### 3.5.3 Route Alternatives

A preliminary route determination study was undertaken in April 2013 by a team comprising representatives of Sedex Desalination, the project engineers (Royal Haskoning DHV (RHDHV)) and environmental consultants and biodiversity specialists (SRK Consulting and Scientific Aquatic Services (SAS)). The purpose of the study was to determine a viable route between the desalination plant and the Zandkopsdrift Mine. The route from Kotzesrus to the Zandkopsdrift Mine follows an existing road and alternative alignments for this section of the road were thus not considered. Several alternative routes from just north of Kotzesrus to the desalination plant were identified as illustrated in Figure 3-7. A high level evaluation of the preliminary routes was undertaken, and several of the identified route options were eliminated based on:

- Poor *in-situ* sub-grade material quality (providing insufficient bearing capacity for load distribution and thus being unsuitable from an engineering perspective);
- Horizontal alignment considerations (where road sections would traverse river embankments and ecologically sensitive areas);
- Gradients and
- Ecological considerations (disturbance of ecologically sensitive areas).

Following the initial evaluation, a preferred route was identified (**Kotzesrus Route**), along with two potential routes bypassing the town of Kotzesrus (**Bypass Route** and **Alternative Bypass Route**). All alternatives considered are briefly described in Table 3-7 below.

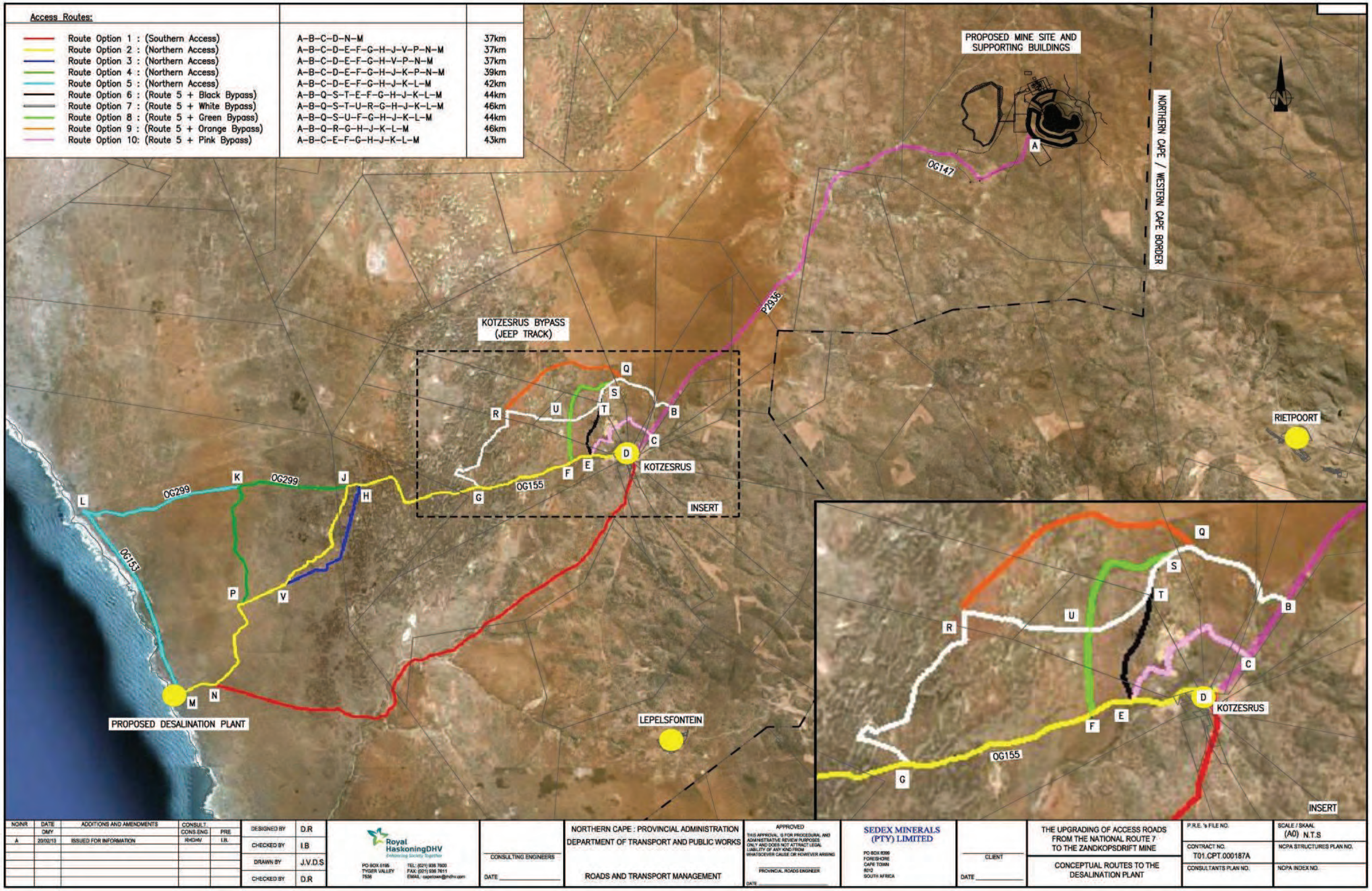



**Figure 3-7: Route Alternatives Identified during Preliminary Route Determination Study**

**Table 3-7: Route Alternatives**

| No. | Description (see Figure 3-7) | Status | Considerations |
|---|---|---|---|
| RA1 | **Route 1**: A-B-C-D-N-M (red) | Eliminated | • Preferred from an ecological perspective as the majority of the route follows existing tracks.<br>• The shortest route.<br>• Not feasible from an engineering perspective, as crossing the Brak River would require extensive and costly concrete drifts, culverts, embankment protection and possibly two small bridges.<br>• The sub-grade material along this route is of poor quality for road construction. |
| RA2 | **Route 2**: A-B-C-D-E-F-G-H-J-V-P-N-M (yellow) | Eliminated | • Feasible from an engineering perspective.<br>• Less suitable from an environmental perspective as it traverses larger areas of sensitive Sand Fynbos. |
| RA3 | **Route 3**: A-B-C-D-E-F-G-H-V-P-N-M (yellow and blue) | Eliminated | • Feasible from an engineering perspective.<br>• Less suitable from an environmental perspective as the route traverses larger areas of sensitive Sand Fynbos. |
| RA4 | **Route 4**: A-B-C-D-E-F-G-H-J-K-P-N-M (yellow and green) | Eliminated | • Traverses smaller area of sensitive Sand Fynbos than Routes 2 and 3.<br>• Less suitable from an engineering due to geometric alignment and the suitability of the subgrade. |
| RA5 | **Route 5**: A-B-C-D-E-F-G-H-J-K-L-M (yellow, green and cyan): **Kotzesrus Route** | Assess in EIA: **preferred route** | • Feasible from an environmental perspective as it traverses a smaller area of Sand Fynbos and follows an existing track along the coast. |
| RA6 | **Route 6**: A-B-Q-S-T-E-F-G-H-J-K-L-M (route 5 with black bypass at Kotzesrus): **Alternative Bypass Route** | Assess in EIA | • Feasible from both environmental and engineering perspectives.<br>• Avoids crossing the Brak River at the town of Kotzesrus.<br>• Follows larger number of existing tracks than Route 8. |
| RA7 | **Route 7:** A-B-Q-S-T-U-R-G-H-J-K-L-M (route 5 with white bypass at Kotzesrus) | Eliminated | • Less feasible from both an environmental and engineering perspective as it traverses large areas with no existing tracks.<br>• Traverses large portions of undisturbed Sand Fynbos. |
| RA8 | **Route 8**: A-B-Q-S-U-F-G-H-J-K-L-M (route 5 with green bypass at Kotzesrus): **Bypass Route** | Assess in EIA | • Preferred option (significantly) from engineering perspective due to alignment considerations.<br>• Feasible from an environmental perspective it avoids crossing the Brak River at the town of Kotzesrus.<br>• Traverses a larger area of undisturbed vegetation than Route 6. |
| RA9 | **Route 9**: A-B-Q-R-G-H-J-K-L-M (route 5 with orange bypass at Kotzesrus) | Eliminated | • Less feasible from both environmental and engineering perspectives as it traverses large areas with no existing tracks.<br>• Also traverses large portions of undisturbed Sand Fynbos. |
| RA 10 | **Route 10:** A-B-C-E-F-G-H-J-K-L-M (route 5 with pink bypass at Kotzesrus) | Eliminated | • Less feasible from both environmental and engineering perspectives as it crosses over a koppie/ dune area that is considered to be a more specialised and sensitive habitat due to the presence of rocky outcrop areas. |

### 3.5.4 Power Supply Alternatives

A high level cost comparison of three options for the supply of power to the desalination plant was undertaken by RHDHV prior to the start of the EIA process. This comparison was strongly influenced by the long term operational requirements of each option. Alternatives power sources considered are presented in Table 3-8. Wind turbines were excluded as a feasible option based on extremely high capital costs, while the operational costs of diesel generators excluded this alternative.

**Table 3-8: Alternatives Sources of Power to the Desalination Plant**

| No. | Description | Status | Considerations/Motivation |
|---|---|---|---|
| PS1 | **Grid power** supplied by overhead line from the mine | Assess in EIA | • Preferred alternative.<br>• Acceptable capital and operational costs. |
| PS2 | On site diesel **generators** | Eliminated | • Lowest capital cost.<br>• Technically acceptable alternative.<br>• Operational costs significantly higher than grid power (360%) – least preferred option based on operational considerations.<br>• Potential air and noise pollution. |
| Ps3 | **Wind turbines** backed by diesel generators | Eliminated | • Highest capital cost. Installation costs significantly higher than grid power or diesel generators (278% and 890% respectively) and not considered economically feasible. |

### 3.5.5 Process and Design Alternatives

Various process and design alternatives are being identified and investigated during the Feasibility Study. These alternatives are not described here in detail but include:

- Alternatives for discharge/disposal of waste (other than brine – see Section 3.7.2) from the desalination process which could include:
  - Blending with brine for discharge to the sea;
  - Discharge to on-site wastewater treatment facility;
  - Disposal at tailing facility at Zandkopsdrift Mine; and
  - Disposal to landfill;
- Alternative chemicals used in the desalination process and plant; and
- Pipeline alternatives including:
  - The use of a large single pipeline or multiple (2) smaller pipelines; and
  - Positioning of pipe above ground (either on the surface or elevated) or below ground.

### 3.5.6 The No Go Alternative

The No Go alternative will be considered in the EIA in accordance with the requirements of the EIA Regulations, 2010. The No Go alternative entails no change to the status *quo*, in other words the proposed desalination plant site will remain vacant and no linear infrastructure will be built. Due to the lack of water in Namaqualand it is unlikely that the Zandkopsdrift Mine would be developed.

## 3.6 Project Construction and Infrastructure

The project infrastructure described below is based on information provided by the project engineers during the conceptual design phase of the project and will be refined during the detailed design phase of the project. Key components of the project include:

- **Marine infrastructure**, comprising seawater intake and brine disposal outfall works;
- **Desalination plant**, installing a desalination plant including facilities for pre- and post-treatment of water;
- **Bulk water supply and storage infrastructure, pump stations and pipelines** to transfer product water to the mine with a take-off at Kotzesrus, as well as storage reservoirs at the plant and Kotzesrus;
- **Bulk power supply infrastructure** to supply the desalination plant and product water booster pumps with electricity; and
- **Roads** to provide access to the desalination plant, transfer pipeline and power lines.

Project infrastructure is described in Sections 3.6.1 to 0 followed by a description of utilities and services and an overview of (environmental) management during construction.

### 3.6.1 Marine Infrastructure

#### 3.6.1.1 Seawater Intake System

The seawater extraction system will be an open water intake placed inside an existing gully. The system will include:

- Modification to the existing gully, which will serve as the intake channel;
- Marine intake basin, which will be excavated into the underlying rock within the gully;
- Intake heads and screens;
- Intake pipes;
- Slurry type seawater extraction pumps;
- A pump station; and
- Pipeline(s) from the pump station to the desalination plant.

The intake basin, with associated screens and grids and suction inlets will be installed below the high water mark (HWM) of the sea, with all other intake infrastructure above the HWM.

Water will be drawn into the intake heads at a velocity of < 0.15 m/s and will be screened through coarse (120 - 150mm) and fine screens (40mm) before being pumped to the desalination plant.

The installation of seawater intake infrastructure will require some blasting, excavation and concrete work below the HWM and in the intertidal zone.

| | |
|---|---|
|  Looking seaward along the intake gully |  Looking shoreward from the gully, with propsoed position of intake pumpstation in upper right of image (below vehicles) |

| | | |
|---|---|---|
| srk consulting | **Figure 3-8: Photographs of Proposed Seawater Intake Site at Volwaterbaai** | Project No. 451101 |

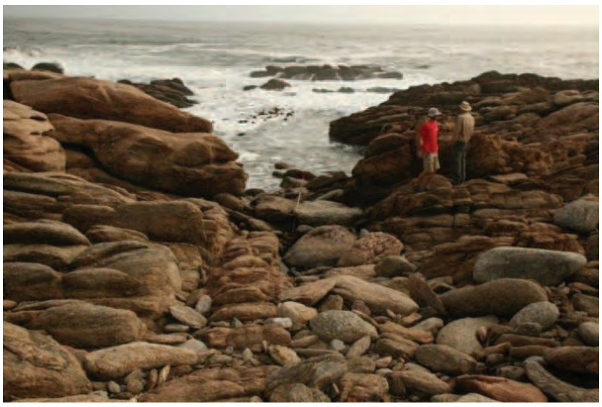
*Source: WSP*

#### 3.6.1.2 Brine Discharge System

The brine discharge system includes a brine discharge pipeline from the desalination plant to the sea and a diffuser system. The final design of the brine discharge pipeline and diffusers will ensure:

- Brine discharge within the (separate) discharge gully, with the brine outlet positioned below the low water mark (LWM) of the sea;
- Efficient dilution of brine; and
- Shielding of the diffuser from waves.

Design of the diffuser and discharge rates will meet the requirements of the South African Marine Water Quality Guidelines and the Operational Policy for the Disposal of Land-derived Water containing Waste to the Marine Environment of South Africa insofar as they are applicable to this type of installation.

| | |
|---|---|
|  Looking seaward along the brine discharge site at high tide |  Brine discharge location during rough sea conditions |

| | | |
|---|---|---|
| srk consulting | **Figure 3-9: Photographs of Proposed Brine Discharge Site at Volwaterbaai** | Project No. 451101 |

*Source: WSP*

The system allows for the discharge of all solid waste material (sludge), wastewater and brine to the sea (see Section 3.7.2). Brine along with the pre-treatment waste stream and other co-discharges will be discharged into the sea either under gravity or pumped.

The preferred position for the brine discharge site is approximately 500m north of the seawater intake site, to prevent the intake of discharge water.

The brine discharge pipeline will be routed from the desalination plant across the intertidal zone and be installed, together with the outlet diffuser port and weight blocks below the HWM. The construction of the brine discharge system will require excavation and concrete work in the intertidal zone and below the HWM.

### 3.6.2 Desalination Plant

The desalination plant will include all infrastructure associated with the desalination process as described in Section 3.7 (apart from the marine infrastructure) housed in or adjacent to a desalination plant building. The final position of the desalination plant will be finalised during the EIA process (see Section 3.5.2.4)

The desalination plant building will be constructed of concrete, brick and mortar, with a roof design informed by architectural considerations aimed at reducing the visual impact of the structure. A portion of the building will have a second storey, and as such the maximum height of the building will be approximately 8m.

The plant building footprint will be approximately 3 000 $m^2$. Some process units and facilities at the plant will be placed outside of and adjacent to the main plant building. The total footprint of the facility, including entrance road, screening structures and fencing will be approximately 15 000 $m^2$.

No staff accommodation will be provided at the desalination plant.

A 6$m^3$ septic tank will be installed at the desalination plant to deal with domestic wastewater and sewage generated at the plant. The exact position of the septic tank will be determined during detailed design.

### 3.6.3 Bulk Water Supply Infrastructure

#### 3.6.3.1 Pipelines

Product water pipelines between the desalination plant and the mine will follow the same route as the roads once the route has been finalised (see section 3.5.3). At the mine, the pipeline leading to the on-site reservoir[8] will deviate from the alignment of the road.

The options of a single product water delivery pipeline as well as two delivery pipelines are being considered. Different installation options will also be investigated further, i.e. installation of pipelines above ground either on the surface or on concrete support pillars, or installing pipelines below ground.

Pipelines will be positioned within the road reserve if acceptable to the roads authorities, failing which they will be placed in an 8 m wide servitude adjacent to the road reserve.

All pipelines will be protected against pressure surges and an adequate number of valves will be installed to facilitate maintenance (shut off and scour). Air release and drain valves will also be installed at appropriate points. All bulk water pipelines will be fitted with flow measurement devices at specific locations to allow for continuous water auditing/balancing and leak detection.

[8] The on-site reservoir and pipelines leading from the reservoir are excluded from the scope of this EIA will be assessed by AGES in the EIA process for the mine.

#### 3.6.3.2 Pump stations

Product water will be pumped from the desalination plant to the mine, requiring pump stations at the desalination plant as well as intermediate (booster) pump stations along the pipeline route. The number of main and booster pump stations still need to be determined. The position of the pump stations will be informed by the alignment of the bulk power lines, which will follow the same route as the access road and pipelines, and can thus not yet be finalised.

#### 3.6.3.3 Reservoirs / Water Storage Tanks

Water storage tanks are required in the pre-treatment, desalination and product stages of the process (see Section 3.7.1). Retention times and tank storage capacities vary for different stages and processes. Storage tank capacities are based on the full operational capacity of the plant, and allow for 0.5hr storage of feedwater, wastewater and brine and 4 day storage of product water, i.e. the product storage reservoir will have a 20.0 Ml capacity. In addition a 1Ml reservoir is proposed at the take-off at Kotzesrus. The exact positions of the reservoirs at the desalination plant and at Kotzesrus have not yet been finalised. It should be noted that the reservoir at Kotzesrus will require an access road and power line that will deviate from the main access road between the mine and the desalination plant.

### 3.6.4 Bulk Power Supply Infrastructure

Electrical infrastructure to support the project includes bulk supply to the desalination plant (including transmission lines) as well as motor control and electrical services at the desalination plant.

Power will be articulated supplied to the desalination plant by overhead power lines fed directly from the Zandkopsdrift Mine's 11kV intake medium voltage substation. The optimal voltage of the transmission line (11kV, 22kV or 33kV) will be determined during detailed design. The overhead power lines will follow the route of the roads and pipelines once these have been finalised, and will be installed in an 8m wide servitude adjacent to the road reserve.

### 3.6.5 Roads

Access roads need to be provided from the desalination plant to the Zandkopsdrift Mine, situated approximately 40 km from the plant, as well as to all pipelines, power lines, reservoirs and any other associated infrastructure. Three route alternatives for the main access roads have been identified for further assessment (see Section 3.5.3 and Figure 1-1).

It is anticipated that the proposed roads will be unpaved (gravel), subject to confirmation during the detailed design phase. Roads will be 4m wide, with a 2m wide graded strip along one side where required and a road reserve (total width) of 15m. The pipelines and power lines will largely follow the road.

Additional short, access roads may be required off the main route to access reservoirs, the desalination plant and associated infrastructure. The positions of these access roads have not yet been determined.

Some road construction materials may be obtained from borrow pits to be established in the area[9].

#### 3.6.5.1 Road Drainage Structures

Suitable drainage structures will be provided along access roads, in accordance with relevant engineering guidelines. Depending on local conditions, these structures could include side drains, berms, mitre banks (to remove water from a drain and discharge to beyond the road reserve) and

[9] Authorisation of any borrow pits will be undertaken as a separate study by RHDHV and falls outside the scope of this EIA process.

cross-drainage structures such as concrete pipes or box culverts where larger streams or water courses need to be crossed.

### 3.6.6 Water Supply and Use

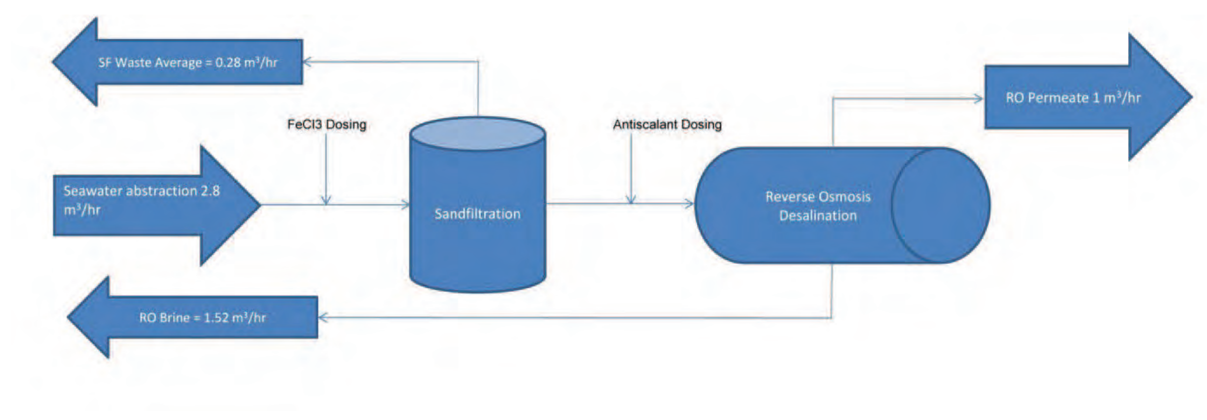
Fresh water will be required for construction of the desalination plant, although no other viable sources are available for this purpose. It is thus proposed that a containerised RO plant be used temporarily, to supply fresh water during the construction phase of the project.

The temporary desalination plant will comprise a containerised plant approximately 15 $m^2$ in size, with external sand filters, feedwater and filtered water tanks. The plant will be powered by a diesel generator and enclosed in an 80 $m^2$ fenced area. Water will be abstracted from the sea via a submersible pump, positioned in a tidal pool close to the shore (to obtain the cleanest possible seawater). Water will be conveyed to the temporary desalination plant via a 50mm pipe.

The desalination process used in this plant will differ slightly from the process described in Section 3.7 below, although it is based on the same principles.

The temporary desalination process will include the following key steps, as depicted in Figure 3-10:

- Seawater abstraction;
- Ferric Chloride ($FeCl_3$) dosing for flocculation;
- Sand filtration;
- Antiscalant dosing;
- RO desalination; and
- Brine discharge.




| srk consulting | **Figure 3-10: Temporary Desalination Process** | Project No. 451101 |
|---|---|---|

*Source: Veolia Water*

The intake and discharge flow rates for the temporary desalination plant are indicated in the figure above and summarised in Table 3-9.

**Table 3-9: Intake and Discharge Flow Rates for Temporary Desalination Plant**

| Flow | Flow rate ($m^3$/hr) |
|---|---|
| ***Intake*** | |
| Seawater abstraction | 2.8 |
| ***Discharge*** | |
| Waste from Sand Filters | 0.28 |
| Brine | 1.52 |
| Product Water | 1 |

Wastewater from the temporary desalination plant will be discharged to the ocean as a single waste stream via a 50mm pipe. Anticipated concentrations of waste from the sandfilter backwash, antiscalant and $FeCl_3$ used for flocculation in the brine stream are detailed in **Appendix 3B**.

Untreated seawater will be used for construction of the road between the desalination plant and Zandkopsdrift Mine. , pumped out of the sea at the closest point at which a water tanker is able to access the coast,

### 3.6.7 Power Supply

It is anticipated that power during the construction phase will be provided by diesel generators.

### 3.6.8 Traffic

Construction traffic would include construction equipment, large vehicles / trucks for material delivery as well as smaller passenger vehicles used to transport construction staff. It is estimated that for the duration of the construction phase there would be 22 vehicles trips[10] per day by light passenger vehicles and 26 trips by heavy construction vehicles transporting workers and construction materials.

### 3.6.9 Waste Management

Waste management during the construction phase will be the responsibility of relevant contractors. All construction waste will be removed from the relevant work areas and disposed of at approved (municipal) waste disposal facilities, or waste facilities at the mine. Where possible, options for the reuse or recycling of waste materials will be favoured over disposal.

It is envisaged that material from cutting and blasting will be used as fill material and disposal will not be required.

### 3.6.10 Air Quality Management

Sources of emissions during the construction phase will include dust generated by the movement of construction vehicles on dirt roads, drilling and blasting (where required) and bulk earthworks (where required) as well as exhaust emissions from construction vehicles and diesel generators.

Emissions during the construction phase of the project will be limited as far as possible through stabilisation of any exposed areas and watering of dirt roads where dust becomes problematic to surrounding residents. Construction vehicles and generators will be maintained in good working order to minimise emissions.

[10] In a single direction

### 3.6.11 Noise and Vibration Management

Sources of noise and vibration during construction include construction vehicles and generators, as well as drilling and blasting where required. Nuisance impacts of noise, particularly in residential areas such as Kotzesrus will need to be managed.

### 3.6.12 Workforce

It is estimated that the construction of the desalination plant and associated infrastructure could create 40 direct temporary jobs during the first 18 months and an average of 60 over the following 12 months of the construction phase.

### 3.6.13 Construction Schedule

It is anticipated that the desalination plant and associated infrastructure will be constructed in 2015-2017, with production commencing in 2017. The construction of linear infrastructure would be completed in approximately 12 months, following which the desalination plant would be constructed (over a period of 18 months).

## 3.7 Project Operations and Process Description

### 3.7.1 Desalination Process

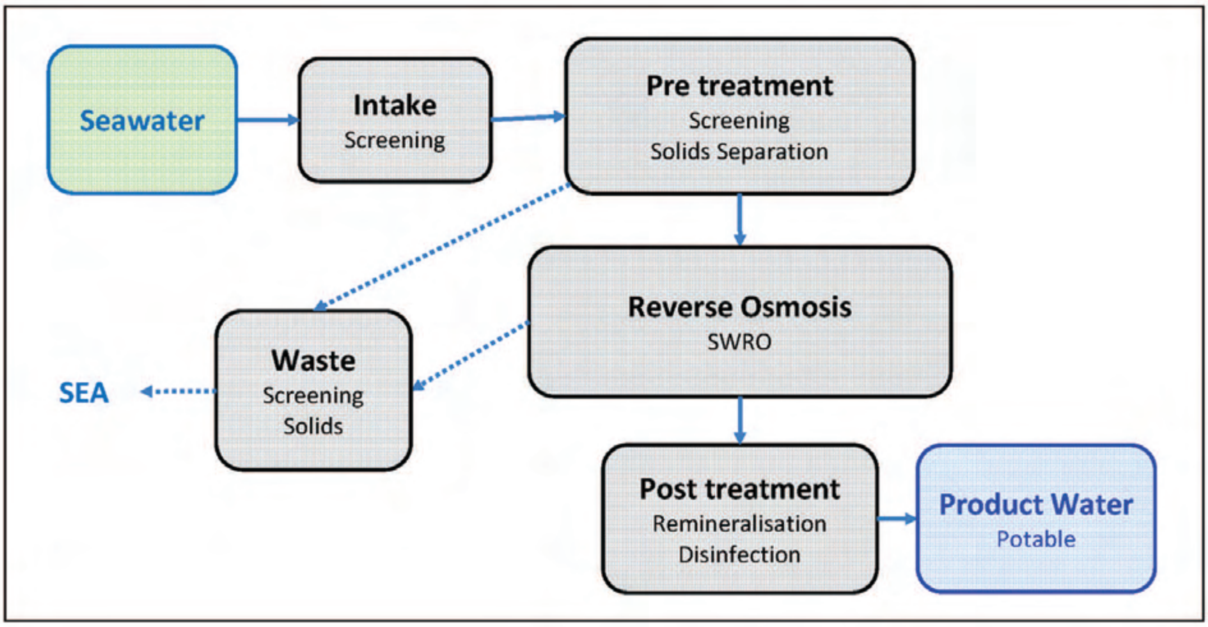
Desalination refers to a water treatment process whereby salts are removed from saline water to produce fresh water. The proposed desalination process will make use of Reverse Osmosis (RO) technology to remove salt from sea water, thereby producing fresh product water as well as high salinity brine. The recovery rate of product water through the process would be approximately 40%.

***Reverse Osmosis:*** *Osmosis is the natural movement of solvent from an area of low solute concentration through a membrane to an area of high solute concentration when no external pressure is applied. Reverse Osmosis is a separation process used to purify concentrated solutions of dissolved minerals and salts by forcing water through a semi-permeable membrane under high pressure, leaving the dissolved salts and other solutes behind on the surface of the membrane. Reverse osmosis allows for complete desalination of water i.e. retaining all solutes.*

The main elements in the desalination process are:

- Seawater intake;
- Pre-treatment (screening, suspended solid removal and filtration);
- Media filtration (pre-treatment);
- RO (desalination);
- Post-treatment (remineralisation of process water);
- Disinfection and storage of product water; and
- Discharge of brine from the desalination process.

A desalination process flow diagram is presented in Figure 3-11.




| srk consulting | Figure 3-11: Desalination Flow Diagram | Project No. 451101 |
|---|---|---|

*Source: RHDHV*

#### 3.7.1.1 Seawater Intake

The feedwater for the desalination plant is seawater from the Atlantic Ocean, abstracted at a marine intake located in a rock protected gully at Volwaterbaai (see Section 3.5.2.2). Seawater along the west coast of South Africa can be relatively cold and of variable quality. Common problems associated with desalination feedwater along the West Coast include:

- Cold temperatures;
- Upwelling of cold, nutrient rich water (causing red tides); and
- Phytoplankton and algae.

Sampling and analysis of the quality of water at the proposed seawater intake is on-going and will be used in the final process design, in particular the design of the pre-treatment system.

The seawater intake system will be fitted with coarse screens to prevent large solids (e.g. kelp) from entering the system. It is anticipated that seawater will be abstracted 24 hours per day, although this may be reduced depending on demand. Projected seawater abstraction volumes are presented in Table 3-10 below.

#### 3.7.1.2 Pre-treatment

The aim of pre-treatment of feedwater is to minimise fouling of RO membranes by producing feedwater that complies with the following water quality requirements:

- Silt Density Index < 3
- Turbidity < 1 Nephelometric Turbidity Units (NTU)
- Dissolved Organic Carbon < 1 mg/l

Pre-treatment includes screening to remove plankton and algae and filtration to remove suspended solids and reduce turbidity. Dissolved Air Flotation (DAF) and Dual Media Filtration (DMF) are commonly used pre-treatment processes.

DAF uses a combination of coagulation / flocculation and dissolved air to float suspended matter to the surface of the liquid for removal (rather than settling it). Flotation is an effective process, particularly in cases of algal bloom or hydrocarbon pollution and is commonly used for open sea water intakes. As seawater enters the DAF unit it passes through a coagulation and flocculation chamber where a coagulant like $FeCl_3$ and a polymer are dosed. Dissolved air then carries flocculants to the surface for removal with a scraper.

DMF is then used to polish the product water from the DAF unit removing suspended matter. The DMF filter comprises multiple layers, in this case: a bottom layer of gravel, a middle layer of sand and a top layer of anthracite. In order to remove the suspended matter effectively it first need to be chemically flocculated thus a typical flocculent like $FeCl_3$ is dosed prior the sand filters. Sulphuric acid may also be used to lower the pH to the optimal flocculation pH of around 6.9. Flocculated water is then filtered from the top down through the media layers capturing the suspended matter. Once enough material is collected in the filter or after a pre-determined time the flow are reversed and the captured material are removed from the filter media through a backwash process.

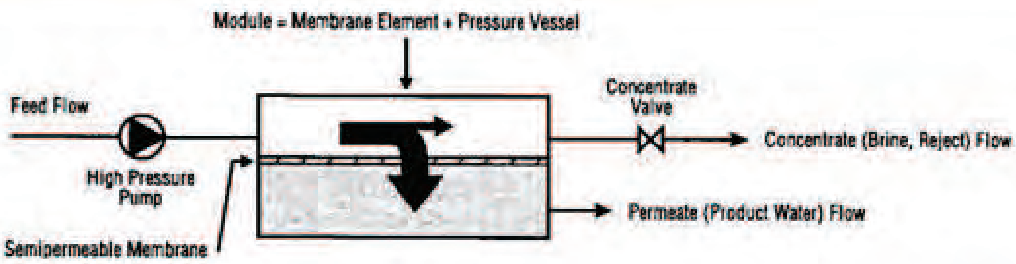
Waste (backwash) from pre-treatment will be blended with other waste from the system and discharged to the sea via the brine discharge system (see Section 3.7.2).

#### 3.7.1.3 Desalination

The proposed desalination process will make use of RO technology.

In the desalination plant, pressurised pre-treated feedwater will pass through a series of RO vessels, thus allowing only water (low saline permeate) to pass through the membranes. Salts and organics will accumulate in brine which does not pass through the membranes. The series of membranes is housed in high pressure casings in tubular, spiral or hollow-fibre configurations. (See **Appendix 3C** for additional information regarding the RO desalination process).

A simplified diagram of the RO process is provided below.




$$\text{Recovery (\%)} = \frac{\text{Permeate Flow} \cdot 100}{\text{Feed Flow}}$$

$$\text{Salt Passage (\%)} = \frac{\text{Permeate Salt Concentration} \cdot 100}{\text{Feed Salt Concentration}}$$

$$\text{Salt Rejection (\%)} = 100 - \text{Salt Passage}$$

srk consulting | **Figure 3-12: Simplified Diagram of RO Process** | Project No. 451101

*Source: Veolia Water*

The envisaged volumetric flows through the desalination plant are indicated in Table 3-10 below, based on the production of 4.0 $Mm^3/a$ of product water.

**Table 3-10: Volumetric Flows through Desalination Plant**

| Operation | Raw seawater intake | Product water | Brine discharge (total waste) |
|---|---|---|---|
| **Average[11] Operation** | 27,390 $m^3$/day | 10,952 $m^3$/day | 16,438 $m^3$/day |
| **Instantaneous[12] Capacity** | 30,368 $m^3$/day | 12,142 $m^3$/day | 18,226 $m^3$/day |

It is assumed that production will be phased as indicated in Table 3-11 to meet the water demand at the mine, which is likely to increase over time during the first few years of operation.

**Table 3-11: Phased Increase in Water Supply**

| Phase | Volume of product water | Daily volume |
|---|---|---|
| Phase 1 (year 1-4) | 2,660 $Mm^3$/a | 7,300 $m^3$/day |
| Phase 2 (year 5+) | Full capacity operations | |

#### 3.7.1.4 Product Water

Permeate from the desalination process will need post treatment i.e. remineralisation and disinfection to obtain the desired characteristics for the product water, based on the intended water use. Full remineralisation is proposed, which would include:

- Carbon dioxide ($CO_2$) injection;
- Calcium carbonate ($CaCO_3$) stabilisation; and
- pH correction.

The quality of the product water must comply with SANS 241:2011 (Drinking Water), must have a $CaCO_3$ precipitation potential index > 0; and a minimum calcium (Ca) level of 20mg/l.

#### 3.7.1.5 Brine Discharge

On average 60% of the sea water passing through the desalination plant will be returned to the sea as brine from the plant. Brine is the portion of the feedwater which does not pass through the membranes in the high pressure RO vessels. Brine has higher salinity and a slightly increased temperature compared to the incoming feedwater. The anticipated brine composition is as follows.

**Table 3-12: Composition of Brine**

| Component | $NH_4$ | K | Na | Mg | Sr | Ba | $CO_3$ | $HCO_3$ | Cl | F | $SO_4$ | TDS | $CO_2$ | Boron | Ca | $SiO_2$ | $NO_3$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **mg/l** | 0 | 838 | 19598 | 2271 | 13 | 0 | 12 | 265 | 34800 | 2 | 5345 | 63949 | 4 | 8 | 724 | 4 | 15 |

The rate of brine discharge as well as the discharge infrastructure (see Section 3.6.1.2) is intended to ensure that the concentrated brine mixes with the seawater and is diluted as quickly as possible, and that brine does not accumulate within the surf zone in the vicinity of the discharge outfall.

Daily brine discharge rates are presented in Table 3-10 above.

The discharge of brine is likely to create a sacrificial zone in the gulley in which high salinity levels and co-discharges (any chemicals remaining in the brine) are likely to negatively affect marine life which has not already been disturbed by construction activities in the immediate area. The design of the discharge infrastructure would aim to minimise the size of this sacrificial zone.

[11] Average flows are based on the process recovery rate only

[12] Instantaneous flows are based on plant availability (90%) and process recovery rate (40%)

#### 3.7.1.6 Use of Chemicals

Most of the chemicals used in the desalination process are to protect and prevent fouling of the RO membranes. Chemicals are also used to clean the plant and preserve membranes when not in operation. Remineralisation and disinfection chemicals are added to the product water to obtain the desired characteristics for the intended water use.

The chemicals used during the normal operation of the plant are as follows.

**Table 3-13: Chemicals Used in Normal Plant Operation**

| Chemical | Application | Function |
|---|---|---|
| *Feedwater and pre-treatment stream* | | |
| Chlorine (Cl) | At seawater intake on shock basis | Biocide |
| $FeCl_3$ | Seawater feed line before DAF and DMF | Flocculation |
| Anionic Polymer* | Seawater feed line before DAF | Flocculation |
| Sulphuric Acid* ($H_2SO_4$) | Seawater feed line before DAF | Flocculation |
| *Pre-treated water* | | |
| Sodium Metabisulfite (SMBS) | In filtrate before RO membranes | Reduction of chlorine |
| Phosphonate | In filtrate before RO membranes | To control scale on membranes |
| *In RO permeate* | | |
| Sodium Carbonate (Soda Ash) ($Na_2CO_3$) | Product water | pH correction |
| $H_2SO_4$ or $CO_2$ | Prior to limestone columns | To lower pH for dissolution of $CaCO_3$ |
| $CaCO_3$ | Dissolved into permeate | Stabilisation |
| *Final product water* | | |
| Cl | Dosed continuously to the product water stream | Disinfection |

*(* denotes alternative or additional chemicals which may not be required)*

Chemicals used in the plant during cleaning and maintenance are as follows:

**Table 3-14: Chemicals Used Cleaning and Maintenance**

| Chemical | Function |
|---|---|
| *Cleaning in place (CIP)* | |
| Peroxyacetic acid ($CH_3CO_3H$) | Removal of biofouling from membranes |
| Low pH CIP solution or Hydrochloric acid (HCl)* | Removal of biofouling from membranes |
| High pH CIP solution containing Sodium Hydroxide (NaOH); or Ammonium Hydroxide ($NH_3$)* | Removal of biofouling from membranes |
| *Membrane preservation* | |
| SMBS | Preserving membrane when not in operation |

*(* denotes alternative or additional chemicals which may not be required)*

Chemical dosing rates as well as the estimated concentrations in the brine stream are detailed in **Appendix 3D** and illustrated in Figure 3-1 in this Appendix.

Chemicals will be supplied in different forms (solid, liquid or gas) and are either ready for use, or may require make-up and dilution on site. All chemicals will be stored and handled in bunded areas and any spillages will be contained and handled in those areas. Spillages will not be directed to the waste sump, unless they have been neutralised and diluted to the same concentrations that are permitted for discharge.

### 3.7.2 Power Supply

The main power supply to the plant will be via overhead power lines from the mine (see Section 3.6.4). A back-up generator will be provided at the plant to provide for essential power and lighting, high lift pumps (to the mine) and membrane flushing and maintenance of the plant in case of emergencies. No backup power will be provided for the operation of the plant.

### 3.7.3 Waste Management

#### 3.7.3.1 Waste/Discharges from Desalination Process

The desalination process will produce various waste streams as indicated in Table 3-15 below.

**Table 3-15: Waste from Desalination Process**

| Waste type | Nature of waste | Origin | Proposed storage and disposal |
|---|---|---|---|
| *Seawater Intake and screening* | | | |
| Solid waste | Kelp, shells, sand, grit etc. | Washing into marine intake basin | Returned to the sea or alternatively sold/provided to kelp farmers in the area. |
| Screenings | Seawater containing suspended solids, organic matter, algae etc. | Drum filters | Discharge into the sea along with brine |
| *Pre-treatment* | | | |
| Pre-treatment waste | Continuous stream of seawater containing suspended solids, organics and trace coagulant during pre-treatment | DAF effluent | Discharge into the sea along with brine |
| Filter backwash | Intermittent flow of seawater containing suspended solids, organics and trace coagulant generated during backwashing and rinsing of filters in the pre-filtration system | Filters | Discharge into the sea along with brine |
| *Desalination process* | | | |
| Brine | Continuous flow of high salinity water containing concentrated constituents of seawater feed for the RO units | RO Units | Disposal into the sea via marine outfall |
| *Cleaning and maintenance* | | | |
| Spent CIP solution | Intermittent stream of used cleaning solution from cleaning of membranes and containing low concentrations of chemicals used for cleaning (see Table 3-14) | Membrane CIP | Stored in CIP waste tank and drip fed into waste stream for discharge into the sea along with brine.[13] |
| Spent SMBS | Used solution from membrane preservation (on shut down) | Membrane vessels | Discharge into the sea along with brine |

Waste stream characteristics are detailed in **Appendix 3D**. Sources of waste and respective concentrations are also illustrated in Figure 3-1 of **Appendix 3D**.

The majority of the waste from the desalination process will be discharged at sea along with the brine. If this is shown not to be compliant with discharge standards, alternative waste disposal methods will be considered (see Section 3.5.5).

#### 3.7.3.2 Solid Waste Management

A limited amount of domestic and general waste will be generated by staff at the desalination plant. Domestic and general wastes will include food waste, food packaging, drinking containers, metal

[13] When the plant is not operational and brine is not being discharged, CIP waste will be removed by tanker and disposed of at the mine's waste /tailings facilities.

cans, paper, cardboard, plastics, general packaging materials, light bulbs and fluorescent tubes, which will be disposed of at the mine's waste facilities.

The conventional hierarchy of waste reduction and management will be employed at the desalination plant:

- *Reduce* – e.g. modify processes to reduce the amount of waste going into the waste stream and/or identify alternative uses for waste such as removal of kelp by local kelp farmers;
- *Reuse* – e.g. cleanse and reuse bottles to eliminate them from the waste stream;
- *Recycle* – remove recyclable materials from the waste stream;
- *Treat (compost)* – compost organic material separated from the waste stream, preferably by source separation; and
- *Landfill* – final disposal of materials, which cannot be economically or technically removed from the waste stream.

The aim of this approach is to minimise the amount of waste generated by applying waste reduction strategies, and then to maximise alternative uses of waste so as to minimise the amount of waste requiring final disposal to landfill.

#### 3.7.3.3 Waste Water and Sewage Management

Domestic wastewater is defined here as water that does not contain a human organic waste component. Sewage is defined as human organic waste, usually within a water suspension. Sources of domestic wastewater and sewage are the kitchen, toilets, washrooms and offices. Domestic wastewater and sewage will be captured in combined waste streams and directed to the septic tank.

### 3.7.4 Surface Water Management

Namaqualand is in an arid area with low rainfall and stormwater management is not considered to be a major challenge. Surface water management aims to capture and reuse water and prevent contamination of surrounding areas. To achieve this objective, the stormwater system at the desalination plant will be designed to allow for:

- Natural infiltration of uncontaminated stormwater from all (unpaved) hardened surfaces including dirt roads;
- The capture and reuse of uncontaminated rainwater from the roofs of buildings, for irrigation on site; and
- The capture of any potentially contaminated stormwater from hardened surfaces around the desalination plant will be directed to a bund from where it will be tested and removed via truck for suitable disposal off-site.

### 3.7.5 Air Quality Management

Potential sources of emission during the operations phase may include dust generated be vehicles moving on unpaved roads, as well as exhaust emissions from these vehicles and generators used during power outages.

Equipment which may generate emissions will comply with international emission standards. Exhaust emissions from diesel-powered equipment will be subject to periodic checks as part of regular maintenance programmes. This will allow Sedex to detect increased emissions and implement improvement measures where necessary.

### 3.7.6 Noise Management

Potential sources of noise during the operations phase include noise from vehicles the road between the desalination plant and Zandkopsdrift Mine, as well as generators and the desalination equipment at the plant.

Mobile equipment, vehicles and power generation equipment will be sourced from reputable manufacturers and all equipment will be subject to commissioning tests at handover by the supplier, and noise emissions will be measured against the manufacturer's specifications to confirm compliance before the equipment is accepted.

Noise emissions from mobile and fixed equipment will be subject to periodic checks as part of regular maintenance programmes or through ambient noise measurements. This will allow Sedex to detect increases in noise and implement improvement measures where necessary.

The remoteness of the desalination plant will influence noise mitigation required in this area.

### 3.7.7 Workforce

Plant operators will be on site at all times, with full communication with the operations centre at the mine, and the control of certain aspects of the plant may be provided by the operations centre. It is estimated that five to seven plant operators and support staff will be permanently employed at the desalination plant.

### 3.7.8 Traffic

Traffic during the operations phase would be limited to the daily movement of staff to the desalination plant as well as traffic associated with infrastructure maintenance (when required) and monthly deliveries of chemicals and other supplies. It is estimated that traffic on the access route between the desalination plant and Zandkopsdrift Mine would be limited to approximately 6 light and 6 heavy vehicle trips per day. In addition, 20 trips by delivery vehicles (5 to 8 t) per month are anticipated.

### 3.7.9 Operational lifecycle

The operational life cycle of the plant is assumed to be 30 years, with a phased increase in capacity over the first five years of operation (Table 3-11). Electrical and mechanical infrastructure may need refurbishment after 10 years.

## 3.8 Analysis of Need and Desirability of the Project

Best practice requires that the need and desirability of a project (including viable alternatives) is considered and evaluated against the tenets of sustainability. It requires an analysis of the effect of the project on social, economic and ecological systems; and places emphasis on consideration of a project's *justification* not only in terms of financial viability, but also in terms of the specific needs and interests of the community and the opportunity cost of development. Proposed actions of individuals are therefore measured against the interests of the broader public, and project impacts are not allowed to be distributed in such a way that they unfairly discriminate against members of society (DEA&DP, 2013).

Regional planning documents such as SDFs, IDPs and EMFs enunciate the strategic needs and desires of communities, and project alignment with these documents must therefore be considered and reported on in the EIA Report. With the use of these documents or - where these planning documents are not available - using best judgment, the EAP (and specialists) must consider the project's strategic context, or justification, in terms of the needs and interests of the broader community (DEA&DP, 2013).

The compatibility of the proposed project (or the "desirability" thereof) with the objectives for planning and development for the area (or the "need") is considered in Table 3-16 below, based on the above analysis of the existing planning framework and proposed project activities.

**Table 3-16: Need and Desirability of the Project in the Context of Planning Objectives**

| **Economic** | |
|---|---|
| **Objective ("Need")** | |
| Provincial, District and Local Municipality level planning documents all reiterate the need for:<br>• Poverty alleviation;<br>• Socio- economic development;<br>• Encouraging trade and investment;<br>• Maximising the benefits of mining and agriculture through ensuring inclusive growth;<br>• The development of human capital and a skilled and capable workforce;<br>• The provision of adequate and appropriate infrastructure to stimulate economic growth;<br>• Addressing water scarcity as a limiting factor to economic growth; and<br>• Improving accessibility in order to stimulate growth in the tourism industry, provide linkages to other regions and support effective service delivery. | |
| **Compatible aspects** | **Potentially incompatible aspects** |
| The project will create employment opportunities during the construction and operation phases.<br>Opportunities for skills development will arise (particularly for unskilled labourers during the construction phase).<br>The provision of service infrastructure (including roads and the possibility of water supply) to Kotzesrus and Lepelsfontein will likely stimulate economic growth and tourism potential in the area.<br>The desalination plant will supply water to the Zandkopsdrift Mine. Water scarcity would otherwise have been a limiting factor to the development of the mine. The mine is expected to stimulate economic growth in the area and provide a number of employment opportunities to local residents.<br>The expected project lifetime of the desalination plant is 30 years and employment opportunities at the desalination plant will thus be sustained over the long term (more than 15 years).<br>Improvement of the road network, and particularly access to the coast would promote tourism, with economic benefits. | The development of the desalination plant on Farm Strandfontein 559 may impact on scenic and tourism resources at the coast, and could potentially impact upon economic growth in the tourism sector. |
| **Environmental** | |
| **Objective ("Need")** | |
| Provincial, District and Local Municipality level planning documents stipulate that:<br>• The unique biodiversity of the Namaqua area is important for economic, cultural, aesthetic, scientific and educational purposes and has significant conservation importance;<br>• The coastal area provides an abundance of marine and coastal resources;<br>• Visually and ecologically sensitive areas should be protected in order to promote conservation and tourism;<br>• Biodiversity in the Namaqua area is threatened by invasive species, habitat loss and climate change; and<br>• Longitudinal developments that traverse biodiversity corridors should incorporate mitigation measures to ensure that corridors are not severed. | |
| **Compatible aspects** | **Potentially incompatible aspects** |
| The development area (desalination plant and associated infrastructure) is not located in close proximity (less than 10km) to any National Park identified in NEM: PAA.<br>The development area does not fall within any threatened vegetation type, although some Species of Conservation Concern (SCC) may occur in the area.<br>The desalination plant on Farm Strandfontein 559 is not located in a CBA.<br>While traversing a terrestrial ESA and some aquatic CBAs and ESAs, the Kotzesrus route follows an existing route.<br>The desalination plant and portion of the Kotzesrus route along the coast is located within a terrestrial ESA. However, according to the Namaqua District Biodiversity Sector Plan, a limited loss of ecosystem services is permissible in ESAs. | The route leading from the coastal route on Farm Strandfontein 559, towards Kotzesrus follows existing 4 x 4 tracks, but is located within a terrestrial CBA.<br>Both the Bypass and Alternative bypass routes (at Kotzesrus) traverse a terrestrial CBA.<br>According to the NDBSP, linear engineering structures as well as water projects and transfers are listed as restricted activities within terrestrial and aquatic CBAs and ESAs, but are not considered to be unsuitable activities in these areas. |

<table>
<tr><th colspan="2">Regional planning</th></tr>
<tr><th colspan="2">Objective (“Need”)</th></tr>
<tr><td colspan="2">A number of regional planning documents have particular relevance to the project. According to the:<ul><li>Northern Cape PSDF, Garies is identified as a high priority area for public and private investment and infrastructural development.</li><li>EMF and SEMP, development should be discouraged where water supplies cannot be secured and alternative sources of water supply should be investigated, including desalination; and</li><li>Mining should be encouraged where environmental impacts are deemed to be acceptable, the appropriate environmental controls are in place and economic benefits will exceed potential environmental impacts.</li></ul></td></tr>
<tr><th>Compatible aspects</th><th>Potentially incompatible aspects</th></tr>
<tr><td>Garies will benefit from economic opportunities generated by the Zandkopsdrift Mine (which is reliant on the proposed desalination plant for development). The town is identified as a high priority area in terms of the Northern Cape PSDF and economic growth in the town is in line with regional planning principles.<br>The desalination plant provides an alternative water source that can be utilized to support development and mining in the arid Namaqua environment.<br>The coastal area on Farm Strandfontein 559 is identified as EMZ B in terms of the EMF and SEMP. The EMF and SEMP indicates that development should not be restricted in EMZ B areas where compelling economic and social benefits will be derived for the local and regional population.</td><td>Potential environmental impacts should be carefully weighed against economic benefits in order to ensure that the development is deemed to be acceptable from an environmental perspective and it should be ensured that the appropriate environmental controls are in place.</td></tr>
</table>

The relevant regional and local policies and planning guidelines support mining activities in the KLM as a means to achieve economic growth and poverty alleviation. The recent downscaling of the mining industry was identified as a concern in the KLM IDP. Limited infrastructure and accessibility is identified as a constraint to economic growth, while water scarcity is highlighted as a key concern.

Plans and guidelines also recognise the importance and sensitivity of Namaqualand’s biodiversity, which presents significant potential in terms of tourism and conservation. The challenge would be to encourage economic growth in the area, while ensuring that environmental resources are maintained.

The proposed desalination plant and associated infrastructure will support economic growth in the area by facilitating development of the Zandkopsdrift Mine. The associated infrastructure will improve linkages and accessibility in the region, including accessibility to the coastal environment thus promoting tourism in the area. However, the development of the desalination plant may affect the tourism potential of the coastal area and may generate economic benefits. Economic benefits associated with the development should be carefully weighed against potential environmental impacts in order to ensure its sustainability.