
- Ripgut brome (*Bromus diandrus*)
- Paterson's curse (*Echium plantagineum*) [NEMBA category 1b invasive]
- Mediterranean storksbill (*Erodium botrys*)
- Lupin (*Lupinus* sp.)
- Fragrant evening primrose (*Oenothera stricta*)
- Ribwort plantain (*Plantago lanceolata*)
- Narrow-leaf clover (*Trifolium angustifolium*)

Invasive Alien Plants (IAPs) occur mostly outside the protected areas and are associated with disturbed vegetation. The most common IAP is the Port Jackson willow (*Acacia saligna*) [NEMBA category 1b]. This species is dominant in the Atlantis Industrial Area, along roads, servitudes, and basins. Rooikrans (*Acacia cyclops*) [NEMBA category 1b] was not commonly encountered and would likely be more extensive if not for the coastal sections being within protected areas with active clearing programs in place.

4.1.1. Atlantis Sand Fynbos

Atlantis Sand Fynbos (ASF) occurs over approximately 50% of the study area, while Cape Flats Dune Strandveld occupies the remaining 50%. The areas in which the vegetation is most ecologically intact include:

1. Silwerstroom wellfield?
2. Silverstream Road east of the R27 (Figure 4)
3. Between structures AT-EX09 and AT-EX10 (mostly the western half)
4. The Eskom Transmission Lines between Basin 6 and Basin 7
5. Between the Pella Reservoir and Pella Road

Species diversity is typically higher in the most intact areas, declining with increasing levels of disturbance. The most transformed areas, ranging from (1) built-up or recently cleared areas with no vegetation present to (2) brush-cut or heavily impacted sites, may only support a few species, often dominated by exotic species. Figures 4 to 7 provide examples of the varying levels of disturbance.

Commonly occurring species:

- Cape asparagus (*Asparagus capensis*)
- Bristle Capegorse (*Aspalathus hispida*)
- Tall flowerseed (*Anthospermum aethiopicum*)
- Three Capegorse (*Aspalathus ternata*)
- Late goldfig (*Carpanthea pomeridiana*)
- Grey clut (*Clutia daphnoides*)
- Klapper (*Cysticapnos vesicatoria*)
- Perennial veldtgrass (*Ehrharta calycina*)
- Pipegrass (*Ehrharta villosa*)
- Common bitterbuchu (*Diosma hirsuta*)
- Kapkap kapok (*Eriocephalus racemosus*)

- *Hermannia angustibracteata*
- Snakestem pincushion (*Leucospermum hypophyllocarpodendron* subsp. *canaliculata*)
- Skilpadbessie (*Muraltia spinosa*)
- Common gonna (*Passerina corymbosa*)
- Koeberg tentfig (*Ruschia indecora*)
- Rooisalie (*Salvia lanceolata*)
- Blue kunirhus (*Searsia glauca*)
- Dune currantrhus (*Searsia laevigata*)
- Ribbed Capespray (*Struthiola striata*)
- Sprawling seacoral (*Tetragonia fruticosa*)
- Dune reed (*Thamnochortus spicigerus*)
- Dogsface (*Trichocephalus stipularis*)
- Sonqua sunreed (*Willdenowia incurvata*)

Figure 4. Intact Atlantis Sand Fynbos along Silverstream Road east of the R27.

Figure 5. Previously disturbed Atantis Sand Fynbos west of the Eskom transmission line. The vegetation has recovered to intact condtion, supporting high numbers of the *Ruschia tecta* (EN), *Ruschia indecora* and to a lesser extent *Microdon capitatatus* (EN).

Figure 6. Degraded Atlantis Sand Fynbos with dominant dune thatchreed *Thamnochortus spicigerus* and blue-eye snotblom *Grielum grandiflorum*, with Port Jacskson willow visible in the background.

Figure 7. Transformed land adjacent to the R27. The blue line represents the pipeline.

4.1.2. Cape Flats Dune Strandveld

The areas in which Cape Flats Dune Strandveld is most ecologically intact include:

1. Silwerstroom
2. Koeberg Nature Reserve
3. Witsands Aquifer Nature Reserve and the areas east of the reserve, which transition to Atlantis Sand Fynbos at the Koeberg Transmission Lines

Cape Flats Dune Strandveld typically forms a thicket and, unlike Atlantis Sand Fynbos, can be dominated by large shrubs, most notably seegwarrie (*Euclea racemosa*) and Cape sumach (*Osyris compressa*). Disturbed areas along the pipeline, if not maintained by brush-cutting (such as the section within the road reserve immediately east of Witsands Aquifer Nature Reserve), typically become dominated by *Ruschia misera*. This species forms dominant patches in the Koeberg Nature Reserve and is an important species for the active rehabilitation of pipeline installations. It is, however, not known whether this species persists artificially in the landscape for a long period of time, but it is effective in reestablishing vegetation structure. Dune olive (*Olea exasperata*), if present, is a good indicator of intact vegetation. In some instances, this species has re-established within the pipeline footprint.

Commonly occurring species:

- Cape asparagus (*Asparagus capensis*)

- Sabre sourfig (*Carpobrotus acinaciformis*)
- Grey clut (*Clutia daphnoides*)
- Cape sumach (*Osyris compressa*)
- Klapper (*Cysticapnos vesicatoria*)
- Seegwarrie (*Euclea racemosa*)
- Pipegrass (*Ehrharta villosa*)
- Strandveld beachfig (*Jordaaniella dubia*)
- Muraltia spinosa
- Dune olive (*Olea exasperata*)
- Bastard spikethorn (*Putterlickia pyracantha*)
- *Ruschia misera*
- Rooisalie (*Salvia lanceolata*)
- Blue kunirhus (*Searsia glauca*)
- Dune currantrhus (*Searsia laevigata*)
- Beach pegreed (*Restio eleocharis*)
- Sprawling seacoral (*Tetragonia fruticosa*)
- Dune reed (*Thamnochortus spicigerus*)

Figure 8. Intact Cape Flats Dune Strandveld at Silwerstroom. The blue line represents the pipeline.

Figure 9. Intact CFDS within the pipeline route within the road reserve immediately adjacent to the Witsands Aquifer Nature Reserve. The blue line represents the pipeline.

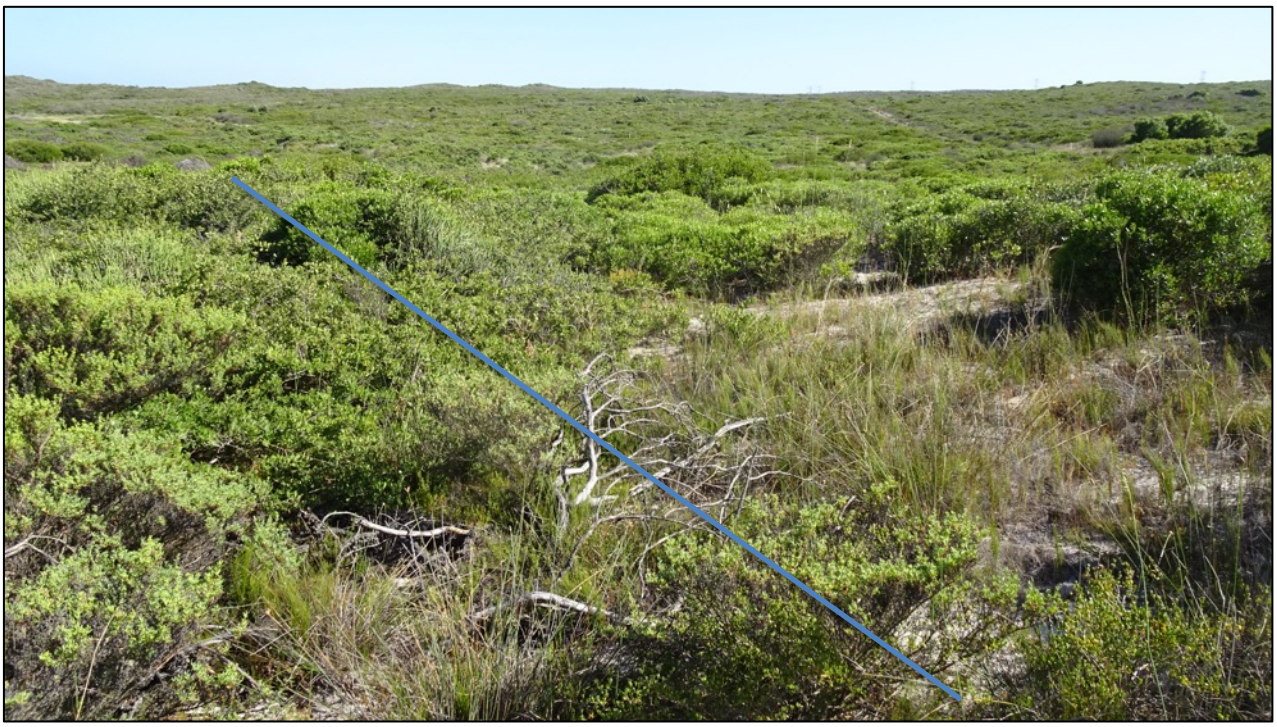

Figure 10. A patch of dune olive *Olea exasperata* that has reestablished along the pipeline east of Basin 7. The blue line represents the pipeline.

Figure 11. Degraded CFDS within the pipeline route adjacent to Intact CFDS left within the road reserve immediately adjacent to the Witsands Aquifer Nature Reserve. The blue line represents the pipeline.

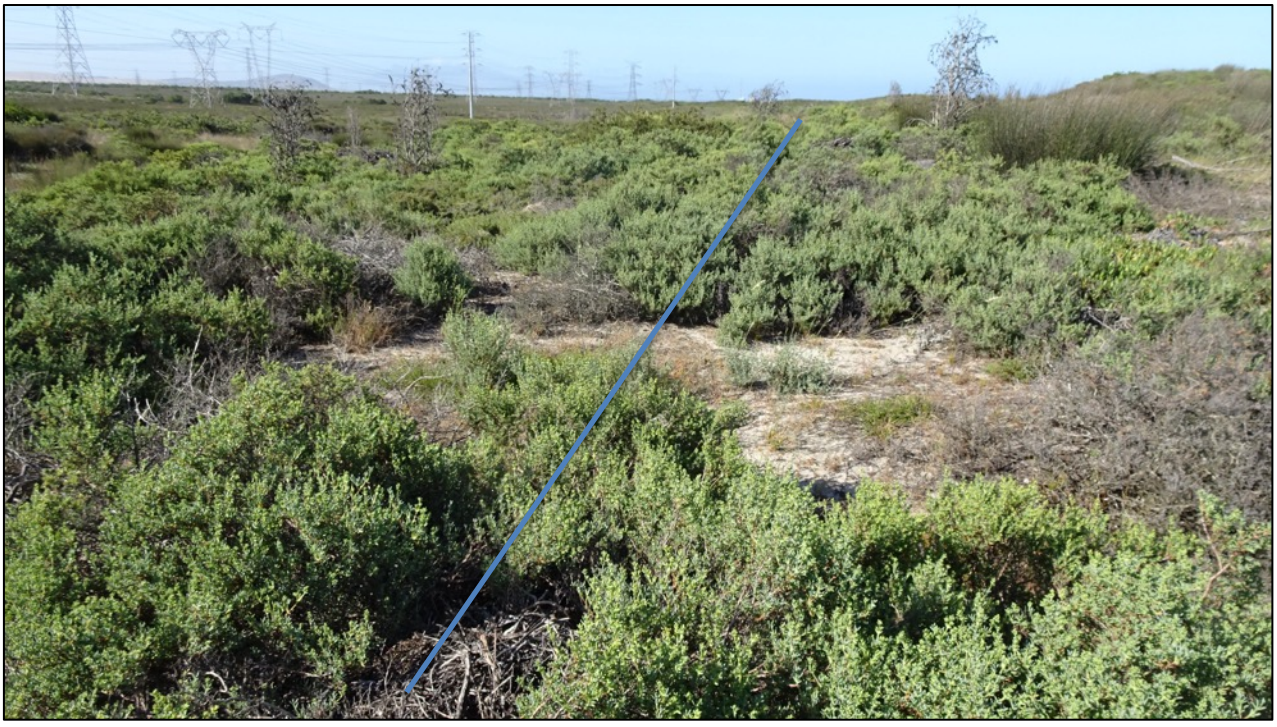

Figure 12. Degraded Cape Flats Dune Strandveld dominated by *Ruschia misera*. This species is dominant along the previously disturbed section of pipeline within strandveld and is key ecological species in that it establishes readily, forming an important role in natural rehabilitation. However, it is unknown for how long the species dominates the landscape. The blue line represents the pipeline.

Figure 13. Pipeline disturbance footprint visible (blue line) in the Witsands Aquifer Nature close to the R27 showing degraded CFDS. The blue line represents the pipeline.

4.1.3. Cape Flats Sand Fynbos and Swartland Shale Renosterveld

This transitional vegetation type, which may have some elements of dune strandveld present, is located on the lower slopes of Blouberg Hill, just north of Blouberg Reservoir. The vegetation is transformed on the lower slopes and the slopes north of Blouberg Hill (Figure 14), apart from a heavily modified (degraded to highly degraded) section a few hundred meters north of the reservoir (Figure 15). The soils are neutral and indicative of a mix between Atlantis Sand Fynbos and Swartland Shale Renosterveld.

Commonly occurring species:

- Kraalbos (*Aizoon africanum*)
- Three Capegorse (*Aspalathus ternata*)
- African thistle (*Berkheya rigida*)
- Juniper Caperose (*Cliffortia juniperina*)
- Shiny dewfig (*Drosanthemum calycinum*)
- Dune tortoistea (*Leysera gnaphaloides*)
- Grey bitou (*Osteospermum incanum*)
- Common gonna (*Passerina corymbosa*)
- Common storksbill (*Pelargonium capitatum*)

- *Ruschia umbellata*
- Dune currantrhus (*Searsia laevigata*)
- Slangbos (*Seriphium plumosum*)
- Sprawling seacoral (*Tetragonia fruticosa*)
- Willow pennypea (*Wiborgia obcordata*)

Figure 14. Transformed land where Cape Flats Sand Fynbos would historically have occurred north of Blouberg Hill.

Figure 15. Degraded Atlantis Sand Fynbos-Swartland Shale Renosterveld ecotone on the lower slopes of Blouberg Hill near the Blouberg reservoir. The blue line represents the pipeline.

4.2. Species of Conservation Concern

Species of Conservation Concern (SCC) include those listed as Near Threatened (NT), Vulnerable (VU), Endangered (EN), and Critically Endangered (CR) in the Red List of South African Plants (redlist.sanbi.org). The ASF was found to support the highest incidence of SCC compared with CFDS. The occurrences of these species are provided in Table 3. Note that the area located between the Pella Reservoir and Pella Road supports high numbers of SCC, but these were not recorded individually due to safety concerns. Photographs of the SCC observations are provided in Figures 16 and 17.

Table 3. Species of Conservation Concern observations, including Red List status and localities

Waypoint	X	Y	Species	Red List Status
1	18.38315	33.56584	Aspalathus ternata	NT
2	18.38271	33.56616	Aspalathus ternata	NT
3	18.38240	33.56632	Aspalathus ternata	NT
3	18.38240	33.56632	Leucospermum tomentosum	NT
4	18.38212	33.56675	Aspalathus ternata	NT
4	18.38212	33.56675	Ruschia indecora	NT

6	18.38090	33.56744	Aspalathus ternata	NT
7	18.38085	33.56746	Lachnaea grandiflora	VU
8	18.38065	33.56757	Aspalathus ternata	NT
9	18.37897	33.56869	Leucospermum hypophyllocarpodendron subsp. canaliculata	EN
13	18.38204	33.57043	Aspalathus ternata	NT
13	18.38204	33.57043	Leucospermum hypophyllocarpodendron subsp. canaliculata	EN
14	18.37994	33.57050	Aspalathus ternata	NT
15	18.37955	33.57042	Leucospermum hypophyllocarpodendron subsp. canaliculata	EN
19	18.38967	33.57589	Ruschia tecta	EN
19	18.38967	33.57589	Ruschia indecora	NT
20	18.38940	33.57592	Ruschia tecta	EN
22	18.38374	33.57709	Ruschia tecta	EN
29	18.37549	33.58514	Microdon capitatus	EN
34	18.37260	33.58592	Disa draconis	EN
38	18.37108	33.58609	Disa draconis	EN
39	18.36834	33.58624	Aspalathus ternata	NT
40	18.36726	33.58876	Ruschia indecora	NT
41	18.36712	33.58963	Ruschia indecora	NT
42	18.39979	33.58544	Ruschia tecta	EN
43	18.40038	33.58521	Ruschia tecta	EN
44	18.40030	33.58516	Ruschia tecta	EN
45	18.40067	33.58500	Ruschia tecta	EN
46	18.40135	33.58470	Ruschia tecta	EN
47	18.40201	33.58430	Ruschia tecta	EN
48	18.40205	33.58419	Ruschia tecta	EN
49	18.40679	33.57826	Ruschia tecta	EN
50	18.40692	33.57809	Ruschia tecta	EN
51	18.40705	33.57791	Ruschia tecta	EN
52	18.40726	33.57760	Ruschia tecta	EN
53	18.40736	33.57749	Ruschia tecta	EN
54	18.40774	33.57696	Ruschia tecta	EN
55	18.40850	33.57583	Ruschia tecta	EN
65	18.40677	33.55065	Lampranthus explanatus	NT
66	18.40589	33.55122	Ruschia indecora	NT
69	18.39581	33.55760	Aspalathus ternata	NT
69	18.39581	33.55760	Aspalathus ternata	NT
70	18.39490	33.55824	Aspalathus ternata	NT
71	18.39064	33.56093	Leucospermum hypophyllocarpodendron subsp. canaliculata	EN
72	18.38668	33.56350	Aspalathus ternata	NT
73	18.38470	33.56474	Aspalathus ternata	NT
74	18.38443	33.56502	Aspalathus ternata	NT
74	18.38443	33.56502	Aspalathus ternata	NT
75	18.38516	33.56456	Ruschia indecora	NT

75	18.38516	33.56456	Aspalathus ternata	NT
76	18.38601	33.56401	Aspalathus ternata	NT
77	18.38659	33.56365	Aspalathus ternata	NT
78	18.38692	33.56344	Aspalathus ternata	NT
79	18.38806	33.56269	Ruschia indecora	NT
80	18.38883	33.56220	Aspalathus ternata	NT
81	18.38942	33.56183	Aspalathus ternata	NT
83	18.39017	33.56135	Aspalathus ternata	NT
84	18.39105	33.56075	Aspalathus ternata	NT
85	18.39125	33.56063	Aspalathus ternata	NT
86	18.39309	33.55949	Aspalathus ternata	NT
87	18.39325	33.55938	Aspalathus ternata	NT
88	18.39395	33.55894	Aspalathus ternata	NT
89	18.39423	33.55876	Aspalathus ternata	NT
91	18.39796	33.55638	Leucospermum hypophyllocarpodendron subsp. canaliculata	EN
92	18.39980	33.55520	Leucospermum tomentosum	NT
93	18.40023	33.55492	Aspalathus ternata	NT
94	18.40170	33.55398	Ruschia indecora	NT
95	18.40252	33.55354	Leucospermum hypophyllocarpodendron subsp. canaliculata	EN
96	18.40326	33.55298	Aspalathus ternata	NT
96	18.40326	33.55298	Leucospermum hypophyllocarpodendron subsp. canaliculata	EN
98	18.40586	33.55134	Aspalathus ternata	NT
99	18.40957	33.54897	Leucospermum hypophyllocarpodendron subsp. canaliculata	EN
101	18.41496	33.54555	Leucospermum hypophyllocarpodendron subsp. canaliculata	EN
103	18.45422	33.52099	Lampranthus explanatus	NT
103	18.45422	33.52099	Pelargonium triste	NT
104	18.46644	33.52071	Leucospermum hypophyllocarpodendron subsp. canaliculata	EN
104	18.46644	33.52071	Serruria decipiens	VU
106	18.48665	33.52829	Aspalathus ternata	NT
107	18.49268	33.53769	Ruschia indecora	NT
108	18.49882	33.53615	Protea scolymocephala	VU
111	18.50604	33.53460	Ruschia geminiflora	VU
220	18.45735	33.62923	Ruschia indecora	NT
220	18.45735	33.62923	Ruschia indecora	NT
221	18.45770	33.62937	Ruschia tecta	EN
222	18.45832	33.62940	Ruschia tecta	EN
222	18.45832	33.62940	Microdon capitatus	EN
223	18.45974	33.62856	Microdon capitatus	EN
223	18.45974	33.62856	Ruschia tecta	EN
225	18.46059	33.62742	Ruschia tecta	EN
226	18.46250	33.62466	Ruschia tecta	EN
227	18.46810	33.61561	Aspalathus ternata	NT
228	18.46789	33.61508	Helichrysum cochleariforme	NT

245	18.48237	33.61447	Lachnaea grandiflora	VU
245	18.48237	33.61447	Lachnaea grandiflora	VU
246	18.48236	33.61303	Aspalathus ternata	NT
253	18.48341	33.59455	Lachnaea grandiflora	VU
253	18.48341	33.59455	Lachnaea grandiflora	VU
254	18.48471	33.59576	Aspalathus ternata	NT
257	18.47310	33.60457	Leucospermum tomentosum	NT
257	18.47310	33.60457	Ruschia indecora	NT
260	18.47455	33.60239	Aspalathus ternata	NT
265	18.39851	33.58612	Ruschia tecta	EN
265	18.39851	33.58612	Ruschia indecora	NT
267	18.39815	33.58638	Ruschia indecora	NT
268	18.39783	33.58647	Ruschia indecora	NT
270	18.39663	33.58712	Ruschia tecta	EN
270	18.39663	33.58712	Lampranthus explanatus	NT
270	18.39663	33.58712	Lampranthus explanatus	NT
271	18.39618	33.58739	Ruschia indecora	NT
288	18.45613	33.71703	Pelargonium triste	NT
288	18.45613	33.71703	Aspalathus ternata	NT
289	18.45616	33.71683	Pelargonium triste	NT
289	18.45616	33.71683	Aspalathus ternata	NT
293	18.46336	33.73797	Drosanthemum calycinum	NT
298	18.46627	33.74127	Aspalathus ternata	NT
299	18.46808	33.74278	Aspalathus ternata	NT
300	18.46879	33.74334	Aspalathus ternata	NT

Figure 17. Fynbos SCC (from top left to right): *Disa draconis* (EN), *Lachnaea grandiflora* (VU), *Protea scolymocephala* (VU), *Aspalathus ternata* (NT), *Ruschia indecora* (NT), *Leucospermum tomentosum* (NT), *Serruria decipiens* (NT) and *Ruschia geminiflora* (VU).

Figure 18. Fynbos SCC (from top left to right): *Ruschia tecta* (EN), *Microdon capitatus (*EN), *Lampranthus explanatus* (NT) and *Drosanthemum calycinum* (NT). Strandveld specials: *Helichrysum trocostatum* (NT) and *Helichrysum cochleariforme* (NT).

5. SENSITIVITY

Sensitivity is defined here as the 'conservation value' together with the 'degree of resilience to disturbance'. The conservation value relates to the conservation status (including the ecosystem threat status) and other factors including ecological connectivity, habitat condition, persistence of ecological processes and the site's role in supporting biodiversity. The degree of resilience takes into consideration factors such as sensitivity to disturbance and restoration potential. Species sensitivity was rated as per the Species Environmental Assessment Guideline (2020) "*Recent occurrence records for all threatened (CR, EN, VU) and/or Rare endemic species are included in*

the high sensitivity level." The sensitivity spatial files are provided for both vegetation and species and should be viewed together.

Table 4. Criteria for deriving sensitivity

Sensitivity rating	Description	Habitats & Features	MMP requirements
Very Low	Transformed areas with no remaining natural vegetation.	ASF/CFDS/ASF/SSR.	No specialist oversight
Low	Degraded and Highly degraded vegetation (Endangered or Critically Endangered ecosystem).	ASF/CFDS/ASF/SSR.	No specialist oversight
Medium	Degraded vegetation (Endangered or Critically Endangered ecosystem).	ASF/CFDS/ASF/SSR.	Specialist oversight
High	Intact, Semi-intact to Intact, and Degraded to Intact (Endangered or Critically Endangered ecosystem).	ASF/CFDS/ASF/SSR.	Specialist oversight
ASF = Atlantis Sand Fynbos; CFDS = Cape Flats Dune Strandveld; CFSF – Cape Flats Sand Fynbos; SSR = Swartland Shale Renosterveld.			

6. IDENTIFIED IMPACTS AND MITIGATION

The identified impacts include those associated with routine and emergency maintenance and impacts observed during the site visits. The potential impacts are assigned for each activity. Mitigation measures are recommended for each impact. These are provided in Table 5. The mitigation measures are intended to reduce the overall impacts, with the main focus being on minimization of vegetation loss.

Table 5: Planned maintenance activities, identified botanical impacts and recommended mitigation measures.

Activity	Description of impact	Impact rating	Actions to mitigate impacts
Maintenance of Drainage Structures			
1.1. Repair of damaged water crossing infrastructure: Replacement of broken culverts, redirecting of culverts located against the natural flow of a river, dredging inside the watercourse to obtain access to infrastructure, removal of flood debris and silt and the infilling of material for stabilisation and support of new infrastructure.	Loss/damage to vegetation during access.	Low	Do not pile removed debris and silt onto adjacent vegetation. Remove debris and silt by hand wherever possible. Either load directly onto a tipper truck or stockpile within a previously disturbed or open area prior to removal. Only use required equipment and vehicles to reduce damage/loss of vegetation and minimise erosion. Avoid unnecessary trampling and damage to vegetation when accessing working areas. Ensure adequate storage (separately) and reinstatement of topsoil. Monitor the occurrence of weeds following disturbance and ensure removal thereof. Quarterly checks for a period of one year following rehabilitation are recommended.
1.2.1. Replacement of damaged road and pipeline infrastructure after large storm events: In most instances after large storm events there is some degree of damage, including erosion of banks, gravel roads and bridge approaches. Some flood debris could also cause damage to the infrastructure itself which would need to be fixed or replaced if damaged extensively. This could entail dredging, excavating and infilling in a stream. 1.2.2. Repair of pipeline and cable infrastructure:	Impacts would be mostly freshwater related, however, as with point 1.1. loss/damage may occur to vegetation during access and construction.	Low	Besides efforts to minimise the working width/area in sensitive habitats, it is recommended that the following measures are implemented during maintenance and repair activities: • Search and Rescue of plant material as well as seed collection must be undertaken within the disturbed areas prior to commencement of maintenance activities. Seed collection should be undertaken primarily during the summer months (November to January). Species translocation should occur in early winter when bulbs are visible and still in their active growth phase. The translocation of sods and perennial species should also take place in early winter with the first onset of rains.

Activity	Description of impact	Impact rating	Actions to mitigate impacts
Over time some damage could occur to the installed pipeline, electrical and communication infrastructure, which would result in machinery needing to access the pipe or cables over / underneath the stream and would entail dredging, excavating and potentially infilling inside a watercourse. More than 300 square metres of indigenous vegetation could be cleared for maintenance of below ground linear infrastructure (e.g. pipelines, powerlines, telemetry etc.) where the linear infrastructure would need to be excavated and repaired.			• All alien vegetation within a band of 50m from the infrastructure route must be cleared prior to the commencement of maintenance activities. This activity is specific to those areas that are currently invaded with alien vegetation and/or plantations. • In cases where trench excavation is required, such must take place in short sections. A minimum of 500mm of topsoil should be stripped and stored adjacent to the work area prior to the removal of subsoil. • Topsoil must then be returned to the same habitat from which it was removed following the completion of maintenance activities, making sure that bed material and topsoil are not compacted more than they are naturally. • Ensure that the profile of the excavation once top material is returned has the same cross section profile as it was prior to excavation. Thus, any excess material would need to be disposed of elsewhere, so that a raised mound is not created along the pipeline. • Following the return of topsoil, it is important that areas affected by the infrastructure route are rehabilitated as far as possible through replanting of indigenous vegetation within the affected areas. This may include a mix of locally indigenous plants that are functional (to stabilise the habitat) as well as replacement of conservation worthy vegetation. Seed collection should be undertaken primarily during the summer months (November to January). Species translocation should occur in early winter when bulbs are visible and still in their active

Activity	Description of impact	Impact rating	Actions to mitigate impacts
			growth phase. The translocation of sods and perennial species should also take place in early winter with the first onset of rains. • To mitigate against potential hydrological changes to wetlands and watercourses associated with obstructed flow, it is important that during the maintenance activity, such as replacing a pipeline/powerline, the infrastructure is placed at least 50 cm below ground level (i.e., top material following construction should be at least 50 cm above the top of the pipe) to reduce or minimise changes in the nature of subsurface flows through wetland habitats. • Excavations shall be excavated within the predefined and demarcated working widths/areas in order to install the infrastructure as per the construction design drawings and the working width must include sufficient area for the storage of topsoil material**.** Excavations shall be excavated using an excavator or alternative approved excavation methods. The excavation shall be excavated to the depth specified on the construction drawings and the excavated materials would be stockpiled at designated stockpile areas. The excavated subsoil material must not be mixed with the topsoil material. Open excavations should be demarcated and checked at regular intervals to ensure no fauna has fallen into them. • No stringing of pipeline outside of the demarcated working area must be allowed.

Activity	Description of impact	Impact rating	Actions to mitigate impacts
			• The offcuts and shavings created during HDPE pipeline welding must be collected at the end of each weld and stored in appropriate waste containers to be taken to the site camp at the end of the day. A drop sheet to collect the shavings must be used when welding HDPE pipelines. Care must be taken when using the hot plate to melt the HDPE pipe so as to not cause any harm to people or animals, and to not cause any fires. If portable generators are used, they must be equipped with drip trays. • Sandbag and concrete collar location/positions may be required based on the freshwater ecologists recommendations. Once the trench is open, the botanical and aquatic ecologists must refine the location of each collar prior to installation to preserve wet and dry sections along the trench as far as possible. The need for additional collars must be checked with the specialists before pipeline pressure testing. Compaction of the soil will apply to all trenching, however in wetland and stream areas the *in-situ* material will be replaced without compaction up to a depth of 500mm unless otherwise stated by freshwater ecologist, who will verify this by a walk-through of the site with the contractor/site engineer. Monitor for weeds and invasive species and remove during regular checks. Quarterly checks for a period of one year following rehabilitation are recommended. In the case of maintenance to both **below** and **above** ground crossings, it is recommended that construction be undertaken

Activity	Description of impact	Impact rating	Actions to mitigate impacts
			during the dry season as far as possible when risk of contamination is minimised: • Work areas must be confined to minimise the negative effects of trampling. • Bank rehabilitation would require the input of a restoration botanist / freshwater ecologist.
1.3.1. Replacement and maintenance of erosion control measures: Where erosion control measures are already installed, maintenance would have to be done to ensure these remain in good working order or that areas that become prone to erosion is secured to protect infrastructure and prevent downstream impacts to the aquatic ecosystems. This would entail the potential excavation and infilling of material within watercourses or wetlands and activities such as gabion basket installations. 1.3.2. Clearing of silt or flood debris from infrastructure (e.g., culverts, weir and basins) and watercourses: Over time, material such as silt, dead vegetation and litter will accumulate along, under, downstream of, behind and within infrastructure, and in rivers and wetlands. These need to be cleared regularly to	Localized changes in the runoff that may promote erosion and contaminate these systems through increasing sediment loads into natural systems (particularly during maintenance). Disturbance of river or wetland habitat during removal of sediment. Destabilisation of slopes, banks and beds of wetlands and rivers, leading to increased mobility of sediments into sensitive areas. Increased sedimentation in sensitive areas, such as wetlands, riparian areas and channels.	Low	Erosion is expected to be low given the topography of the site (vegetated dunes and gently undulating to flat sandy areas with few watercourses and wetlands). Any destabilization of slopes or riparian areas should be rehabilitated with appropriate erosion control measures and may require re-vegetation.

Activity	Description of impact	Impact rating	Actions to mitigate impacts
ensure proper functioning of the infrastructure and ecosystems and prevent flooding and associated damage within these areas. The clearing would entail the dredging or excavating of debris, silt and other flooded material from the crossings.			
1.4.1. Clearing of alien invasive vegetation from watercourses, weirs and basins: Large alien invasives will be cleared using chainsaws. Smaller plants will be removed by hand using hand tools to remove the roots from the beds and banks of watercourses. Excavators may be needed to clear alien invasives in areas where access is limited, such as within saturated basins and abstraction ponds above weirs. All plant material will be removed and disposed of at a licenced WDF, with proof thereof retained. Eradication of undesired vegetation, by either physical or chemical means. Including the felling and removal of undesirable/alien trees, shrubs, and grass.	Damage to environment due to use of machinery to remove alien vegetation. Damage to fauna (may cause death) and flora due to use of diesel-based herbicides. Poisoning of aquatic systems due to off-target damage from herbicides to riparian areas.	Low This is typically a positive impact provided no damage to natural vegetation or stream embankments occurs during the clearing process. If piles of Invasive Alien Plants (IAPs) are not removed these can cause soil	• It is recommended that all alien trees within a band of 50m from the maintenance footprint be cleared to allow rejuvenation of seed within the topsoil. Where necessary, topsoil and mulch will need to be added and impacted areas revegetated with appropriately specified plants • Prior to the removal of topsoil for trenching and excavations, the need to remove or clear all alien vegetation must be assessed and indicated by the freshwater and botanical ecologists or the relevant management authority. If required, the clearance of alien vegetation will be done by the rehabilitation contractor who must remove all alien vegetation within the vicinity of the work areas and control the re-emergence thereof, for the duration of the rehabilitation activities. The removed alien vegetation must be taken off-site and disposed of at licenced WDF, with proof thereof retained. A 50m buffer should be applied around the working area. • Wherever possible, manual methods of alien vegetation removal shall be selected instead of using machinery, as this will have far less impact on the environment. Herbicide use may be considered (e.g. for stump

Activity	Description of impact	Impact rating	Actions to mitigate impacts
		hotspots with fire events. Impacts due to herbicides on flora likely to be Low. Impacts to fauna and freshwater likely to be more severe. If no herbicides are allowed as stated above these (herbicides related) impacts are N/A.	treatments where alien trees are cut down by chainsaw), but may only be used if approved in writing, by the relevant management authority. • Should the use of registered herbicides be the most effective option for control of alien invasive vegetation, and agreed to in terms of an approved Method Statement, then this shall be undertaken in compliance with the terms and conditions of the SANS for handling, storage and disposal of pesticides (SANS 10206:2010, Edition 2.2): i) The use of diesel-based herbicides near watercourses shall not be permitted. ii) Only herbicides registered for the particular plant species requiring control shall be used. Where no herbicide has been registered, the least hazardous herbicide registered for a similar plant species (i.e. another species of tree or shrub or grass) may be used. iii) Herbicide operators mixing and applying herbicides shall be appropriately trained and supervised and shall be equipped with the requisite personal protective clothing in accordance with the SANS requirements and the herbicide labels. iv) Supervisors shall be literate, shall understand the instructions on the herbicide labels, and shall ensure that the necessary safety protocols are implemented.

Activity	Description of impact	Impact rating	Actions to mitigate impacts
			v) The requisite washing facilities and herbicide mixing area shall comply with the SANS requirements, as shall the transport, handling and storage of herbicides. vi) There is a very high risk of off-target damage from herbicides within riparian areas as many herbicides are toxic to aquatic systems, and only herbicides that are approved for use near a watercourse shall be used. vii) Herbicides shall not be used in windy or rainy conditions, and care shall be taken to avoid drift onto indigenous plants. • The disposal of alien invasive vegetation by burying or burning is prohibited in terms of national legislation, and shall not occur: • Alien vegetation shall be disposed of at licenced WDF, with proof thereof retained. Follow up clearing should take place at least annually.
1.4.2. Clearing of indigenous vegetation around the borehole sites in case of borehole maintenance or drilling activities: More than 300 square metres of indigenous vegetation could be cleared during redrilling or maintenance activities (e.g., borehole cleaning) needed at any of the borehole sites for the establishment of drill rigs and/or other equipment.	Loss of vegetation. Erosion of areas that are cleared of vegetation cover, or that remain bare during times of heavy rainfall.	Low	Demarcate working area to prevent unnecessary clearing and damage by machinery. Only use required equipment and vehicles to reduce loss of vegetation and minimise erosion. Brush cut vegetation and place topsoil to one side. Remove species that can be relocated (e.g. succulents, bulbs). Remove sods and store on site for rehabilitation. Cover topsoil with shade cloth and do not allow any activity on topsoil stockpiles (vehicle, foot traffic).

Activity	Description of impact	Impact rating	Actions to mitigate impacts
			Reinstate topsoil after construction. Stabilize embankments if needed. Plant back sods. Monitor for weeds and invasive species and remove during regular checks. Quarterly checks for a period of one year following rehabilitation are recommended.
1.5. Replacement of eroded stream crossing approaches: Over time some of the gravel road approaches alongside the stream crossings could erode and cause the need for replacement or installation of erosion control measures. This would entail the infilling of material within close proximity of watercourses or within wetlands.	Loss and/or damage to vegetation	Low	Only use required equipment and vehicles to reduce loss of vegetation and minimise erosion.
General maintenance activities			
Unsupervised vegetation clearing. Brush-cutting of firebreaks along pipeline infrastructure. Repair or replacement of fencing around infrastructure which may require clearing of indigenous and/or alien vegetation.	Loss of vegetation	Low	Rehabilitate on a case-by-case basis. Passive rehabilitation is the preferred option for areas with light clearing and seed bank intact.

7. CONCLUSIONS

The vegetation associated with the AWRMS falls within an extensive area that includes threatened vegetation types with varying degrees of disturbance. This includes high-sensitivity habitats within and outside of the protected areas. In addition, Species of Conservation Concern were observed and are generally associated with the intact and semi-intact high-sensitivity habitats. Specialist ecological oversight should be consulted if any maintenance activities impact these medium- and high-sensitivity areas.

The most critical intervention required to reduce impacts concerns the management of topsoil. The recommended approach should involve the reinstatement of topsoil to its original position on the soil surface and its original profile. This ensures that the seed bank, organic material, and microbes are not lost. The upper 500mm contains these components and should thus be set aside and reinstated during the construction process. Rehabilitation can also be supplemented with search-and-rescue efforts, seed collection, and broadcasting.

The second most important intervention is weed management. With the introduction of gravel roads, weeds have become dominant around the edges of roads and borehole sites within the protected areas. It is recommended that a weed control program is incorporated into the management plan, which includes herbicide application and hand removal where appropriate.

8. REFERENCES

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APPENDIX 1: Curriculum Vitae: Paul Emms

EDUCATION

MSc (Botany) - University of the Western Cape (2014).

BSc: Hons (Botany) – University of the Western Cape (2005).

BSc: Biodiversity and Conservation Biology - University of the Western Cape (2002 – 2004).

National Diploma in Horticulture - Cape Peninsula University of Technology (1998 – 2000).

CAREER HISTORY

April 2019 – present – Director at Capensis

March 2011 – April 2019 – independent botanical specialist and associate at Bergwind Botanical Surveys & Tours CC.

March 2008 - March 2010 - field botanist and botanical specialist - Coastec (Coastal & Environmental Consultants).

January 2006 – December 2007 - Kirstenbosch Scholarship: horticultural research - South African National Biodiversity Institute.

ACCREDITATION

Registered Professional Natural Scientist with the South African Council for Natural Scientific Practitioners (SACNASP). Registration number 400352/14.

EXPERIENCE and SKILLS

Botanical specialist consultant

- Ecological Constraints Analysis
- Botanical Impact Assessment
- Invasive Alien Plant Management Plans
- Vegetation Rehabilitation Plan
- Plant Search and Rescue Plans
- Conservation Management Plans
- Over 350 botanical assessments

PERSONAL DETAILS

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