# SOCIAL AND ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED RÖSSING URANIUM DESALINATION PLANT NEAR SWAKOPMUND

## Beach and Shoreline Dynamics Specialist Study and Impact Assessment

2014/10/14 Revised: 2014/10/28

# Quality Management

| Issue/revision | Issue 1 | Revision 1 | Revision 2 | Revision 3 |
|---|---|---|---|---|
| Remarks | Issue to client | Aurecon's comments included | Rössing's comments included | |
| Date | 2014/10/14 | 2014/10/21 | 2014/10/28 | |
| Prepared by | C Soltau | C Soltau | C Soltau | |
| Signature | | | | |
| Checked by | G Smith | C Soltau | C Soltau | |
| Signature | | | | |
| Authorised by | G Smith | G Smith | G Smith | |
| Signature | | | | |
| Project number | 18710.R | | | |
| Report number | 18710/11.2/002 | | | |
| File reference | 11.2 | | | |

# SOCIAL AND ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED RÖSSING URANIUM DESALINATION PLANT NEAR SWAKOPMUND

## Beach and Shoreline Dynamics Specialist Study and Impact Assessment

2014/10/14 Revised: 2014/10/28

## Client

Aurecon South Africa and SLR Namibia, on behalf of Rio Tinto – Rossing Uranium

## Consultant

WSP Coastal Engineers Division
Stein House
Brandwacht Office Park, Trumali Street
Stellenbosch
7600
South Africa

Tel: +27 21 883 9260

Fax: +27 21 883 3212

www.wspgroup.co.za

## Registered Address

WSP Group Africa (Pty) Ltd
1999/008928/07
WSP House, Bryanston Place, 199 Bryanston Drive, Bryanston, 2191, South Africa

## WSP Contacts

Christoph Soltau

# Table of Contents



## List of Figures

## List of Tables



## List of Acronyms and Abbreviations

| | |
|---|---|
| g/ℓ | Gram per litre |
| m | Metres |
| mm | Millimetres |
| m/s | Metre per second |
| $m^3$/s | Cubic metres per second |
| $m^3$/d | Cubic metres per day |
| $m^3$/yr | Cubic metres per year |
| mg/ℓ | Milligrams per litre |
| Mℓ/d | Megalitres per day (1 Megalitre = 1 000 cubic metres) |
| $Mm^3$/a | Million cubic metres per annum |
| MSL | Mean sea level |
| ppt | Part per thousand |
| psu | Practical salinity units |
| µm | Microns |

# 1 Introduction

## 1.1 Project Description

Rio Tinto Rössing Uranium Limited (Rössing Uranium) is investigating the design, construction and operating of a new seawater reverse osmosis desalination plant in order to supply the water needs of the Rössing Uranium mine. The mine is located near Arandis in the Erongo region of Namibia. The desalination plant will be located within the Swakopmund Saltworks mining licence area, approximately 6km north of Swakopmund (locally known as Mile 4), see Figure 1.1.

Rössing Uranium's product (fresh) water requirement is 3 $Mm^3$/a, or 8.2Mℓ/d. The plant's peak capacity will be 10Mℓ/d. This will require a seawater feed of approximately 25Mℓ/d, with 15Mℓ/d of brine to be discharged back to the sea.

The plant design proposes a seawater intake located close to shore, similarly to the existing Saltworks intake jetty, and in the same general area of the coast. The brine from the desalination plant will be disposed to the surfzone via a pipeline. Two sites have been proposed: one north of the Saltworks seawater intake jetty, and the second in the south near the present location of the Saltworks' brine discharge. The waste discharge from the Saltworks operations is in the form of a hyper-saline brine or "bitterns", which is discharged above the high-water mark and flows across the beach to the ocean.The size of the desalination plant, and thus the scale of the seawater intake and brine outfall works are comparatively small when compared to the Wlotzkasbaken desalination plant and the plan that was proposed by Namwater at Mile 6. These have/had product water capacities of 20 and 25 $Mm^3$/a respectively, or 6 to 8 times larger than the proposed Rössing plant.


**Figure 1.1: Proposed site for the desalination plant within the Swakopmund Saltworks complex**

## 1.2 Terms of Reference

WSP Group Africa, Coastal Engineers Division, was appointed by SLR Namibia and Aurecon South Africa to undertake a desktop study of the potential impacts of the development on the beach and shoreline dynamics. The beach and shoreline dynamics refer to the beach characteristics, such as beach slope and coastline orientation, and behaviours, such as erosion and accretion, and the coastal processes that drive the behaviours. The main processes are the local waves, currents, and resulting sediment transport.

Specifically, the study is required to assess the potential impacts of the intake and outfall structures on the beach and shoreline stability. This includes consideration of the erosion and accretion of the beach, and any changes to sediment transport patterns. Consideration of biological impacts is excluded, as these are dealt with separately in the Marine Ecology Assessment. The present study therefore considers only abiotic impacts.

The study will assess the level of the impacts, and provide mitigation and monitoring measures, where applicable.

# 2 Project Components Relevant to Impacts on Beach and Shoreline Dynamics

The components of the project that have been identified as potentially impacting the beach and shoreline dynamics at the site are the seawater intake structure and the brine outfall. These are discussed further below. Their locations are shown in Figure 2.1.


**Figure 2.1: Intake and outfall locations and other coastal features**

## 2.1 Seawater Intake Structure

The intake site is located 160m south of the existing Saltworks jetty, which can be seen in Figure 2.2. The intertidal area at the site is very gently sloping and consists of rock shelves and boulders. The beach is sandy mainly above the 0m MSL contour.

The Rössing desalination plant's seawater intake will also be a jetty extending across the rocky intertidal shelf. The rock shelf, termed "Yellow Shelf", at the proposed intake site can be seen in Figure 2.2. The shelf has an elevation of approximately 0.1 m above MSL and would therefore be above water level except at high tide.

The intake jetty will be 70m long, with approximately 65m occurring below the high water mark. The intake pipeline/s will be located on top of the jetty and raised approximately 4m above mean sea level (MSL). Seawater intake pumps will be located on the seaward end of the jetty, abstracting water from a gully between the rocks where the water depth is 1.7m below MSL.

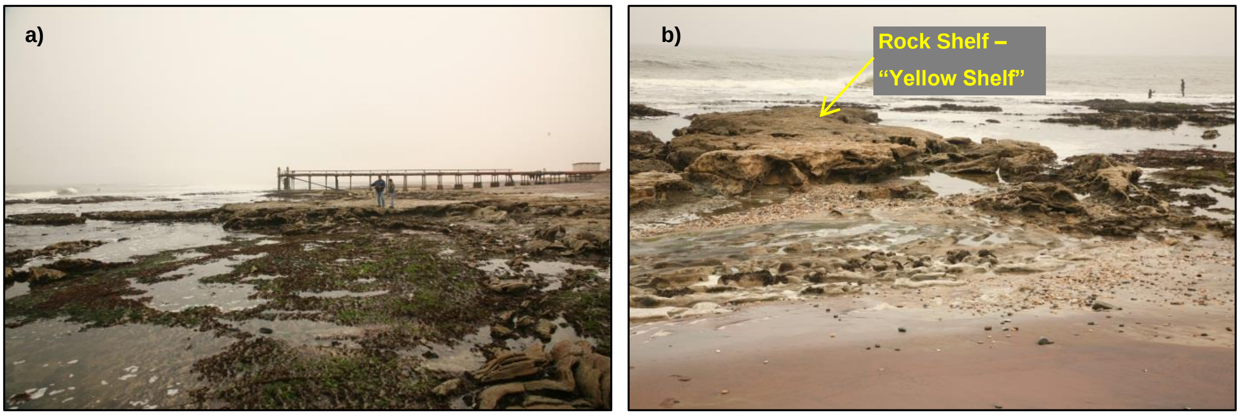


**Figure 2.2: a) Saltworks' existing intake Jetty; b) Rock shelf proposed for Rössing's intake jetty**

## 2.2 Brine Outfall

The engineering studies have identified a preferred location for the effluent/brine outfall, termed Outfall 5, with an alternative location, Outfall 1. Locations are shown in Figure 2.1. Outfall 5 is located 2.5 km to the south of the intake, near the location of the Saltworks' bitterns discharge channel. The alternate location, Outfall 1, is located 1km to the north of the intake location, at a disused Saltworks intake that incorporates a concrete structure extending into the sea beyond the low-water mark. Photographs of the two sites are shown in Figure 2.3.

The outfall pipeline will be placed in a trench on land and across the beach and concrete encased from the high water mark to the discharge location in the surf zone. The outfall will terminate in a diffuser located at 1.6m below MSL. The pipeline diameter will be 400mm.

The brine discharge infrastructure and pipeline can potentially affect the shoreline dynamics.

The impacts that the Rössing seawater intake jetty and the brine outfall, including the alternative location, may have during construction, operation and decommissioning are considered in this study.

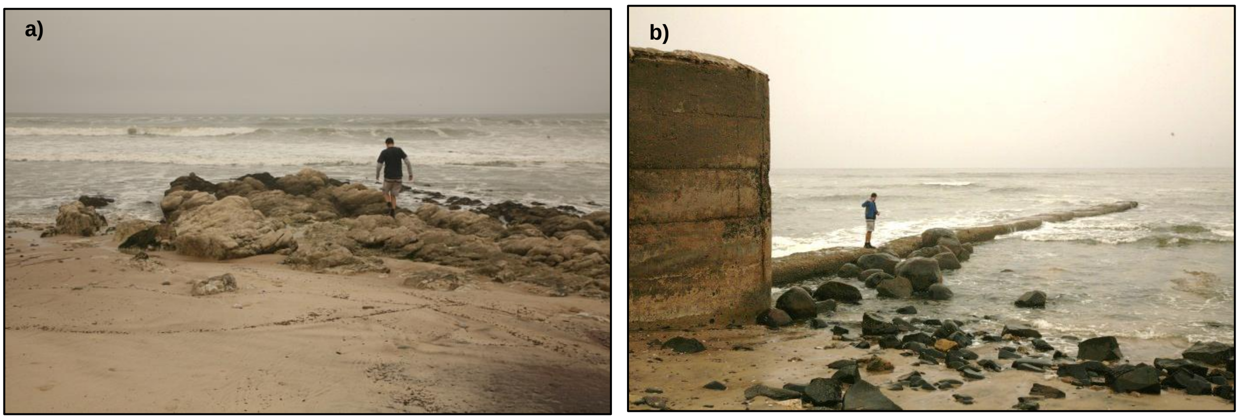


**Figure 2.3: a) Rocky shelf at Outfall 5, preferred location; b) Concrete structures at old Saltworks intake – Alternative location - Outfall 1. The old concrete-encased pipe is visible.**

# 3 Study Approach

## 3.1 Methodology

The study was undertaken as a desktop qualitative evaluation based on available information. Two site visits were undertaken to the intake and outfall locations. Information from similar projects, particularly the Wlotzkasbaken desalination plant, and the EIA for the NamWater Mile6 desalination plant (CSIR, 2009), were used. Supporting information included topographic surveys of the intake and outfall locations, as well as a diving survey of the seabed opposite the outfall locations.

## 3.2 Assumptions and Limitations

The scope of work did not include numerical modelling of waves, currents or sediment transport and shoreline evolution. It was initially assumed that the physical scale of the proposed infrastructure would not justify such studies – coastal infrastructure, such as jetties or breakwaters that impact the coastline, are typically in the order of several hundred metres long. The comparatively small scale of the intake and outfall structures confirms that this assumption is not a limitation.

# 4 Description of Affected Environment

This section provides a description of the physical beach and shoreline environment, based on published information and observations and data collected during the site visit.

## 4.1 Beach and Seabed Topography

The shoreline north of Swakopmund is generally sandy, with long sand beaches interspersed with low rock outcrops and surfzone reefs. These form a gently undulating shoreline that faces west south-west. An extensive rock outcrop along the northern boundary of the site forms a north-west facing headland, where the present saltworks intake is located. This rocky headland leads into a shallow embayment that extends into further sandy beaches to the north, see Figure 2.1.

The beaches at the site consist of medium sized sand, with pebble and cobble deposits. Sand samples taken on the intertidal beach at three locations indicate the sand has typical median grain size ($D_{50}$) ranging between 269 microns and 471 microns and is well sorted. The locations of the samples are shown in Figure 2.1, with typical size parameters given in Table 4.1.

**Table 4.1: Beach sediment sizes**

| Sample: | S1 | S2 | S3 |
|---|---|---|---|
| $D_{10}$ (μm): | 302.0 | 282.4 | 191.1 |
| $D_{50}$ (μm): | 471.6 | 414.7 | 269.6 |
| $D_{90}$ (μm): | 688.8 | 654.7 | 444.0 |

Cobbles are found along the shoreline of the entire site, and are a characteristic feature of this part of the coastline. Along approximately 1km of the site the cobbles form a continuous berm between the low-water and high-water marks. The approximate location of the cobble berm, as observed at the time of the site visit in July 2014, is marked on Figure 2.1. Sand is exposed beneath the cobble, as can be seen in Figure 4.1. Such cobble deposits can be dynamic in the medium to long term, migrating along the shoreline. They limit landward movement (erosion) of the shoreline in the short term.

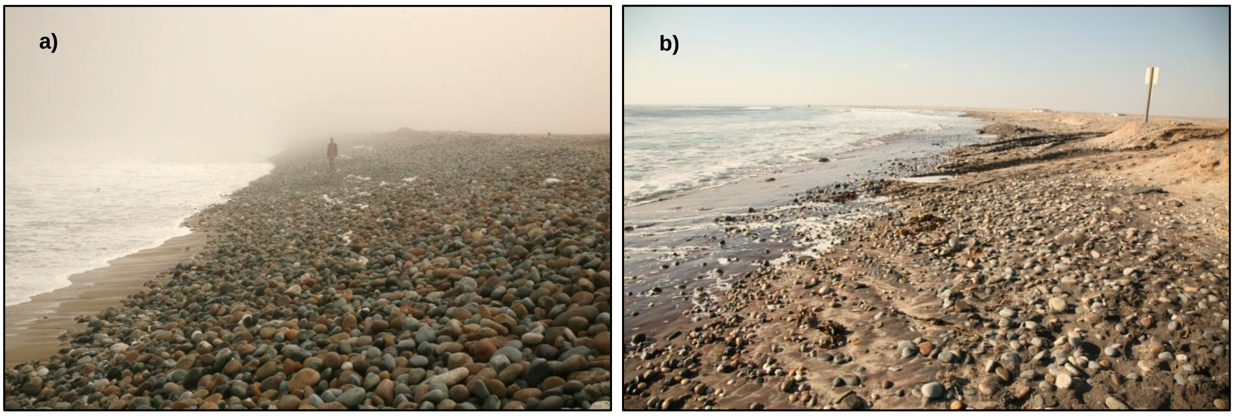


**Figure 4.1: a) Cobble berm near Outfall 5 location; b) Scattered cobbles on the beach just north of the Saltworks' intake jetty**

A topographic survey of the beach indicates a steep beach slope, typically 1:10. The crest of the beach (highest part reached by the waves) is at an elevation of approximately 3.2m above MSL (Mean Sea Level).

The relatively thin (3 – 4 m thick) sand cover on the beach appears to be underlain by bedrock sheet, with individual rock outcrops on the inter-tidal beach and below the low-water mark. The rock outcrops are of low relief and would likely be covered and uncovered by sand on a seasonal basis. The rock outcrop at brine Outfall 5 is prominent along this section of coastline and can be seen in the right hand photo in Figure 4.2.

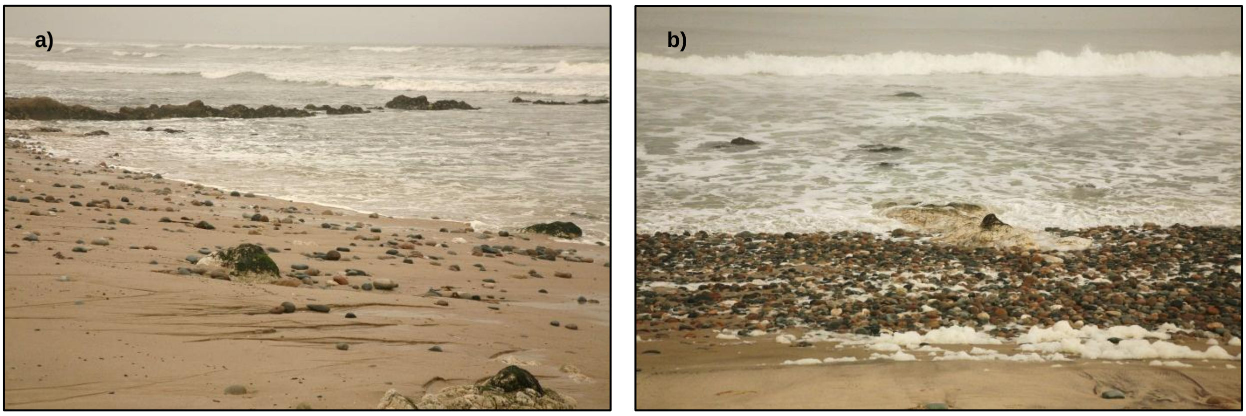


**Figure 4.2: a) and b) Rock outcrops in the intertidal zone and surfzone near the outfall site**

Navigation charts and bathymetric surveys done for the Mile 6 Desalination Project (CSIR, 2009) indicate that the seabed is generally rocky with sparse sediment accumulations. This was confirmed by a diver survey at the brine outfall locations, the survey indicating cobbles and bedrock with thin layers of sand in patches up to a distance of 200m from the shoreline.

The 10m depth contour is located approximately 1km offshore. The nearshore seabed slope is irregular, with a number of isolated reefs, or blinders, located between 250 m and 500 m from the shore.

There are no distinct sand dune features present on this part of the coastline. This is likely a result of the comparatively coarse nature of the surface sediments and the absence of fine sands that are easily transported by the wind. Aeolian (wind-blown) sand transport at the site is thus likely to be small compared to other areas of the Namibian coastline. Large scale disturbance of the soil could, however, lead to the formation of dunes or wind-blown sand problems.

## 4.2 Waves

The central Namibia coastline is exposed to wave action year round. During winter, swell energy from frontal systems in the South Atlantic Ocean dominate. During summer, local sea waves occur in response to the persistent southerly winds.

Figure 4.3 shows a rose diagram of offshore wave height and occurrence, using hindcast data from NOAA NCEP (National Centres for Environmental Prediction in the USA). Average wave heights are in the range 1.5 m to 2.5 m, with typical periods between 8 s and 14 s. Offshore wave heights exceed 3 m for 15 % of the time. Higher waves are most common in winter. Offshore wave directions are predominantly from the south-south-west.

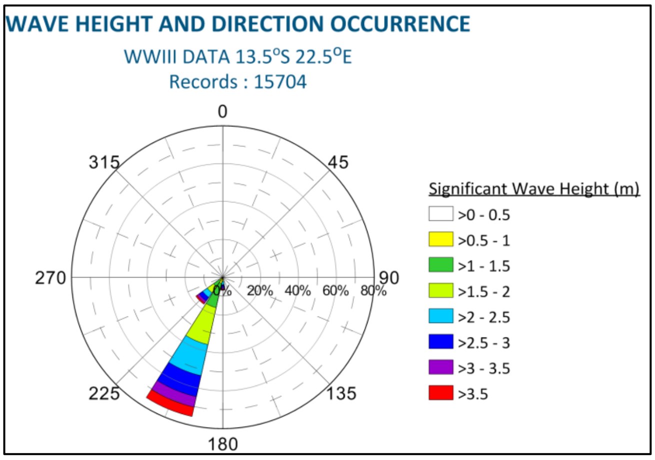


**Figure 4.3: Rose diagram of offshore wave conditions (Data: NOAA NCEP)**

Surfzone wave conditions at the site are moderate, with waves first breaking some distance from shore. The offshore reefs create irregular breaking patterns in places. The inner breaker zone and swash zone are quite active, with powerful breaking close to shore. This is reflected in the steep beach slopes and presence of coarser materials such as cobbles along the shore.

## 4.3 Tides

Tides along the Nambian coastline are semi-diurnal (meaning there are two high and two low tides per day). The closest tide station is located at Walvis Bay. Data from this station are given below. Due to its proximity to

Walvis Bay, these tides can be taken as representative of Swakopmund. The typical tidal range is 0.6 m during neap tides, and increasing to 1.4 m during spring tides.

Water levels at the shoreline can deviate from the tidal levels in response to changes in atmospheric pressure, wind setup during strong onshore winds, and wave-related effects. These changes are typically related to specific events, usually storms.

**Table 4.2: Tidal levels at Walvis Bay (SANHO, 2013)**

| Description | | Level in m Relative to Mean Sea Level |
|---|---|---|
| Highest Astronomical Tide | HAT | +1.004 |
| Mean High Water of Spring Tide | MHWS | +0.724 |
| Mean High Water of Neap Tide | MHWN | +0.324 |
| Mean Level | ML | +0.014 |
| Mean Sea Level | MSL | 0.00 |
| Mean Low Water of Neap Tide | MLWN | -0.296 |
| Mean Low Water of Spring Tide | MLWS | -0.696 |
| Lowest Astronomical Tide | LAT | -0.966 |
| Chart Datum | CD | -0.966 |

## 4.4 Currents

Currents near the shore are mainly generated by winds and waves. The Benguela ocean current, flowing northward off the coast of Namibia, has little impact on circulation near the shoreline. Its speeds typically range between 0.02 and 0.17 m/s.

Tidally driven currents an attain speeds in excess of 1m/s at the entrances to bays. However, on open coastlines, tidal currents are generally weak and have a negligible influence on nearshore circulation.

Strong northward flows are generated near the coast by the predominant southerly winds (CSIR, 2009). Speeds peak during times of strongest winds and reduce when the wind drops or during northerly wind events.

Wave driven flows dominate the nearshore area from just beyond the surfzone, up to the beach. Longshore currents are generated by waves approaching the shore at an angle. They are strongest in the surfzone. Typical velocities can range between 0.2 m/s and 0.5 m/s. At the site, the predominant south-south-westerly direction wave direction will lead to a general northerly drift. High longshore currents can be expected along the rocky headland at the north of the site at the Intake Jetty and Outfall 5 locations, as waves approach this headland at an oblique angle.

Wave breaking also causes localised rip currents. These are a seaward directed return flow of water and can readily attain velocities of up to 1 m/s. Rip currents can extend beyond the surfzone. They are more likely to occur near features that cause gradients in wave height, such as rock outcrops or reefs and ridges on the seabed. It is likely that rip currents occur at the site.

## 4.5 Sediment Transport

Sediment transport near the shore is driven primarily by wave effects. The turbulent action of wave breaking stirs up sediments. Longshore currents then move this sediment along the shoreline, leading to longshore sediment transport. This transport rate is highest in the surfzone, where wave breaking action and longshore current speeds are strongest. Waves do cause movement of sediment seaward of the zone of wave breaking, although rates of transport are generally significantly less than in the surfzone.

The longshore sediment transport rate at Vineta in northern Swakopmund has been estimated to be between 140 000 and 400 000 $m^3$/yr (CSIR, 2009). The net direction of this longshore sediment transport is northward. The magnitude is likely to vary, depending on wave conditions and the availability of sediment.

The net northerly direction of longshore transport can be seen by the accumulation of sediment on the southern side of groynes and breakwaters in Swakopmund, such as the wide beach on the southern side of “Die Mole” and the comparatively narrow beach on its northern side. When built, this structure extended through the surfzone, blocking the longshore sediment transport. This resulted in accretion of the beach on its southern (updrift) side, and relative erosion of the beach on its northern (downdrift) side.

The size of sediments also affects their rate of transport, with finer materials requiring less energy to transport. The pebbles and cobbles present at the site are thus comparatively stable and will move at a much slower rate than sand-sized particles. During storms the cobble berm is thus likely to be show limited changes, while the adjacent sandy shoreline will change rapidly.

During storms, high waves and elevated water levels result in rapid erosion of material from the inter-tidal beach, with this material deposited in deeper water. During periods of low wave energy, this eroded material is returned to the beach, although at a slower rate. This on and offshore movement of sediment is termed cross-shore sediment transport and typically occurs in concurrently with longshore sediment transport.

# 5 Identification of Key Issues and Sources of Potential Impact

The following key issues and sources of potential impact were identified in this specialist study:

- Temporary berms or bunds. Berms of sand, rock or sand-filled geotextile bags, may be required to protect the working sites from wave action and allow dewatering. An example is shown in Figure 5.1. This is most likely to be required at the Outfall sites, and less likely for the Intake Jetty. The bunds can temporarily interrupt the natural longshore transport of sand during the construction phase;

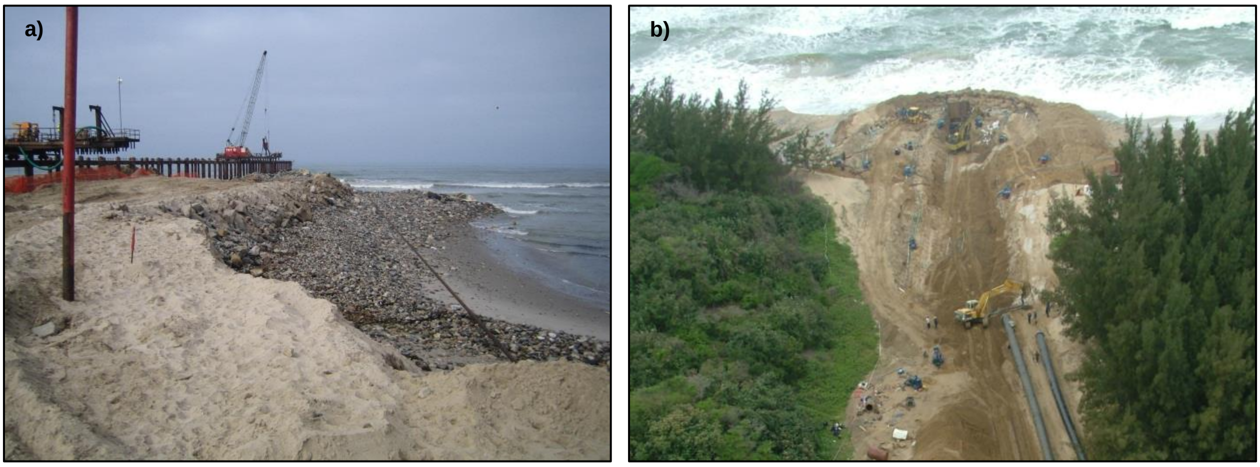


**Figure 5.1: a) Beach erosion adjacent to rock bund at Wlotzkasbaken; b) Aerial view of a temporary bund on the beach during installation of a pipeline at Richards Bay**

- Placement of rock on the beach to protect construction in the inter-tidal zone from waves. If not removed afterwards, this rock can alter the composition of the native beach material. This occurred during construction of a jetty at Coega, where rock was used and proved difficult to remove from the sandy beach afterwards;
- Excavation of the upper beach can change the natural beach profile, leading to erosion, or allowing waves to wash over the beach and flood low-lying areas;
- The piles supporting the intake jetty structure could impact the coastal dynamics, particularly the waves, currents, and sediment transport;
- The abutment, or embankment, where the intake jetty connects to the land can interfere with natural sand movement if it is located in the dynamic beach zone;
- The outfall pipeline and its concrete encasement could lead to updrift accretion of sand and downdrift erosion of the beach – see Figure 5.2. The magnitude of this effect will be determined by the height of the

structure and the distance that it extends into the surfzone. The old concrete-encased pipe at the alternative location Outfall 1 appears to have little effect on sand movement – see Figure 2.3;

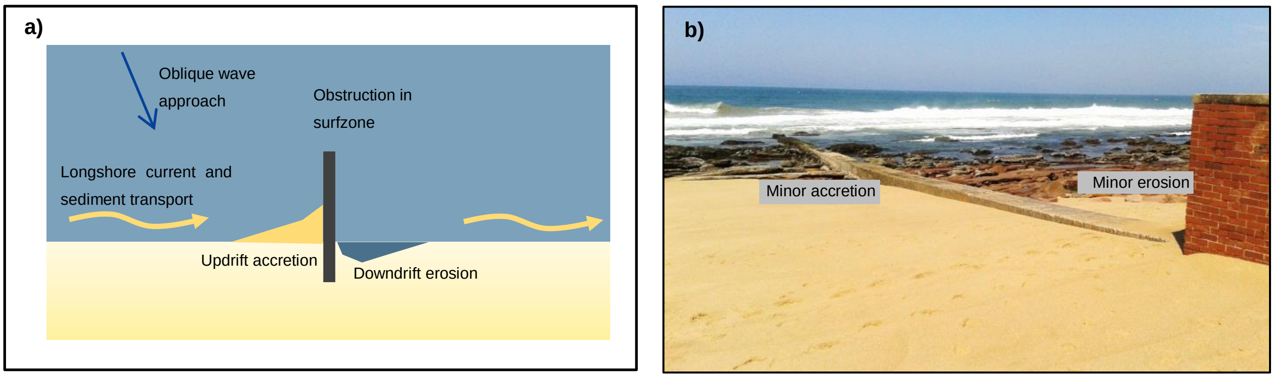


**Figure 5.2: a) Schematic map of accretion/erosion due to an obstruction such as a pipeline or bund in the surfzone; b) Example of sand accretion adjacent to a concrete encased outfall pipe in the inter-tidal zone.**

- Pipelines and infrastructure located above ground can disturb natural wind-blown sand pathways;
- High velocity brine flow exiting the outfall can cause scouring of the seabed.

In terms of the SEIA, several project alternatives have been identified for assessments. However, these relate to the on-land infrastructure (e.g. alternative site options for the desalination plant and overhead versus buried powerline) and have no bearing on the shoreline dynamics and have therefore been excluded from this specialist assessment. Similarly, the "no-go" option alternative has not been assessed in this study since not proceeding with the project would have zero impact on the shoreline dynamics at the site.

# 6 Impact Assessment

The impacts are assessed in the following tables, using the method given by SLR/Aurecon and reproduced in Appendix A. The Construction, Operation, and Decommissioning impacts are assessed separately for each the Intake Jetty, Outfall 5 and the alternative, Outfall1.

## 6.1 Construction Phase

| NATURE OF IMPACT | EXTENT | MAGNITUDE | DURATION | SIGNIFICANCE (NO MITIGATION) | PROBABILITY | CONFIDENCE | REVERSIBILITY | MITIGATION/ MANAGEMENT ACTIONS | SIGNIFICANCE AFTER MITIGATION |
|---|---|---|---|---|---|---|---|---|---|
| **CONSTRUCTION OF SEAWATER INTAKE JETTY** | | | | | | | | | |
| **Coastal processes are disrupted by temporary berms used for wave protection and dewatering** | Local (site only) | Low, berms would be relatively small, extending into only part of surfzone, and thus natural process only slightly altered | Short (construction time) | Very Low | Probable, depends on construction method | Sure | Reversible, processes naturally re-establish when berm is removed | Keep construction period short | Very Low (unchanged) |
| **Alteration of beach composition if rock is used for berms** | Local (site only) | Low, some rock is already present on the shore | Medium (Rock will remain there unless removed) | Low | Probable, depends on construction method | Sure | Reversible, processes naturally re-establish if rock is removed | Remove all rock after construction | Very Low (reduced) |

| NATURE OF IMPACT | EXTENT | MAGNITUDE | DURATION | SIGNIFICANCE (NO MITIGATION) | PROBABILITY | CONFIDENCE | REVERSIBILITY | MITIGATION/ MANAGEMENT ACTIONS | SIGNIFICANCE AFTER MITIGATION |
|---|---|---|---|---|---|---|---|---|---|
| **CONSTRUCTION OF BRINE OUTFALL AT OUTFALL 5 LOCATION** | | | | | | | | | |
| **Coastal processes are disrupted by temporary berms used for wave protection and dewatering** | Local (site only) | Low, berms would be relatively small and thus natural process only slightly altered | Short (construction time) | Very Low | Probable, depends on construction method | Sure | Reversible, processes naturally re-establish when berm is removed | Keep construction period short | Very Low (unchanged) |
| **Alteration of beach composition if rock is used for berms** | Local (site only) | Low, some rock is already present on the shore | Medium (Rock will remain there unless removed) | Low | Probable, depends on construction method | Sure | Reversible, processes naturally re-establish if rock is removed | Use native materials only, alternatively remove all rock after construction | Very Low (reduced) |
| **Flooding or beach erosion occur as a result of excavation of the beach** | Local (site only) | Medium, flooding can affect the Saltworks | Short, construction period. The natural beach profile will re-establish itself | Low | Probable | Sure | Reversible, process ceases if beach profile is restored | Natural beach profile to be restored. | Very Low (reduced) |
| **ALTERNATIVE: CONSTRUCTION OF BRINE OUTFALL AT OUTFALL 1 LOCATION** | | | | | | | | | |
| **Coastal processes are disrupted by temporary berms used for wave protection and dewatering** | Local (site only) | Low, berms would be relatively small and thus natural process only slightly altered. There is an existing structure at the site. | Short (construction time) | Very Low | Probable, depends on construction method | Sure | Reversible, processes naturally re-establish when berm is removed | Keep construction period short | Very Low (unchanged) |

| NATURE OF IMPACT | EXTENT | MAGNITUDE | DURATION | SIGNIFICANCE (NO MITIGATION) | PROBABILITY | CONFIDENCE | REVERSIBILITY | MITIGATION/ MANAGEMENT ACTIONS | SIGNIFICANCE AFTER MITIGATION |
|---|---|---|---|---|---|---|---|---|---|
| **Alteration of beach composition if rock is used for temporary berms** | Local (site only) | Low, some rock is already present on the shore | Medium (Rock will remain there unless removed) | Low | Probable, depends on construction method | Sure | Reversible, processes naturally re-establish if rock is removed | Use native materials only, alternatively remove all rock after construction | Very Low (reduced) |
| **Flooding or beach erosion occur as a result of excavation of the beach** | Local (site only) | Low, there is little that can be impacted by flooding | Short, construction period. The natural beach profile will re-establish itself | Very Low | Unlikely | Sure | Reversible, process ceases if beach profile is restored | Natural beach profile to be restores. | Very Low (unchanged) |

## 6.2 Operation Phase

| NATURE OF IMPACT | EXTENT | MAGNITUDE | DURATION | SIGNIFICANCE (NO MITIGATION) | PROBABILITY | CONFIDENCE | REVERSIBILITY | MITIGATION/ MANAGEMENT ACTIONS | SIGNIFICANCE AFTER MITIGATION |
|---|---|---|---|---|---|---|---|---|---|
| **OPERATION OF SEAWATER INTAKE JETTY** | | | | | | | | | |
| **The coastal processes (waves, currents, sediment transport) are affected by the jetty structure** | Local (site only) | Very Low, the piles present only small obstructions to the coastal processes | Long Term, life of jetty | Low | Definite | Certain | Reversible, if jetty is removed | None | Low (unchanged) |
| **Natural sand movement is impacted by the jetty abutment to shore** | Local (site only) | Low, the abutment would be small compared to the width of the surfzone | Long Term, life of jetty | Medium | Definite | Certain | Reversible, if jetty is removed | Locate abutment above high water mark to avoid impacting sand movement | Neutral (reduced) |
| **Wind-blown sand pathways are impacted by the intake structure and pipelines** | Local (site only) | Low, wind-blown sand pathways are absent or indistinct | Long Term, life of jetty | Low | Probable | Uncertain | Reversible, if infrastructure is removed | Reduce height of pipelines and infrastructure above ground | Very Low (reduced) |

| NATURE OF IMPACT | EXTENT | MAGNITUDE | DURATION | SIGNIFICANCE (NO MITIGATION) | PROBABILITY | CONFIDENCE | REVERSIBILITY | MITIGATION/ MANAGEMENT ACTIONS | SIGNIFICANCE AFTER MITIGATION |
|---|---|---|---|---|---|---|---|---|---|
| **OPERATION OF BRINE OUTFALL AT OUTFALL 5 LOCATION** | | | | | | | | | |
| **The outfall pipeline and its concrete encasement cause updrift accretion and downdrift erosion of the beach** | Local (site only) | Low, the pipeline encasement forms only a small obstacle to longshore transport (1m high and terminates close to shore) | Long Term, life of desalination plant | Low | Definite | Sure | Reversible, processes naturally re-establish when pipeline is removed | Reduce height of pipeline encasement. Considered trenching into rock to below natural beach level. | Low (unchanged, encasement design is already low) |
| **Wind-blown sand pathways on the upper beach are impacted by the brine outfall pipeline** | Local (site only) | Zero, the design indicates that pipelines will be buried | Long Term, life of desalination plant | Neutral | Probable | Sure | Reversible, processes naturally re-establish when pipeline is removed | Pipelines to be buried | Neutral (unchanged) |
| **The high velocity flow from the outfall causes scouring of the sandy seabed.** | Local (site only) | Low, the existing seabed is partly rocky with thin sand cover | Long Term, life of desalination plant | Low | Definite | Sure | Reversible, processes naturally re-establish when flow stops | None (high velocities must be maintained for good brine dilution) | Low (unchanged) |

| NATURE OF IMPACT | EXTENT | MAGNITUDE | DURATION | SIGNIFICANCE (NO MITIGATION) | PROBABILITY | CONFIDENCE | REVERSIBILITY | MITIGATION/ MANAGEMENT ACTIONS | SIGNIFICANCE AFTER MITIGATION |
|---|---|---|---|---|---|---|---|---|---|
| **ALTERNATIVE: OPERATION OF BRINE OUTFALL AT OUTFALL 1 LOCATION** | | | | | | | | | |
| **The outfall pipeline and its concrete encasement cause updrift accretion and downdrift erosion of the beach** | Local (site only) | Low, the pipeline encasement forms only a small obstacle to longshore transport (1m high and terminates close to shore). There is an existing structure at the site, which causes low impact on sediment movement | Long Term, life of desalination plant | Low | Definite | Sure | Reversible, processes naturally re-establish when pipeline is removed | Reduce height of pipeline encasement | Low (unchanged, encasement design is already low) |
| **Wind-blown sand pathways on the upper beach are impacted by the brine pipeline.** | Local (site only) | Zero, the design indicates that pipelines will be buried | Long Term, life of desalination plant | Neutral | Probable | Sure | Reversible, processes naturally re-establish when pipeline is removed | Pipelines to be buried | Neutral (unchanged) |
| **The high velocity flow from the outfall causes scouring of the sandy seabed.** | Local (site only) | Low, the existing seabed is partly rocky | Long Term, life of desalination plant | Low | Definite | Sure | Reversible, processes naturally re-establish when outfall is removed | None (high velocities must be maintained for good brine dilution) | Low (unchanged) |

## 6.3 Decommissioning

No additional impacts have been identified that would occur as a result of decommissioning of either the Intake Jetty, the brine outfall at Outfall 5 nor at the alternative location Outfall 1. It is foreseen that decommissioning would include the removal of the intake jetty and the brine outfall pipeline. Impacts to shoreline dynamics would be comparable with those experienced during the construction phase, although they will be of a lesser magnitude. The same mitigations proposed for the management of construction related impacts should therefore be implemented during any decommissioning activity.

## 6.4 Cumulative Impacts

The impacts of the intake and outfall structures are limited to the immediate site. This, together with the generally low nature of the impacts, would result in a negligible effect on the regional beach and shoreline dynamics. Developments further south in Swakopmund, such as at Vineta, are likely to be the major driver of any cumulative impacts on shoreline dynamics in the region.

# 7 Conclusions and Recommendations

Of the potential impacts that have been identified, the only one that is of **medium** significance is the potential for the seawater intake jetty abutment to disrupt natural longshore movement of sediment. The recommended **mitigation** measure is to locate the abutment landward of the high-water mark and out of the active beach zone. This reduces the significance to **neutral**.

The outfall pipeline could have a similar impact – resulting in updrift accretion and downdrift erosion of the beach – however the design information indicates that the pipeline will be located on the bedrock and its concrete encasement is only 1m high. Its impact significance is therefore considered to be **low**. Mitigation to reduce its impact further is not possible, except if a trench were excavated into the rock and the pipeline placed inside. However, this construction method typically requires blasting, which is undesirable as it creates a new set of potential impacts.

All other construction and operation phase impacts on coastal processes and shoreline dynamics were rated as either low, very low, or neutral.

The impacts of the preferred brine outfall location, Outfall 5, are very similar to that of the alternative location, Outfall 1.

Recommended monitoring measures are the following:

- During construction:
  1. All temporary berms used for wave protection or dewatering are to be removed. In particular, any rock material that is imported to site must be removed after construction is complete. As an alternative to rock, sand-filled geotextile bags can be used for berm construction. The geotextile bags should be designed for this purpose and must be retrieved and removed after construction is completed.
  2. Excavations on the beach profile, such as for pipeline installation, are to be backfilled after construction is complete.
- General:
  1. The beach topography should be surveyed updrift and downdrift of the intake and outfall location before construction commences, immediately after construction is complete, and after 1 year of operation, in order to confirm that the structures have had low impact on accretion or erosion of the beach.

# References

CSIR, 2009. Environmental Impact Assessment for the Proposed Desalination Project at Mile 6 Near Swakopmund, Namibia, Draft EIR Report. CSIR Report N0. CSIR/CAS/EMS/ER/2009/0015/A, Stellenbosch.

Sanho, 2013. Tide Tables, South African Hydrographic Office.

WSP Group Africa (Pty) Ltd
Stein House
Brandwacht Office Park, Trumali Street
Stellenbosch
7600
South Africa
Tel: +27 21 883 9260
Fax: +27 21 883 3212
www.wspgroup.co.za

UNITED BY OUR DIFFERENCE

WSP