Walvis Bay Salt Holdings (Pty) Ltd

Amended Environmental Management Plan for Walvis Bay Salt Holdings (Pty) Ltd

November 2024

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ENVIRONMENTAL MANAGEMENT PLAN FOR WALVIS BAY SALT HOLDINGS (PTY) LTD

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*(**Note**: The approved (2021) EMP has been amended as part of the* Environmental Clearance Certificate (*ECC) renewal application. All changes from the previously approved EMP are highlighted in grey in this document. Key commitments that were changed from the previous (approved) EMP, were motivated by relevant Specialists and memos prepared accordingly, which are attached as Appendices A to C.Also, certain commitments were moved to more appropriate sections in the document, also highlighted).*

1 INTRODUCTION TO THE PROJECT

The salt field operation (Salt Works) at Walvis Bay was established in 1964 and is one of the largest solar evaporation facilities in Africa, currently processing approximately 100 million tons of seawater to produce approximately 1,000,000 *metric* tons of high-quality crude salt per annum. Walvis Bay is situated on the western coast of Africa midway between the northern and southern borders of Namibia.

The Salt Works presently consists of three operating companies, namely Salt and Chemicals (Pty) Ltd, which is the mining operation; Walvis Bay Salt Refiners (Pty) Ltd; and Ekango Salt Refiners (Pty) Ltd, both manufacturing operations, which are all subsidiary companies of Walvis Bay Salt Holdings (Pty) Ltd (WBSH). WBSH is again a subsidiary company of BUD Chemicals and Minerals. In short, Salt & Chemicals produces the raw salt whilst Walvis Bay Salt Refiners further processes and markets the salt. Ekango Salt produces refined table salt.

Salt and Chemicals (Pty) Ltd utilises approximately 5 000 hectares for the production of crude coarse salt through solar evaporation and fractional crystallisation. Walvis Bay Salt Refiners processes the crude salt for export to markets in Southern and West Africa. It is used by the chlor-alkali industry for the production of chlorine and caustic soda, other industrial uses such as pool salt, oil drilling, washing powder additive and others, by the agricultural sector as a feed supplement as well as a feedstock and for refined table salt for human consumption.

After the re-integration of Walvis Bay into Namibia the Salt Works applied for and was granted the current mining licence (ML 37) in January 1998 and environmental clearance was obtained in November of the same year (following the issuance of the ML). Figure 1-1 indicates the extent of the ML-37 superimposed over a Google Earth Image of the area. Subsequent to the mining license and in accordance with the Minerals (Prospecting and Mining) Act (Act No. 33 of 1992) (Mining Act), Salt & Chemicals (Pty) Ltd also entered into an environmental contract with the Government of Namibia, duly represented by the Ministry of Mines and Energy (MME) and the Ministry of Environment and Tourism: Directorate of Environmental Affairs (MET: DEA) (now Ministry of Environment, Forestry and Tourism (MEFT)). In 2009, an Environmental Clearance was granted for the development of the refined salt plant (the above-mentioned

Ekango Project). In 2010, WBSH applied for environmental clearance for various additional activities (sewage pipeline, underground electrical cable and water pipeline) via a process outlined in the Environmental Management Act (Act No. 7 of 2007) (EMA) regulations that were in their draft form at the time. WBSH also took the opportunity to develop a holistic Environmental Management Plan (EMP) covering all of the existing activities at the time. This application and EMP were approved by the MET: DEA in 2011.

FIGURE 1-1: MINING LICENSE 37
(Image source: Google Earth)

When the Environmental Management Act was enacted on 6 January 2012, WBSH re-submitted the EMP as part of a clearance renewal application. The MET: DEA approved the existing operations in early 2013. WBSH then proposed to increase their production from 750 000 tons to roughly 1 000 000 metric tons of salt per annum. This required an additional 1 500 ha of land within ML 37 to be converted to salt generation facilities (the project details are provided in Section 2). The EIA amendment application including the EIA

Amendment Report (SLR, 2014a) and Amended EMP (SLR, 2014b) relating to these project changes were approved in December 2018 when MEFT (DEA) issued an Environmental Clearance Certificate (ECC) that was valid until December 2021. An ECC renewal Application and associated / support documents (with an Amended (2021) EMP) was submitted to MEFT (DEA) and approved in January 2022 when they issued a new (i.e. current) ECC.

As the current ECC will therefore expire in January 2025, WBSH is now applying for the next ECC renewal with further amendments to the 2021 EMP to allow the ongoing operations of the salt works and associated activities.

1.1 KEEPING EMPS CURRENT

Section 50 (g) of the Minerals (Mining and Prospecting) Act, 33 of 1992 states that the holder of a mining license shall undertake a periodic review of the EMP(s) should circumstances change. Should a listed activity as defined in the Environmental Impact Assessment Regulations: Environmental Management Act (EMA), 2007 be triggered as a result of future modifications/changes, this EMP will have to be updated through another EIA process as stipulated in the EMA and its Regulations. Furthermore, proposed amendments to the approved activities and facilities need to be re-assessed and the EMP amended, as and where required. This EMP has been updated (amendments) by WBSH assisted by Namisun Environmental Projects and Development and input from relevant (key) specialists. The motivation for the amendments are somatised in Appendices A to C.

1.2 DETAILS OF THE COMPANY WHO PREPARED THIS EMP

SLR Environmental Consulting (Namibia) (Pty) Ltd, who conducted the EIA (amendment) process and compiled the EIA Amendment report (SLR, 2014a) for the Walvis Bay Salt Works (WBSW), with input from various specialists (refer to SLR, 2014a) also compiled the original (approved) EMP in 2014 (SLR, 2014b). Amendments to the EMP were incorporated by Namisun as part of the ECC renewal Application processes[1]. These amendments were supported by input from the following specialists:

- Water specialist (Sandra Muller)
- Marine Ecologist (Pisces – Andrea Pulfrich)
- Terrestrial biodiversity – also considering all monitoring requirements linking with biodiversity (EnviroScience – Antje Burke).

[1] Note: Namisun assumes that the original assessments (i.e. EIAs) were accurately conducted and did not re-assess the impacts associated with the WBSW activities. Therefore, the commitments from the original EMP still (largely) form the basis of this document, with some changes made, to keep the EMP current, move commitments to more appropriate sections in the document, consider previous audit findings and incorporate input from the relevant specialists, etc.

2 BRIEF DESCRIPTION OF THE WALVIS BAY SALT WORKS

The detailed description of the (approved) activities and facilities, as assessed during the EIA Amendment process and documented in the EIA Amendment report (SLR, 2014a), is not repeated in this (Amended) EMP.

Below is a brief summary of the various activities undertaken at the WBSW (i.e. within ML 37) as well as the activities associated with the export of the final product (i.e. refined salt) through the Walvis Bay Port.

WBSH currently produce approximately 1 Mmt of high quality NaCl from seawater per annum that is distributed to various clients locally and exported to other markets. The total project site, including evaporation ponds, covers an area of ~ 5 000 ha.

Salt is transported by truck from the plant to the harbour via Kovambo Nujoma Avenue and 5th Road in Walvis Bay. The truck fleet has a payload of 50 tons on average. WBSH currently employs 121 permanent workers, all being locals (i.e. Namibians) and 40 fixed term contractors.

The various facilities / infrastructure on ML 37, which relate to the WBSW, are indicated in Figure 2-1. The associated (brief) descriptions of the activities at WBSW is summarised in the sections below.

2.1 SEAWATER INTAKE

With reference to section 1, WBSH process approximately 100 million tons of seawater per annum. The seawater is pumped via a pipeline to the first evaporator ponds. There is also a second intake point at the Evaporator 1 electrical kiosk.

2.2 PRE-EVAPORATION

Seawater contains ~3.5% solution of a mixture of various salts, with Sodium Chloride (NaCl) accounting for about 2.7% of seawater's salinity. The process involves the pumping of seawater from the lagoon at a rate of 280m³ per minute into a series of evaporating ponds with progressively decreasing surface areas. During this stage the salinity of the sea increases to ~15%.

2.3 CONCENTRATION

The brine concentration increases to approx. 24% salinity. A wide range of impurities including gypsum ($CaSO_4.2H_2O$) precipitates and settles on the pond floors.

2.4 CRYSTALLIZATION

The concentrated brine, with a salinity greater than 25%, is pumped into the crystallization ponds. NaCl (Sodium Chloride) crystallizes on the pond floors. Just before harvesting, the remaining brine now called

"bitterns" is pumped away. The bittern contains various unwanted chemical impurities which reduce the quality of the harvested salt.

2.5 BITTERNS DISCHARGE

The bitterns discharge comprises a network of canals and/or pipelines that deposit the bitterns in the ocean at Paaltjies.

2.6 HARVESTING

When ready, a harvesting machine operated with a GPS system, removes the layer of salt which is 150 – 180mm thick.

2.7 SALT WASHING (PROCESSING)

The harvest is upgraded through a washing process to remove impurities such as calcium, magnesium and insolubles to meet a wide range of client's specifications. Through a process of centrifugation excess moisture and the remains of the chemical impurities adhering to the salt crystals are removed. This results in a final salt product, with purity levels of more than 99.2%.

2.8 DISTRIBUTION AND MARKETING

Product is either bagged in various pack sizes or shipped in bulk through the company's loading plant in the port of Walvis Bay to various markets internationally. Salt is used in the chemical industry to produce chlorine and caustic soda, which in turn are needed to produce synthetic products including plastics.

2.9 TABLE SALT REFEINERY

Table salt is produced according to various customer standards for the retail market at the Ekango Refinery. This product is also exported to neighbouring countries for human consumption.

FIGURE 2-1: CURRENT LAYOUT OF SALT WORKS

3 OVERALL ENVIRONMENTAL OBJECTIVES FOR THE EMP

The following overall environmental objectives have been set for WBSH:

- To comply with national legislation and standards for the protection of the environment.
- To comply with corporate sustainable development policies and objectives.
- To limit potential impacts on biodiversity through the minimisation of the footprint and the conservation of the surrounding environment.
- To limit contaminated effluent discharge into the environment
- To protect soils and groundwater resources through the implementation of measures for spill prevention and clean-up.
- To ensure the legal and appropriate management and disposal of general and hazardous waste, through the implementation of a strategy for the minimisation, recycling, management, temporary storage and removal of waste.
- To minimise the potential for noise and vibration disturbance in surrounding areas.
- To develop, implement and manage monitoring systems to ensure good environmental performance in respect of the following: ground and surface water, air quality, noise, biodiversity and rehabilitation.
- To ensure the health and safety of surrounding communities.
- To support and encourage environmental awareness and responsibility amongst all employees and service providers.
- To provide appropriate environmental education and training for all employees and service providers.
- Prevent and minimise pollution.
- Ensure compliance to the EMP.

4 ENVIRONMENTAL MANAGEMENT PLAN

The management measures proposed to mitigate the potential negative impacts and enhance positive impacts identified in the original (approved) EIA are detailed in the action plans below. Environmental aspects associated with the Salt Works are listed below:

- Visual (Action plan 4.1.1)
- Air quality (Action plan 4.1.2)
- Biodiversity including avifauna and marine ecology (Action plan 4.1.3)
- Soil, land capability, land use and topography (Action plan 4.1.4)
- Noise (Action plan 4.1.5)
- Surface water (Action plan 4.1.6)
- Groundwater (Action plan 4.1.7)
- Socio-economic (Action plan 4.1.8)

It is expected that the potential impacts associated with the above aspects would mainly occur during the operation and decommissioning phases.

4.1 ACTION PLANS TO ACHIEVE OBJECTIVES

Action plans to achieve the objectives identified above are listed in tabular format, separated according to project phases and activities. The action plans also include the frequency of implementing the mitigation measures and identify the responsible parties.

4.1.1 ACTION PLAN: VISUAL

Objective: To limit the negative visual impact on the surrounding landscape.

Operational phase

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Seawater intake	Deterioration of sea water abstraction infrastructure could have a negative visual impact	• Implement a monitoring and maintenance programme for this infrastructure. • The environmental monitoring programme must include the monitoring of visual conditions.	Ongoing	Maintenance Manager
Ponds	Visual impact of the ponds	• Keep the ponds in order to maintain the current visual "status quo".	Ongoing	Operations Manager
Bitterns discharge	Negative visual impact of pipelines and discharge points	• Monitor discharge points – weekly updates. • Carry out on-going maintenance to maintain the visual integrity of the discharge points.	Weekly	Operations Manager
Operation and maintenance of salt production facilities	Visual impact of washing and heaping operations, salt bagging plant and refinery	• Implement a monitoring and maintenance programme for this infrastructure to ensure that the site always looks neat and tidy. • The environmental monitoring programme must include the monitoring of visual conditions. • Avoid reflective surfaces. • Paint with neutral colours.	Ongoing and during maintenance	Operations Manager / Maintenance Manager
Stockpiling of refined salt	Stockpiles of refined salt	• None possible.	N/A	N/A
Beach Erosion	Managing shoreline erosion and sea level rise	• Monitor vehicle traffic along the beach opposite the ML (see Section 5.5 for further details)	Ongoing	Operations Manager in consultation with other Key Stakeholders (see Section 5.5)
		• Commission a coastal erosion study to ascertain the rate of shoreline erosion	Once-off	Operations Manager
		• Set up communications channels with Namport and the WVB Municipality to consider collaborative initiatives to address possible beach nourishment along the shoreline of the salt works and Pelican Point Peninsula to ensure the safety of the town, port and WBSH under the threats of sea level rise	Ongoing	Operations Manager

Decommissioning phase

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Removal of ponds and surface infrastructure	Visual impact due to removal of dams leaves a bare "scar" on the landscape	• Landscaping will remove the visual incongruity and, where possible, restore the natural aesthetics of the area by mimicking the natural topography. • Natural vegetation establishment (self-propagation) will be encouraged.	Decommissioning and closure planning	Operations Manager / External Consultant

4.1.2 ACTION PLAN: AIR QUALITY

Objective: To reduce air pollutant generation during operation.

Operational phase

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Operation and maintenance of diesel generators	Generators release air pollutants and smoke that have negative impacts on air quality	• Maintenance and monitoring programme for the (backup) diesel generators and HFO burner shall be established. • Air quality will be monitored in accordance with Section 5.	Ongoing	Maintenance Manager
Burning of Heavy Fuel Oil (HFO) to produce heat for drying	The burning of 2300l per day of HFO will produce air pollution			
Transport (use of vehicles)	Emission of greenhouse gases and particulates from vehicles contributes to air pollution	• Fuel consumption will be monitored to reduce it as far as possible (including driver training) and vehicles will be serviced regularly according to a maintenance programme. • Air quality will be monitored in accordance with Section 5.	Ongoing	Operations Manager / Environmental Coordinator

Decommissioning phase: No impacts expected

4.1.3 ACTION PLAN: BIODIVERSITY

Objective: To limit the disturbance of biodiversity during operation and decommissioning.

Operational phase

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Seawater intake	Marine fauna can be caught up with the seawater at the intake	• Install and maintain a screening and/or filtering mechanism (a screen is in place to hold back large fish; small fish pass through and feed a population of seals and birds at the outlet of the intake pipe).	Construction, ongoing	Operations Manager / External Consultant
	Impacts on bay and lagoon hydrodynamics caused through excessive abstraction	• Abstraction volumes may not exceed abstraction licence limits. • All conditions outlined in the abstraction licence will be followed.	Ongoing	Operations Manager
Operation and maintenance of diesel generators and diesel storage tanks	Diesel spills from generators or tanks may contaminate the lagoon surface water and associated marine ecology	• Refer to Table 7.1	Ongoing	Operations Manager / Maintenance Manager
Ponds	~~Seepage of concentrated brine into land alongside the ponds could impact the local flora~~	~~• Visually monitor the surrounding (limited) vegetation and report results in monthly environmental reports.~~ ~~• Recommendation: Though the risk of seepage is managed by engineered containment of ponds, the pond walls must be monitored and maintained continually as the loss of concentrated brine would impact the salt production.~~	~~Design phase, construction and ongoing~~	~~Operations Manager /External Consultant~~
	Impacts on plant diversity (hummocks)	~~The monitoring of the plant health must be carried out periodically by a qualified botanist. The floral health on the hummocks must be monitored on an annual basis and reported on in the annual report submitted to the MEFT.~~ ~~A hummock monitoring plan has been developed and has been included in the EMP.~~ Combine the plant health and hummock health monitoring and revise the associated monitoring plan (which was previously included as Annex B of the EMP) in consultation with a Botanist and implement accordingly. This must become an operational Procedure of WBSH. The monitoring of the plant health and floral health on the hummocks must be carried out periodically by a qualified botanist.	Once off Periodically (to be included in the procedure)	Operations Manager / External Consultant

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Bitterns discharge	Smothering of fauna at site of bittern discharge	• The sand that is removed from the pipe outlet channel should be ~~removed and~~ used for the dike walls of the ponds nearby. • ~~Survey the extent of the mound so that it stays within the existing area.~~	Ongoing	Operations Manager
	~~Loss of intertidal fauna and flora at site of bittern discharge points~~	• ~~Developing a groundwater monitoring network in accordance with the recommendations of the Marine Ecology Study (8 monitoring sites to the east of the discharge point, 4 to the north and 4 to the south – all at 25m intervals). Annual surveys will be required as a minimum.~~ • ~~A reference survey of the macrofauna and meiofauna prior to the pumping of the bittern volumes would provide a picture of the current faunal community structures according to spatial distribution, abundance and biomass.~~	~~Immediate and ongoing~~	~~Operations Manager / External Consultant~~
	Bitterns spill or seep from holding ponds into the southern end of the lagoon	• Regular inspections of the dyke walls to ensure that their integrity is maintained. • Ensure that bitterns are regularly pumped out of these ponds to prevent overflow. • Monitor volumes of bitterns discharged.	Ongoing	Operations Manager
	Legal compliance	• Obtain an effluent discharge licence and comply with all its conditions, specifically ensure that the bitterns discharged meet the conditions outlined in the licence.	Ongoing	Operations Manager
Kuiseb River flow obstruction	Impact on avifauna habitat	• Monitor the siltation effect of added development in the Kuiseb River Delta area on the lagoon. • Ensure that the new ponds on the eastern periphery – i.e. towards the Kuiseb River Delta area – do not impede the occasional flow.	Ongoing	Operations Manager
Transport (use of vehicles)	Vehicles travelling too fast may harm local fauna	• Drivers will receive induction and awareness training informing them of the rules related to travelling in designated areas and the importance of conserving the local fauna and flora. • Speed limits will be maintained. Speed limit signs will be visible and legible on site. • WBSH vehicular movements on site will be controlled to the haul roads, as far as possible.	Ongoing	Operations Manager
Staff on site	Increased harvesting of local fauna and flora	• The poaching and hunting of animals will be strictly forbidden. • Workers' movement will be restricted to operational areas. • All employees will be educated on the procedures to follow and the environmental restrictions regarding all environmental parameters. This will form part of the environmental awareness plan (Section 5 of the EMP). • ~~Penalties will be imposed on all staff that unnecessarily damage any environmental parameters.~~ • Unnecessary damage to any environmental parameters will be investigated by WBSH Management Team and the relevant actions taken (i.e. warnings, consequence management, etc.).	Ongoing	Operations Manager

Decommissioning phase

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Removal of ponds	Removal of the salt ponds would cause a significant loss of avifauna habitat	• The proposed closure plan must address this issue, including the possibility of not removing the ponds. • Regular (minimum every 5 years) updates of the Mine Closure Plan (aligned with the requirements of the Namibian Mine Closure Framework). (Note that the Walvis Bay lagoon including the salt works is a designated Ramsar site (a wetland of international importance to resident and migrating birds)).	During closure planning	Operations Manager

4.1.4 ACTION PLAN: SOIL, LAND CAPABILITY, LAND-USE AND TOPOGRAPHY

Objective: To limit the negative impacts on soil and land capability during all project phases, and to restore the original land-use potential and topography as far as possible after closure.

Operational phase

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Operation and maintenance of vehicles, machinery, plant and fuel storage tanks (incl. HFO)	Hydrocarbon spills or leaks from vehicles and machinery can contaminate soils	• Refer to Table 7.1 for management measures relating to hydrocarbon spills. • Refer to Action tables 4.2 to 4.4 in Section 4.2 for details on hydrocarbon storage, handling and disposal.	Ongoing	Maintenance Manager
Storage and transport of bitterns	Soil contamination by seepage of bitterns into subsoil	• A monitoring and maintenance programme must be established ~~to~~ for the bittern storage and transport infrastructure. • Visual inspections will be used to determine whether spillages have occurred.	Ongoing	Operations Manager / Maintenance Manager
Operation and maintenance of salt bagging facility, refinery and loading plant	Generation of domestic waste, which may impact the local land capability	• A detailed waste management strategy has been established and implemented (refer to Section 4.2).	Ongoing	Environmental Coordinator / Operations Manager

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Hydrocarbon and other hazardous chemical substance storage, use and disposal	Potential soil pollution from leakages	• Refer to the action tables 4.2 to 4.4 in Section 4.2 for details on hydrocarbon storage, handling and disposal.	Ongoing	Environmental Coordinator / Operations Manager
Washing of vehicles	Contaminants removed during the washing process may result in soil contamination	• A vehicle wash-bay will be constructed with a settlement pond and hydrocarbon separator. This wash-bay will be capable of handling a minimum of 30 m^3 per month. • The washing of vehicles will only be permitted within the above-mentioned wash-bay. • The discharge from the settlement pond and hydrocarbon separator ~~will be piped into the sewerage pipeline~~ goes back into the system through the bitterns discharge pipes. • Hydrocarbons will be removed and disposed of as hazardous waste (refer to Section 3-2). • Effluents from the wash-bay settlement pond and hydrocarbon separator will be piped into the sewage pipeline, they may not be discharged into the environment. • Contractors will not be permitted to wash their vehicles on site. • Monitor the wash-bay water use and discharge to ensure no losses from the system. Losses would indicate leakages, which could result in soil or water contamination.	Ongoing	Environmental Coordinator / Operations Manager
Scheduled and unscheduled maintenance of equipment and/or vehicles; General maintenance and housekeeping	Potential hydrocarbon contamination of soils from vehicle and/or machinery spills/leaks.	• The handling, storage and disposal of hazardous chemical substances shall be in accordance with Section 4.2 of the EMP.	Ongoing	Operations Manager / Maintenance Manager
Excavation of sand for earthworks on roads	The uncontrolled excavation of sand impacts land capability on site	• Excavations may only take place in a designated area within the operations boundaries and with prior consent of the Quality and Environmental Management Coordinator. • Excavations will only be permitted within a designated area within the operations boundaries and access by members of the public must be restricted. • All slopes will be maintained at a minimum angle of 18° when the removal of sand has been completed. • Landscape and rehabilitate excavations upon completion of the excavations. • Warning signs must be erected and maintained to control access by members of the public. • Environmental method statements and risk assessments must be compiled for all sand excavations.	When required	Operations Manager / External Consultant
Staff on site	Workers may directly impact soils through improper waste disposal and not using sanitation facilities	• A waste management strategy will be established and implemented (refer to Section 4.2). • A sufficient number of waste bins and toilets will be placed on site. • Workers/visitors will be restricted to operational areas. • All employees will be educated on the procedures to follow and the environmental restrictions regarding all environmental parameters. This will form part of the environmental awareness plan (Section 6 of the EMP). • ~~Penalties will be imposed on all staff that unnecessarily damage any environmental parameters.~~	Ongoing	Environmental Coordinator / External Consultant

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Operation and maintenance of the sewerage facilities and pipeline	Release of inadequately treated sewage may result in soil contamination	~~• There shall be an incident management system, including procedures and training, for dealing with incidents as prescribed within the Emergency Procedures and Response programme.~~ ~~• The incident management programme will address sewage spills.~~ • Refer to Section 7 of the EMP for the Emergency Response Procedures in case of sewage spills. • Major spillage incidents will be reported to the Department of Environmental Affairs, the Department of Water Affairs, the Ministry of Mines and Energy and the Walvis Bay Municipality. Appropriate remedial measures shall be implemented in consultation with these regulatory authorities. • In the event that spills occur and soils become contaminated, the appropriate remedial measures will be identified in consultation with an appropriately qualified specialist. If necessary, the polluted soils will be classified as waste and will be discarded at an appropriate permitted waste site. After removal of the contaminated soils, the affected areas will be landscaped and rehabilitated. • The sewage works are monitored on a weekly basis.	Weekly monitoring	Environmental Coordinator / Operations Manager / Maintenance Manager
Operation and maintenance of water pipeline Washing of salt with concentrated seawater	Safety risks due to sinkholes being formed when fresh water dissolves salt in highly saline soils	• The plant may not utilise freshwater to wash the salt because fresh water could create sinkholes. However, the washing of vehicles and machinery requires fresh water. This water use must be monitored and recorded. • Reduce the risk of sinkholes developing when fresh water dissolves the high salt content in the substrate around the plant by: 1) Not directly discharging any fresh water into the local environment, and 2) Frequent visual inspections to identify signs of freshwater leakages.	Ongoing	Operations Manager / Maintenance Manager

Decommissioning phase

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Removal of generators and fuel storage tanks	Hydrocarbon contamination of soils from spills during removal	• A detailed waste management strategy will be established and implemented (refer to Section 4.2 of the EMP). • Refer to Action tables 4.2-4.4 on hydrocarbon management.	Closure	Environmental Coordinator / Operations Manager / External Consultant
Removal of ponds	Positive topographical alterations	• The area from which the ponds are removed will be ripped and shaped to follow the natural contours as far as practically possible.	Closure	Operations Manager / External Consultant

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
	Habitat destruction in part of the Walvis Bay Ramsar site	• Regular (minimum every 5 years) updates of the Mine Closure Plan (aligned with the requirements of the Namibian Mine Closure Framework). • As part of closure planning, commission an avifauna specialist study to assess the impact of removing this important bird area.	Closure	External Consultant
Removal of infrastructure	Removal of infrastructure will produce waste which may lead to land contamination	• A detailed waste management strategy will be established and implemented (refer to Section 4.2 of the EMP).	Closure	Operations Manager
Removal of sewage facility and pipes	Sewage spills during the removal of the sewage infrastructure may result in soil contamination	~~• There shall be an incident management system, including procedures and training, for dealing with incidents as prescribed within the Emergency Procedures and Response programme.~~ ~~• The incident management programme will address sewerage spills.~~ ~~• Major spillage (>200 50 litres) incidents will be reported to the Department of Environmental Affairs, the Department of Water Affairs, the Ministry of Mines and Energy and the Walvis Bay Municipality. Appropriate remedial measures shall be implemented in consultation with these regulatory authorities.~~ ~~• In the event that spills occur and soils become contaminated, the appropriate remedial measures will be identified in consultation with an appropriately qualified specialist. If necessary, the polluted soils will be classified as waste and will be discarded at an appropriate permitted waste site. After removal of the contaminated soils, the affected areas will be landscaped and rehabilitated.~~ • Refer to Section 7 of the EMP for the Emergency Response Procedures in case of sewage spills.	Closure	Operations Manager / External Consultant /Environmental Coordinator

4.1.5 ACTION PLAN: NOISE

Objective: To minimise noise pollution during all phases of the operation.

Operational phase

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Operation and maintenance of diesel generators	Noise from generators may pose a nuisance to local fauna (limited impact on people as access to this area is limited)	• A maintenance and monitoring programme for the (backup) generator shall be established.	Installation and ongoing	Operations Manager / Maintenance Manager
Operation and maintenance of the refinery	The refining process generates noise	• Noise management and monitoring must take place in accordance with Section 5.	Ongoing	Ekango Plant Manager / Maintenance Manager
Transport (use of vehicles)	Improperly operated or maintained vehicles may produce excessive noise	• Vehicles shall be equipped with the necessary measures to minimise the emission of noise. • Operational noise levels from the bulk transport vehicles (excluding bagged salt / refined salt) may not exceed an average of 87.8 dB at 1.5 m from the source of the noise (average of 10 vehicles). • Not less than an average of 130 trips per day will be permitted (excluding bagged salt / refined salt). • A maximum of 160 trips will be permitted per day. • ~~A noise assessment of the proposed bulk haulage fleet (excluding bagged salt / refined salt) must be carried out by a suitably qualified noise specialist prior to the implementation of the expansion project. Average noise levels from the bulk salt transporting trucks exceeding those described above will not be permitted.~~ • Vehicles travelling at higher speeds generate higher noise levels. Satellite tracking will be installed in all vehicles, thereby preventing excessive speeds and minimising noise generation. • Vehicles will be well maintained to avoid noise generated by equipment in poor repair. • ~~Transporting vehicles shall be serviced regularly and shall be kept in good working order.~~ • Contractors must provide maintenance records upon request of WBSH. • Vehicles transporting salt to the harbour will be restricted to working hours (7:00AM – 6:00PM) on weekdays.	~~New vehicles will for bulk salt transport will be available prior to expansion operations (excluding bagged salt / refined salt)~~ Ongoing speed control and maintenance	Operations Manager / Business Dev. Manager

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
		• Audits on the noise generated by the transport vehicles will be carried out by an external specialist when complaints are received from I&APs or at least every three years. Should an average increase of over 4dBa be observed, steps must be taken to reduce noise levels. Audit results will be made available to the relevant I&APs upon request and be included in annual reports to MEFT. • Noise management and monitoring must take place in accordance with Section 5.		

4.1.6 ACTION PLAN: SURFACE WATER

Objective: To limit the impacts on surface water resources.

Operational phase

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Operation of combustion machinery and fuel storage tanks	Potential hydrocarbon contamination of surface water runoff from spills	• Refer to the action tables 4.2 to 4.4 in Section 4.2 for details on hydrocarbon storage, handling and disposal. • ~~section 4.1.3 for management measures relating to hydrocarbon spills.~~	Ongoing	Operations Manager / Maintenance Manager
Refined salt stockpile	Potential contamination of surface water runoff	• Stormwater management is implemented on site. • Stormwater management infrastructure is maintained.	Ongoing	Operations Manager
Operation and maintenance of the loading plant Scheduled and unscheduled maintenance of equipment and vehicles General plant maintenance and housekeeping	Potential soil pollution from spills or leakages of hydrocarbons and other hazardous chemical substances stored, used and disposed on site	• Refer to Section 4.2 for guidelines on hazardous chemical substance storage, handling and disposal. • All vehicles transporting fuel shall be serviced regularly and shall be kept in good working order. • All chemicals, contaminated water and/or hydrocarbons will be stored in designated areas. • All materials presenting a potential contamination threat will be stored in an area with a bunded capacity of 110% of the volume stored. • Spill kits shall be available at all areas where hydrocarbons are utilised and employees shall be trained in the utilisation of the spill kits. • If any minor spillage occurs the spillage will be cleaned up immediately and the contaminated area will be rehabilitated, as appropriate. • Employees shall be educated by means of training and the Environmental Awareness Plan to make them aware of the necessity to prevent spillages by the implementation of good housekeeping practices. • A rapid response team should be available on 24-hour notice to deal with hazardous spills. • If a major spillage occurs the supplying contractor or area supervisor shall be called out to clean the contaminated area and rehabilitate the soils, as appropriate. • All major spills (>200 l) will be reported to the Department of Water Affairs. • A monitoring and maintenance programme/procedure will be established for the fuel storage facility.	Ongoing	Business Dev. Manager / Operations Manager / Maintenance Manager

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Washing of vehicles	Contaminated wash water may impact surface water	• Refer to Table 4.1.4 for mitigation measures		
Staff on site	Workers may directly impact surface water through improper waste disposal and not using sanitation facilities	• Refer to Table 4.1.4 for management measures relating to workers on site.	Ongoing	Operations Manager / External Consultant
Operation and maintenance of sewage facilities and pipelines	Release of inadequately treated sewage may lead to eutrophication of standing water bodies and potentially harmful algal blooms	• Refer to Table 4.1.4 Section 7.1 for management measures relating to sewage spills.	Ongoing	Operations Manager / Maintenance Manager
Kuiseb River floods ~~Ponds~~	Impact of surface water runoff on the salt works	• Set up a network of contacts upstream to warn of impending floods • Monitor flood protection structures to identify any problem areas which may require placement of extra protection (e.g. sandbags) to combat erosion.	Ad hoc in rainy season ~~Weekly monitoring~~	Operations Manager

Decommissioning phase

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Removal of ponds, infrastructure, roads - landscaping and rehabilitation	Restoration of the natural topography and surface water flow regime	• The area from which the ponds are removed must be landscaped to conform to the natural topography of the area. • Landscaping must take the natural topography and flow regimes into account and restore them where possible.	Decommissioning	Operations Manager / External Consultant
Removal of sewage facility and pipes	Sewage spills during removal cause surface water contamination	• Refer to Section 7.1 for management measures relating to sewage spills.	Decommissioning	Operations Manager / External Consultant

4.1.7 ACTION PLAN: GROUNDWATER

Objective: To prevent and/or limit any negative impact on groundwater resources.

Operational phase

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Ponds	Impact of seepage from ponds and discharge canals on the groundwater quality of the Kuiseb River	~~• In order to establish whether or not there is significant movement of water from the ponds into the groundwater, water levels are monitored.~~ ~~• The combination of compaction and the development of a natural algal lining significantly reduce the probability of this from occurring.~~ ~~• The risk of seepage is mitigated by engineered containment of ponds.~~ ~~• These measures would reduce the probability of seepage to low, and the likely duration of impacts to medium.~~ • Investigate the groundwater flow directions around the salt works and identify remedial measures if seepage could pose a threat to the Kuiseb water quality.	Continuous monitoring and maintenance	Operations Manager / Environmental Coordinator
Use and washing of vehicles Maintenance of equipment, vehicles and plant	Hydrocarbons (diesel, oil, grease etc.) may contaminate groundwater	• Refer to the action tables 4.2 to 4.4 in Section 4.2 for details on hydrocarbon storage, handling and disposal. • ~~section 4.1.3 for management measures relating to hydrocarbon~~ spills. A detailed waste management strategy will be established and implemented (refer to Section 4 of the EMP).	Ongoing	Environmental Coordinator / Operations Manager / Maintenance Manager
Operation and maintenance of sewage facilities and pipeline	Release of inadequately treated sewage may cause groundwater contamination through infiltration	• Refer to Section 4.1.3 and Section 7.1 for management measures relating to sewage spills.	Ongoing	Operations Manager / Environmental Coordinator

Decommissioning phase

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Removal of structures and landscaping	Hydrocarbon spills from earth-moving equipment and tanks	• Refer to Section 4.2 and Section 7.1 for management measures relating to hydrocarbon spills.	Decommissioning	Operations Manager / External Consultant

Activities / facility	**Aspect / impact**	**Technical and management options**	**Action plan**	
			Frequency	**Responsible parties**
Removal of sewage facilities	Sewage spills may result in groundwater contamination	• Refer to Section 4.1.3 and Section 7.1 for management measures relating to sewage spills.	Decommissioning	Operations Manager / External Consultant

4.1.8 ACTION PLAN: SOCIO-ECONOMIC

Objective: To minimise the impacts on recreational (e.g. fishing, sightseeing etc.) and economic activities (e.g. tourism, etc).

Operational phase

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	Responsible parties
Ponds	Uncontrolled access to the ponds by the public poses a safety risk as well as a risk to private property	• With the exception of the areas along public roads, access to the site is restricted. • Warning signage must be erected (and monitored).	Immediate Continuous monitoring	Operations Manager / Environmental Coordinator
~~Washing of salt with concentrated seawater~~	~~The high salt content in the substrate around the plant makes it susceptible to dissolving should freshwater be introduced to the system. This may result in sinkholes developing, which create environmental and safety risks~~	~~• No direct discharge of fresh water into the local environment.~~ ~~• Visual inspections to identify visible signs of freshwater discharge.~~ ~~• Monitor freshwater use and compare this with discharge from the sewerage system.~~ ~~• The use of fresh water would dissolve the salt, and therefore the plant may not utilise freshwater to wash the salt. However, the washing of vehicles and machinery requires fresh water. This water use be monitored and recorded.~~	~~Ongoing~~	~~Operations Manager~~
Transport (use of vehicles)	Vehicles transporting salt to the loading facility at the harbour disturb residents along the route	• Transporting vehicles shall be serviced regularly and shall be kept in good working order (contractors must provide maintenance upon request of WBSH). • Vehicles transporting salt to the harbour will be restricted to working hours (7:00AM – 5:00PM) on weekdays. Should it be necessary to work outside of these hours, all concerned I&APs will be informed ~~consulted~~. • A complaints register will be maintained by WBSH. This register will be included in the annual report submitted to the MEFT.	Ongoing Annual reporting of complaints to the MEFT	Business Dev. Manager / Managing Director
	Additional wear and tear on the roads from product transport to the harbour	• No increase in the number of trucks on the road with the proposed expansion. • The municipal vehicle weight restrictions may not be exceeded. This will be controlled by the use of a weighbridge. ~~• The road is a public road.~~ • The following road maintenance conditions apply: o Maintenance of the road in town (Bungalows to Harbour gate) is carried out by Walvis Bay municipality o Road from bungalows to Paaltjies turnoff is maintained by Roads Construction Company. o The stretch from turnoff to Gate – graded when required ~~– twice a month~~ if not done by RCC.	Every load Ongoing	Business Dev. Manager / External Consultant

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	**Responsible parties**
		• A formal communication mechanism between the RCC and the Walvis Bay Salt Works is required whereby the Walvis Bay Salt Works will regularly report on the condition of the roads. It is recommended that this feedback takes place during the Walvis Bay Environmental Management Forum (WEMAF) Meetings.		
	Salt Works vehicles driving too fast may create additional safety risks	• ~~No increase in the number of trucks on the road~~. Speed control measures will be installed in the new vehicles in order to minimise safety risks.	Prior to expansion activities	Business Dev. Manager / Unitrans
~~Staff on site~~ Local economy	Job creation: WBSH contributes to the local socio-economic environment through job creation and supports local businesses Taxes: WBSH contributes significantly to the regional and local economy through the payment of rates and taxes. CSR: Significant contributions from WBSH	• The Walvis Bay Salt Mine maximises the use of the local workforce component. • A wide variety of training and skills development offers will be made available to all employees. These training materials serve to build flexible, portable skills profiles, and reflect the ~~true~~ lifelong learning opportunities available at WBSH to employees, contractor employees and the wider surrounding communities. • Continue with CSR contributions and include feedback in annual reports submitted to MEFT.	Ongoing	Managing Director

Decommissioning phase

Activities / facility	Aspect / impact	Technical and management options	Action plan	
			Frequency	**Responsible parties**
Operations ceasing	Job losses	• ~~Although no mine closure is envisaged, an emergency mine closure plan must be developed.~~ • Regular (minimum every 5 years) updates of the Mine Closure Plan (aligned with the requirements of the Namibian Mine Closure Framework). • The plan must consider the potential impacts associated with job losses resulting from operations ceasing.	~~Within two years of approval of amended EMP~~ Updated every 5 years	Managing Director

4.2 ACTION TABLES

TABLE 4-1: DISPOSAL OF WASTE

Items to be considered		Intentions
General	**Specific**	
Procedures	General	A waste management procedure will be developed. This will cover the storage, handling and transportation of waste.
	Waste minimi-zation, recycling	Opportunities to minimize waste production will be identified and taken where possible. Where possible, waste will be recycled.
Waste disposal facilities	Collection points	Sufficient waste collection points with adequate capacity will be established on site. They will be serviced frequently. Different skips shall be provided for wood, scrap metal, and hazardous waste.
	On-site waste disposal facilities	No waste disposal facility will be developed without the relevant legal authorisation.
	Off-site waste disposal facilities	Waste will be disposed of at appropriate permitted waste disposal facilities. Conduct spot checks to ensure the waste is correctly disposed. ~~An agreement will be put in place to ensure that the facility is capable of handling the waste.~~
Waste transport	Contractor	An approved subcontractor, working to local authority standards, will undertake the waste transport.
Disposal of different types of waste	Hazardous waste	Hazardous waste will be ~~collected by a contractor with the relevant permits and will be~~ removed to a permitted hazardous waste disposal facility. Hazardous waste will be stored in a designated area on site (with signage and proper bunding where required (if spills could occur). ~~may only be stored on site, in a fenced off area with access control, for up to 90 days.~~
	Non-hazardous waste	Waste will be collected by the Municipality and will be removed to the Walvis Bay waste disposal site.
	Any soil polluted by a spill of chemicals	If remediation of the soil in situ is not possible, the soil will be classified as hazardous waste and will be disposed of at an appropriate permitted waste facility.
	Scrap metal	Scrap metal may not become polluted or mixed with any other waste. Scrap metal will be collected in a designated scrap yard and sold to scrap dealers.
	Oil	Oil will be collected in suitable containers at designated collection points that are bunded and underlain by impervious materials to ensure that any spills are contained. Notices will be erected at each waste oil point giving instructions on the procedure for waste oil discharge and collection. An approved subcontractor will remove oil from site.

TABLE 4-2: STORAGE OF HAZARDOUS CHEMICAL SUBSTANCES

Product	Storage
Oils	Storage in mild steel or stainless-steel drums. The containers will be stored in bunded facilities that will have the capacity contain all potential spills. Bunded areas must be capable of containing 110% of the capacity of maximum capacity of the storage containers within the storage areas.
Diesel	Diesel will be stored in tanks within bunded areas with smooth, impermeable surfaces. Bunded areas must be capable of containing 110% of the maximum capacity of the storage containers within the storage areas. Diesel may be stored in externally clean drums. These drums may only be stored on smooth, impervious surfaces in facilities that will contain spills.
Paint, varnish, thinners, turpentine, detergents etc.	These substances must be stored in clearly marked containers that are sealable and must not leak. They may only be stored within the workshops and storerooms.

TABLE 4-3: HANDLING OF HAZARDOUS CHEMICAL SUBSTANCES

Product	Handling
Oils	All oils will be handled according to their specific Material Safety Data Sheets.
Diesel	Diesel will be handled according to its Material Safety Data Sheet. Where possible, diesel transferrals must take place in the designated refuelling areas on smooth, impervious surfaces. Drip trays will be positioned at each machine whilst being refilled. Drip trays will be drained into suitable containers. Smaller plant and tyre wheeled equipment will also re-fuel at the main storage areas.
Paint, varnish, thinners, turpentine, detergents etc.	These substances must be handled in accordance with their respective MSDS's.

TABLE 4-4: DISPOSAL OF HAZARDOUS CHEMICAL SUBSTANCES

Product	Disposal
Hydrocarbons	Old/used hydrocarbons will be stored in drums and weatherproof waste collection containers. Receipts as proof of their final disposal must be obtained and kept on file.
Paint, varnish, thinners, turpentine, detergents etc.	These substances must be discarded in accordance with their respective MSDS's.

4.3 CLOSURE

Despite the fact that no closure is envisioned for the operations, it is essential that a closure plan be developed to be prepared for ~~in order to ensure that adequate closure can take place in~~ the event of the unplanned mine closure ~~of the~~. This plan will also ensure that adequate financial provisions are made for closure.

Regularly (minimum every 5 years) update the Mine Closure Plan (aligned with the requirements of the Namibian Mine Closure Framework).

5 ENVIRONMENTAL MONITORING AND PERFORMANCE ASSESSMENTS

Based on the location of the project, monitoring will focus on the marine, terrestrial, air quality and groundwater impacts of the mine.

5.1 NOISE MONITORING ~~(GENERATORS AND PUMPS)~~

5.1.1 OPERATIONAL NOISE MONITORING

Continuous readings (for at least 1 hour) must be taken when complaints are received from I&APs or at least every three years for noise-generating activities:

- Pumps;
- Plant.

In the absence of significant human receptors in the area, the monitoring of noise will be used to monitor for deterioration of the noise-making equipment. Should there be an increase in noise levels averaging 3 dB over a period of an hour noise reduction options must be implemented. Where noise levels exceed acceptable/legal occupational health levels, hearing protection PPE must be provided to staff operating within the area at risk. Noise reduction options that should be considered include:

TABLE 5-1: NOISE REDUCTION OPTIONS

Noise reduction options
• Utilising lighter and quieter vehicles. • Selecting equipment with lower sound power levels • Installing silencers for fans • Installing suitable mufflers on engine exhausts and compressor components • Installing acoustic enclosures for equipment casing radiating noise • Improving the acoustic performance of constructed buildings, apply sound insulation • Installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m^2 in order to minimize the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective • Installing vibration isolation for mechanical equipment • Limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas • Re-locating noise sources to less sensitive areas to take advantage of distance and shielding • Siting permanent facilities away from community areas if possible

- Taking advantage of the natural topography as a noise buffer during facility design
- Reducing project traffic routing through community areas wherever possible
- Developing a mechanism to record and respond to complaints

5.1.2 TRANSPORT NOISE MONITORING

Noise readings must be taken when complaints are received from I&APs or at least every three years in the residential area (Meersig) adjacent to one of the speed humps and along the stretch of open road providing access to the salt works. The noise monitoring and interpretation of the data must be carried out by a suitably qualified noise specialist. The noise monitoring measurements will be included in the annual report to be submitted to the MEFT.

5.1.2.1 Lagoon road (access road)

The meter will be placed approximately 1.5m away from the road. Individual measurements of a minimum of 30 trucks will be taken.

5.1.2.2 Speed hump assessment

The meter will be placed approximately 1.5m away from the speed bump in free-field conditions, i.e. at least 3.5m from the nearest vertical, reflecting surface. Individual measurements of a minimum of 30 trucks will be taken.

5.2 AIR EMISSION MONITORING

In order to prevent excessive emissions of air pollutants and to determine the effectiveness of emissions management strategies, an emissions and air quality monitoring programme must be implemented. The emission monitoring and analysis must be conducted by entities permitted or certified for this purpose.

The air quality monitoring must cater for:

- ~~Engines (including vehicles).~~
- Boilers, including HFO and paraffin ~~fuel~~ burning facilities in the refining plant.

The air quality monitoring program must consider the following elements:

- Monitoring parameters.
- ~~Baseline calculations.~~
- Monitoring type and frequency.

The following parameters must be monitored bi-annually:

TABLE 5-2: AIR EMISSION MONITORING PARAMETERS

Emission	Monitoring	Limits
NOx	Continuous monitoring of either NOx emissions or indicative NOx emissions using combustion parameters	Namibia does not have any emission limits or guidelines. As a result, international emission standards and limits need to be referenced, including the EU industrial directive emission limits, the IFC guidelines, as well as the SA Minimum Emission Standards. ~~500 tpy~~
SO_2	Continuous monitoring if SO_2 control equipment is used	

~~Source: World Health Organisation Guidelines~~

5.3 WATER MONITORING

Refer to Appendix A for further details.

5.3.1 GROUNDWATER MONITORING

The movement of water from the ponds into the Dorob aquifer could have potential negative environmental implications. In order to establish whether or not there is significant movement of water from the ponds into the groundwater; water levels are monitored twice every lunar month: at spring and at neap tide. The records will be evaluated annually by a suitably qualified hydrogeologist and reported in one of the biannual reports. Refer to Appendix A.

~~The movement of water from the ponds into the Dorob aquifer could have potential negative environmental implications. In order to establish whether or not there is significant movement of water from the ponds into the groundwater; water levels are monitored.~~
~~The groundwater levels are monitored twice every lunar month: at spring and at neap tide.~~
~~Develop a groundwater monitoring network in accordance with the recommendations of the Marine Ecology Study (8 monitoring sites to the east of the discharge point, 4 to the north and 4 to the south – all at 25m intervals). Annual surveys will be required as a minimum.~~

5.4 SOIL AND VEGETATION MONITORING

~~General soil and vegetation (although limited) monitoring must take place in a qualitative manner and be conducted by the Quality and Environmental Management Coordinator. All non-conformances are to be recorded in an Incident Register. The floral health of the hummocks~~

~~must be monitored on an annual basis and reported on in the annual report submitted to the MEFT. (Refer to Appendix C).~~

Combine the plant health and hummock health monitoring and revise the associated monitoring plan in consultation with a Botanist and implement accordingly.

The monitoring of the plant health and floral health on the hummocks must be carried out periodically by a qualified botanist.

5.5 MARINE ENVIRONMENT

Refer to Appendix C for further details.

Consideration should be given to the inclusion of new monitoring and management measures, namely:

- Monitor vehicle traffic on the beach with a webcam. Webcams have also been successfully used in monitoring shoreline erosion and accretion thereby providing validation for coastal erosion modelling studies. The exact location of the webcam still needs to be determined (which could be closer to the process plant and office building, considering the same monitoring results).

- WBSH should act urgently to further quantify the risks of wave overtopping into their ponds and the associated potential impacts. Once the risk has been better quantified, actions need to be planned and implemented to minimise such risks and avoid impacts. Initiate discussions with MEFT/MFMR, Walvis Bay Municipality and Namport into the feasibility of future beach nourishment along the coastline from the Kuiseb River to Pelican Point to plan (or other possible measures) for the safety of the town, the port and WBSH.

- Consider restricting vehicle traffic on the beach to a daily quota, or preventing vehicle access altogether (preferred option from an environmental perspective).

- Furthermore, it is recommended that WBSH inform / consult with other Key Stakeholders in this regard. Such Key Stakeholders need to be identified by WBSH and could include the MEFT: Directorate of Wildlife and National Parks (DWNP), Namport, Walvis Bay Municipality and the Ministry of Fisheries and Marine Resources (MFMR).

~~The discharge of concentrated sea water into the local marine environment may impact the local marine ecology in the area. A reference survey of the macrofauna and meiofauna prior to the pumping of the new increase bittern volumes would provide a picture of the current faunal community structures according to spatial distribution, abundance and biomass. The methodology for sampling should be carried out by a suitably experienced marine biologist or technician who has done this type of work before. Species identification and laboratory work can be done locally as well. A reference survey of the intertidal beach macro and meiofauna~~

~~could be undertaken at the bittern discharge site, and at 2 km and 4 km to either side of the site. This would not only provide site-specific information on beach communities in the area, but serve as a pre-expansion reference for follow up monitoring surveys to assess the impacts resulting from bittern discharge. After the initial reference survey, two subsequent surveys, at one year intervals could be planned in order to assess changes in the faunal community.~~

The siltation effect of added development in the Kuiseb River Delta area on the lagoon must be monitored. ~~This must be carried out at the same time as the surveys described above.~~

5.6 FRESHWATER USE

The high salt content in the substrate around the plant makes it susceptible to dissolving should freshwater be introduced to the local soil environment. This may result in sinkholes developing, which create environmental and safety risks. It is vital that there be no direct discharge of fresh water into the local environment. Visual inspections shall be used to identify visible signs of freshwater discharge. Another, more accurate, means of ensuring that no freshwater is discharged into the local environment is to monitor freshwater use and compare this with discharge from the sewerage system. The water use in and discharge from the wash-bay must be carefully monitored in order to ensure no losses from the system. Losses would indicate leakages, which could result in soil or water contamination.

5.7 ENVIRONMENTAL REPORTS

The commitments contained in this EMP are WBSH's contractual agreement with the Namibian authorities for sound environmental management. All employees, contractors and sub-contractors and any visitors to site will be expected to comply with the commitments contained herein.

WBSH further undertakes to:

- Appoint a responsible person(s), in writing, who will monitor all environmental aspects of the site on a regular basis.
- The appointed person will communicate, on a regular basis, with the local interested and affected parties identified with regards to the operations and will report on the progress made with regards to implementation of the mitigation measures. Any complaints with regard to the mining activity will be reported to the appointed person and be recorded in a complaint register.
- Maintain records relating to compliance/non-compliance with the conditions of authorisation. These records must be made available to the relevant authorities within 7 (seven) days of receipt of a written request.

5.7.1 AUDITS AND INSPECTIONS

The WBSH Environmental Department will conduct internal management audits against the commitments in the EMP. In the operational phase, these audits will be conducted on a quarterly basis. The audit findings will be documented for both recordkeeping purposes and for informing continual improvement.

The Environmental Department will furthermore conduct daily inspections during construction and weekly inspections during operations.

In addition, an independent professional will conduct an EMP performance assessment at least once every two years. The mine's compliance with the provisions of the EMP and the adequacy of the EMP relative to the on-site activities will be assessed in this report.

5.7.2 SUBMISSION OF INFORMATION

As a minimum, the following documents will be submitted to the relevant authorities on an ongoing basis:

- Biannual reports to be submitted to the MEFT (DEA) will include:
    - Monthly environmental reports will be compiled, which will address all pertinent environmental issues on site and present the findings of all monitoring on site. These reports will be assimilated into biannual reports which will be made available to the MEFT upon request.
- Legal and performance environmental audits conducted by an independent auditor to be carried out and submitted every two years.
- Other monitoring reports will be provided to the relevant authorities as per licence conditions and other agreements.

6 ENVIRONMENTAL AWARENESS PROGRAMME

6.1 MANAGEMENT OBJECTIVE

To ensure that the environmental awareness plan is relevant and sufficient for the Walvis Bay Salt Mine.

6.2 MANAGEMENT MEASURES

6.2.1 INDUCTION

This includes the following:

- Ensure that all employees are aware of their individual and their job descriptions and their potential impacts on the environment.
- Employees are aware of any sensitive sites (ecological, cultural or historical) and the procedures to follow should any sensitive sites be detected.
- The preventative measures and procedures to undertake in order to reduce the risk of a potential impact.
- Establish and continually enhance external and internal communication measures.
- Environmental Management and Advisory Forum (WEMAF):
    - WBSR is a member of the WEMAF.
    - Interested and affected parties will have the opportunity to raise environmental concerns during the Forum sittings.
    - Records will be kept of all decisions and concerns.
    - All issues and concerns raised will be addressed within a specific timeframe as approved by the relevant stakeholders and authorities.

6.2.2 COMMUNICATION FROM EXTERNAL PARTIES AND EMPLOYEES

A formal mode of communication must be established for liaison with the media in respect of all crises within the Salt Works.

Communication from external interested and affected parties is received by e-mail, fax, telephonically or by mail. Where required a written response must be sent, on receiving such communication, by the appropriately appointed individual under signature of the Quality and Environmental Management Coordinator, to the respective interested and/or affected party. All telephonic or facsimile correspondence received on the mine must be forwarded to the Environmental Department for action.

6.2.3 IN-HOUSE TRAINING (AWARENESS)

In-house training sessions will be held with relevant employees. The training sessions will be planned by the Environmental Department, and allow employees to participate in determining what the environmental issues and concerns are with regard to their specific occupation.

6.2.4 ON THE JOB TRAINING

On the job training is an essential tool in environmental awareness. Employees are given details of the expected environmental issues and concerns specifically related to their occupation. Employees are trained on how to respond if an environmental problem or source of environmental pollution arises. The training will be on-going, and all new employees will be provided with the same standard of training as existing employees.

7 ENVIRONMENTAL EMERGENCY PREPAREDNESS AND RESPONSE

An effective, comprehensive, well-considered and tested environmental emergency preparedness and response plan has the potential to save lives, prevent unnecessary damage to the company and other property and to manage environmental risk in the event of a large chemical spill, oil spill, fuel spill, explosives spill or sewerage spill.

Environmental emergencies occur over the short term and require an immediate response. An Emergency Plan must be compiled and disseminated to all employees and contractors and in the event of an emergency, the emergency response plan should be consulted.

This plan should be placed around the mine where it will be easily viewed. The plan should contain a list of procedures, evacuation routes and a list of emergency contact numbers. It is advisable that the mine tests the emergency response plan in order to identify any areas for improvement.

If the emergency has the potential to affect surrounding communities, they should be alerted via alarm signals or contacted in person. The surrounding community will be informed, prior to mining taking place, of the potential dangers and emergencies that exist, and the actions to be taken in such emergencies.

Communication is vital in an emergency and thus communication devices, such as mobile phones, two-way radios, pagers or telephones, must be placed around the mine. A checklist of emergency response units must be consulted and the relevant units notified.

The checklist includes:

- Fire department;
- Police;
- Emergency health services such as ambulances, paramedic teams, poisons centres;
- Hospitals, both local and further afield, for specialist care;
- Public health authorities;
- Environmental agencies, especially those responsible for air, water and waste issues;
- Other industrial facilities in the vicinity with emergency response facilities;
- Public works and highways departments, port and airport authorities; and
- Public information authorities and media organisations.

7.1 EMERGENCY PROCEDURES

Please refer to the table overleaf for the basic environmental emergency procedures to be followed and incorporated into the Emergency Preparedness and Response Plan:

TABLE 7-1: EMERGENCY PREPAREDNESS AND RESPONSE PLAN

Possible Environmental Related Emergency	Action plans/Remediation
Hydrocarbon spills from vehicles, tankers, storage tanks Chemical spills	• The person who first notices a spill must notify the Environmental Department, fill out an incident report and take part in a thorough investigation. • The spillage should be contained (bund earth walls) by all means. Depending on the amount of spilled material it could be remediated in situ or removed in case of a large amount of spillage ~~that is contained~~ • Leakage from a vehicle, tanker etc, that caused the emergency, should be stopped and the vehicle removed to the workshop area for repairs. • In all cases of spillage, irrespective of the chemical, remove or extinguish any fire (naked flame) to within at least 10 metres from the spill. • Cover the spills with absorbent material from the spill kit. • Obtain Material Safety Data Sheet (MSDS) if the substance is known. • Major spillage incidents (>200 l) will be reported to the MEFT Department of Environmental Affairs, the Department of Water Affairs, ~~the Ministry of Mines and Energy~~ and the Walvis Bay Municipality. Appropriate remedial measures shall be implemented in consultation with these regulatory authorities. • If necessary, the polluted soils will be classified as hazardous waste and will be discarded at an appropriate permitted waste site. After removal of the contaminated soils, the affected areas will be landscaped and rehabilitated.
Sewage spills	• The person who reports a spill must notify the Environmental Department, fill out an incident report and take part in a thorough investigation. • The leakage must be stopped and the reason for spill must be rectified. • The spillage should be contained (bund earth walls) by all means. ~~Depending on the amount of spillage it could be remediated in situ or in the case of large amount of spillage that is contained, could be removed, etc.~~ • In the event that spills occur and soils become contaminated, the appropriate remedial measures will be identified in consultation with an appropriately qualified specialist. • If necessary, the polluted soils will be classified as waste and will be discarded at an appropriate permitted waste site. After removal of the contaminated soils, the affected areas will be landscaped and rehabilitated. • Major spillage incidents will be reported to the MEFT Department of Environmental Affairs, the Department of Water Affairs, ~~the Ministry of Mines and Energy~~ and the Walvis Bay Municipality. Appropriate remedial measures shall be implemented in consultation with these regulatory authorities.
Fires	• The necessary equipment should be in place and ready to be used if an accidental fire is started. • There shall be an emergency preparedness plan is in place in order to fight accidental fires, should they occur.

	• No fires may be lit except at places approved by the Quality and Environmental Management Coordinator (basic fire-fighting equipment shall be to the satisfaction of the Local Emergency Services. • Precautions shall be taken when working with welding or grinding equipment near potential sources of combustion. Such precautions include having a suitable, tested and approved fire extinguisher immediately at hand and the use of welding curtains.
Uncontrolled brine discharge into the environment (i.e. from Evaporation Ponds)	• Major spillage incidents will be reported to the MEFT Department of Environmental Affairs, the Department of Water Affairs, MFMR and the Walvis Bay Municipality. Appropriate remedial measures shall be implemented in consultation with these regulatory authorities.

8 PARTIES RESPONSIBLE FOR THE IMPLEMENTATION OF THE EMP

This section describes the roles and responsibilities for implementing the different parts of the environmental management plan (EMP).

8.1 WALVIS BAY SALT HOLDINGS – RESPONSIBLE PARTY

The WBSH Managing Director has overall responsibility for environmental management and for ensuring this EMP is implemented. The Managing Director will be dedicated to managing and monitoring the environmental issues associated with the facilities/activities.

8.2 RESPONSIBILITIES

The ~~Quality and~~ Environmental ~~Management~~ Coordinator ~~/ Environmental Manager / Officer~~ will be responsible for assisting the Managing Director in all environmental issues, and specifically to ensure that the commitments as set out in this EMP are implemented during the construction, operations, decommissioning and closure phases.

Responsible related to compliance of this EMP:

- Regular inspections and auditing compliance to this EMP and any other relevant legal requirements e.g. permits, authorisations, conditions of the Environmental Clearance Certificate.
- Conduct environmental awareness training during induction training and on an ad hoc basis thereafter.
- Ensure compliance to this EMP and permits and authorisations issued to WBSH by relevant authorities. Ensure responsibilities and target dates are developed for each one of the commitments in this EMP. This will be through one of the following mechanisms:
    - Design requirements; or
    - Construction tender documents and contracts.
- Ensure that contractor staff is controlled through the implementation of appropriate security measures.
- Carefully manage the storage and handling of hydrocarbons and other hazardous materials.
- Monitor for excessive dust, noise and vibrations and implement control measures if necessary.
- Implement a waste management strategy.
- Monitoring and maintenance equipment and machinery.
- Ensure the provision of adequate sanitation facilities.
- Implement an environmental awareness plan.

- Installation of emergency plans (fire, evacuation etc.) and first-aid procedures.
- Control of traffic safety and road conditions.
- Ensure that surface runoff is controlled and impacts on water resources are prevented.

8.3 CONTRACTORS

The Contractor Managers will be contractually required to comply with the relevant commitments in this EMP. Each contractor will be required to develop their own individual EMPs and/or relevant Method Statements (MS) based on this EMP and any other relevant Walvis Bay Salt Works' requirements and specifications and any permits or authorisations issued to Walvis Bay Salt Works. These contractor EMPs/MS will focus on the specific aspects of the contractors work requirements and work areas.

The Quality and Environmental Management Coordinator and the relevant contractor's environmental officer will conduct daily informal inspections at contractor areas. Non-compliances will be recorded and action plans developed in conjunction with the contractor that contravened the clause of the EMP.

Contractors will be formally audited on a monthly basis in order to determine compliance with the relevant EMPs/MSs. In the event of non-conformances, the contractor will be required to take corrective action according to the requirements of Walvis Bay Salt Holdings.

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SLR. 2014a Scoping Report (with Assessment) for Walvis Bay Salt Holdings (Pty) Ltd

SLR. 2014b Environmental Management Plan for Walvis Bay Salt Holdings (Pty) Ltd

APPENDIX A: CLOSURE FRAMEWORK

APPENDIX A: RECOMMENDED GROUNDWATER MONITORING AT THE WALVIS BAY SALT WORKS

Introduction

This memo provides a short summary of groundwater investigations carried out in the past, describes the position of the water table and groundwater flow directions, as well as the water quality.

Previous Research

Borehole information from past work includes a geohydrological investigation of the beachfront at Paaltjies, South of Walvis Bay (ICN, 1997) and a report on the Namibia Water Corporation's drilling programme in the Dorop Aquifer (NamWater, 2017). Both projects encountered hypersaline water in some of the boreholes. At the Salt Works, shallow auger drilling in 2022 found brine with total dissolved solids (TDS) concentrations of 106-273 g/litre at the four sites shown in Figure 1 (Namib Hydrosearch, 2023).

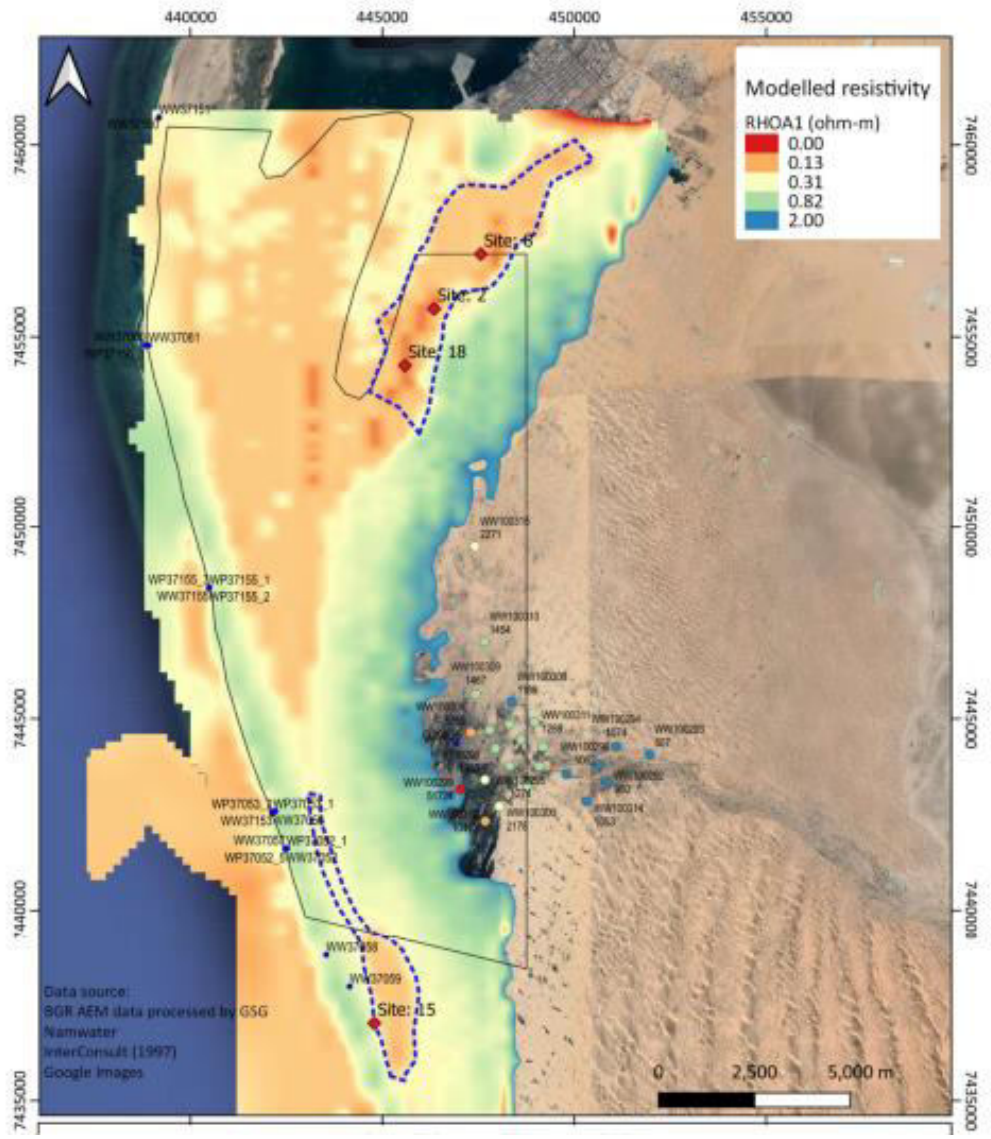

Figure 1: Resistivity Survey Results and Borehole Sites around the Salt Works

(source: Namib Hydrosearch, 2023)

WBSH had six brine exploration boreholes drilled in 2023 to confirm the presence of hypersaline groundwater beneath the salt works. Monitoring boreholes WW206279 (MON01) and WW206280 (MON02) were drilled close to the postulated position of the freshwater/saltwater interface. The gamma logs showed that the aquifer at both sites consists of relatively uniform sands.

Downhole fluid and formation conductivity measurements provided information identifying the depth of the interface where it has been intersected. The downhole fluid conductivity logs of WW206279 and WW206280 clearly illustrated that the fresh-saline interface was intersected in both boreholes; in WW206279 at 12-15 m depth and in WW206280 at 25-28 m depth.

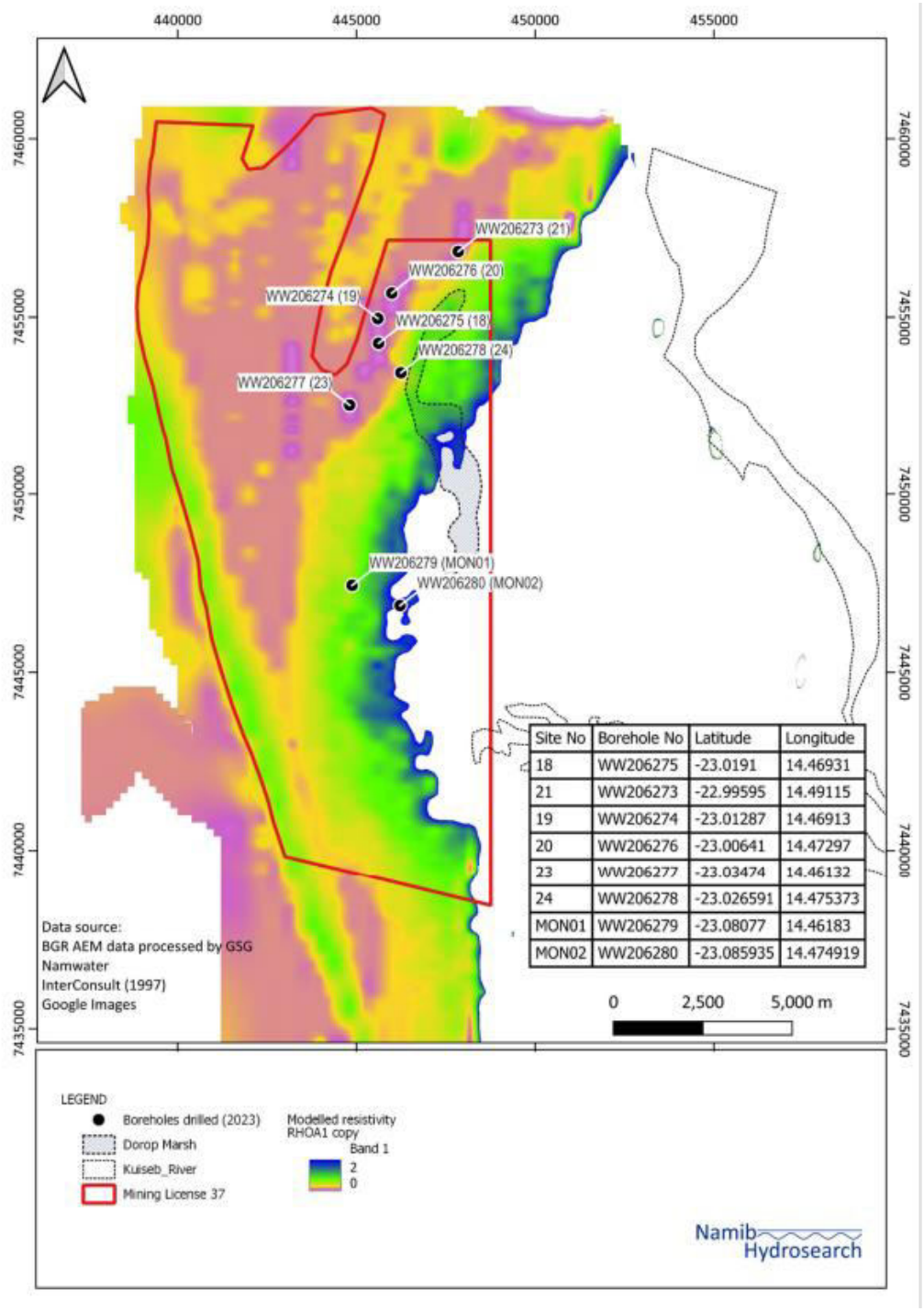

Figure 2: Boreholes drilled in 2023

Table 1: Borehole information

Site	BH number	Latitude	Longitude	Elevation (mamsl)	Water level (mamsl)	TDS (g/l)
18	WW206275	-23.01910	14.46931	0.688	0.068	no data
21	WW206273	-22.99595	14.49115	0.505	-1.055	135
19	WW206274	-23.01287	14.46913	2.038	0.588	169

20	WW206276	-23.00641	14.47297	3.859	2.699	148
23	WW206277	-23.03474	14.46132	1.972	0.402	no data
24	WW206278	-23.02659	14.47537	0.607	-0.093	104
MON01	WW206279	-23.08077	14.46183	1.732	-2.848	52
MON02	WW206280	-23.08593	14.47492	9.129	no data	27

Key: mamsl = metres below average sea level

Water Levels and Flow Directions

Table 1 shows the water levels calculated by subtracting the measured levels in metres below borehole collar from the elevation to obtain an approximate level in metres above mean sea level. It would be good to find out if the elevation given by Namib Hydrosearch refers to the ground surface or the top of the borehole casing and how much of the casing protrudes above the surface.

The levels are generally close to the sea level, except for WW206273 where the water table seems to be more than one metre below sea level and MON01 where it is reported as -2.85 m. The latter reading appears suspect at first, it should be confirmed by further measurements or data from other boreholes in the vicinity. If it is correct, it would indicate that NamWater's pumping may have drawn down the water table below sea level – a situation that could lead to saltwater intrusion.

It is difficult to infer flow directions from a few readings over this large area. There probably is a groundwater mound underneath the ponds that discharges towards the sea in the west, the lagoon in the north and the Kuiseb River in the east, and to a lesser extent towards the south, from the evaporation ponds that have recently been created. Only the outflow towards the east is of concern, as it might affect the water quality of third-party (NamWater, Dept. of Water Affairs) boreholes in the Kuiseb River's Dorop aquifer.

Water Quality

Sodium and chloride are the prevailing ions, as expected in concentrated brine derived from seawater, while magnesium, sulphate, calcium and bicarbonate occur at much lower concentrations. The salinity declines from north to south. The two southernmost boreholes (WW206279 and WW206280) may be affected by an influx of fresh water, presumably from the Dorop Aquifer, as indicated by the lower TDS concentrations.

Monitoring Programme

Six-monthly water level monitoring and annual water quality analyses should be conducted to ensure that activities in ML 37 do not adversely affect freshwater resources in the adjacent Dorop aquifer. The proposed locations include WBSH's boreholes WW206279 and WW206280 and several third-party boreholes in the vicinity, if they are accessible (not locked). Figure 2 shows a few possible monitoring boreholes: WW100315, WW100310, WW100309 and WW100306. The red circle indicates the approximate position of WW206279 and WW206280 for comparison.

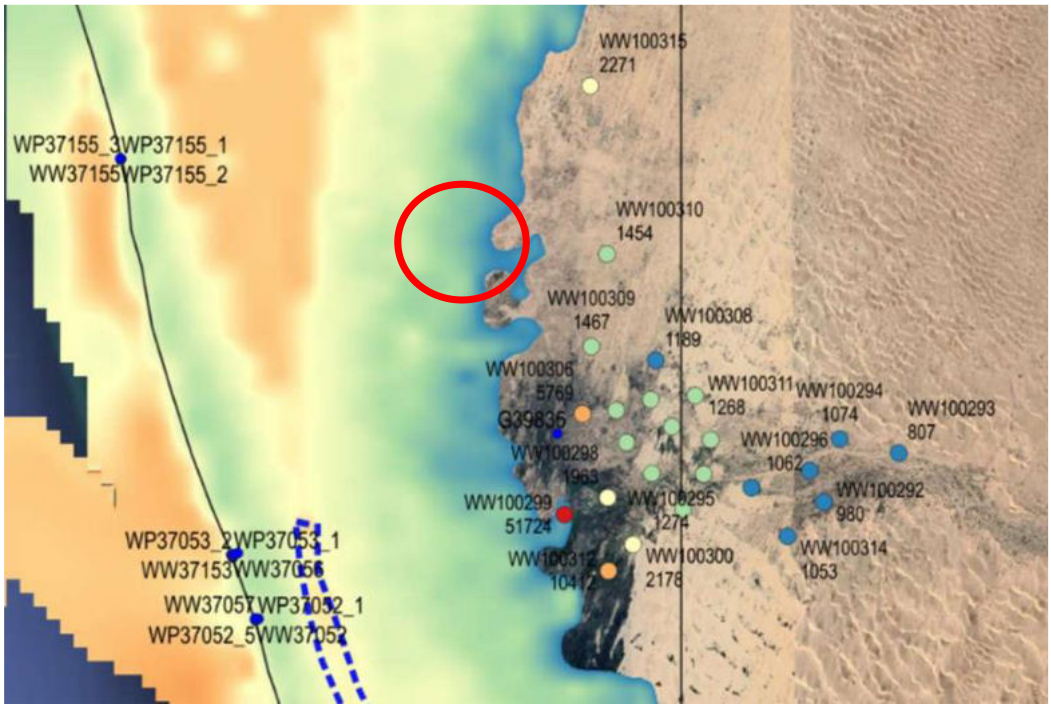

Figure 2: Potential monitoring boreholes

A water level and water quality monitoring procedure should be prepared as guidance for field work. Alternatively, WBSH could ask a consultant to carry out the monitoring programme.

Namib Hydrosearch recommended repeated downhole logging, ideally on an annual basis, to track changes in the position of the interface due to seawater or brine intrusion. Excessive abstraction from the Dorop aquifer may be reflected in a rise of the interface due to saltwater intrusion.

In addition, WBSH should monitor any runoff in the Kuiseb River by recording dates and, if possible estimated flow volumes. This is important to assess the effect of freshwater infiltration on the groundwater salinity.

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APPENDIX B: COMMENTS ON THE VEGETATION MONITORING REQUIREMENTS AND PLAN

The environmental monitoring specified in the Environmental Management Plan of 2021 was reviewed in the light of changes to the salt work's operations and environmental parameters. The entire environmental monitoring program is undergoing a review presently which is not yet available for inclusion in this renewal application. However, it is evident that some changes will need to be made. A rationale for these changes is provided in this document.

The recommendation in this document are based on discussion with Walvis Bay Salt staff, and a review of the vegetation monitoring that has been undertaken to date (Mannheimer 2015, 2019).

The following tasks from the EMP of 2021 were directly addressed:

Ponds	• The seepage of concentrated brine into the land alongside the ponds could negatively impact the local flora	Task 1 Visual monitoring of the surrounding limited vegetation must take place. This must be reported on in the monthly Environmental Report.	Design phase, construction and ongoing
	• Impacts on plant diversity (hummocks)	Task 2 The monitoring of the plant health must be carried out periodically by a qualified botanist. The floral health on the hummocks must be monitored on an annual basis and reported on in the annual report submitted to the MET. A hummock monitoring plan has been developed and has been included in the EMP.	Annual

Task 1. Visual monitoring of the vegetation surrounding the ponds does not necessarily provide an indication of seepage of concentrated brine. The salt marsh vegetation is controlled by a number of factors, including water level, sand deposition and climate. Unless this is also tracked where observations are made, dying of vegetation cannot necessarily be attributed to brine disposal.

=> Recommendation: Omit this task

Task 2. Plant health and hummock health are to be combined into one task. This is the annual photopoint monitoring of *Salsola nollothensis* hummock vegetation.

Multiple, interplaying factors affect plant health in the Kuiseb Delta, and only some can potentially be attributed to the salt work's operations. For example changes in water level and to the saltwater-freshwater interface are influenced by groundwater abstraction from the Dorob aquifer for the town of Walvis Bay. In addition, climate change affects sea level and weather patterns, which in turn can influence water and salinity levels and henceforth the vegetation.

Monitoring of *Salsola* hummocks on its own can therefore not elucidate the impacts of the salt production in the former marshlands on the Kuiseb Delta vegetation. However, keeping track of vegetation changes can provide a warning, and prompt Walvis Bay Salt to investigate further, which could result in changes to management. The hummock photopoint monitoring should therefore be continued.

In principle the *Salsola nollothensis* monitoring set-up by Coleen Mannheimer (2015, 2019) provides a practical method which can likely be sustained in future. The sampling protocol, site positions and similar parameters need to be evaluated in more detail on site and possibly amended in light of changes to the environment and the operations.

=> Recommendation: Combine plant health and hummock health monitoring and revise the coastal hummock monitoring plan (see Annex B in EMP) accordingly.

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APPENDIX C: MARINE ENVIRONMENT MONITORING

1. The need for further monitoring of beach macrofaunal communities to quantify the impact of bitterns discharges

The monitoring recommendations put forward as part of the 2021 EMP were designed as a structured before-after/control-impact study that would provide ***quantitative*** data on invertebrate macrofaunal species diversity, abundance and biomass on the beach prior to bittern discharge and provide a ***quantitative*** measure of impacts to the macrofaunal communities as a result of bittern discharges and their rate of recovery thereafter.

This approach assumed that the beach remains relatively stable and that sampling localities chosen for the baseline survey can be revisited and resampled in subsequent years. Analysis of historical satellite images, however, reveals persistent erosion of the beach at the bitterns discharge point: the beach width has decreased from ~1 km in 2010 to only 400 m in 2024. Reports from WBSH also confirm that overtopping of waves into the evaporation ponds occurs during storm tides and periods of adverse weather. This suggests that the beach is highly dynamic and that changes in beach width, beach slope and possibly sand particle size - all of which determine the structure of the resident macrofaunal communities - are occurring naturally in response to increased storm events associated with sea level rise. Such natural perturbations will mask any discharge-related changes in macrofaunal communities.

Furthermore, the beach opposite the mining licence experiences regular traffic by off road vehicles. Driving off-road vehicles in coastal habitats is recognised as being environmentally highly destructive, as demonstrated in the plethora of international literature investigating the use of vehicles in natural beach systems (see attached memo). As such, the macrofaunal communities will already be highly disturbed by other users, and it will unlikely be possible to attribute any observed changes in macrofaunal community structure (should it occur) to the bitterns discharge alone.

It is thus thought pertinent that the marine ecological monitoring requirements as outlined in the original EMP can be omitted from future amended EMPs submitted as part of the ECC renewal applications.

Consideration should be given to the inclusion of new monitoring and management measures, namely:

- Monitor vehicle traffic on the beach with a webcam. Webcams have also been successfully used in monitoring shoreline erosion and accretion thereby providing validation for coastal erosion modelling studies.
- Initiate discussions with MEFT/MFMR, Walvis Bay Municipality and Namport into the feasibility of future beach nourishment along the coastline from the Kuiseb River to Pelican Point to plan for the safety of the town, the port and WBSH under the threats of sea level rise.

- Consider restricting vehicle traffic on the beach to a daily quota, or preventing vehicle access altogether (preferred option from an environmental perspective).

2. The impacts of vehicle traffic in the coastal zone

Driving off-road vehicles2 (ORV) in coastal habitats is recognised as being environmentally highly destructive (Palmer & Leatherman 1979; Godfrey & Godfrey 1980)., as demonstrated in the plethora of international literature investigating the use of vehicles in natural beach systems. Whilst all human activities (including walking) undertaken on beaches potentially have an impact on the natural beach systems, the potential impact of vehicles compared to pedestrians on the beach geomorphological and ecological systems is far greater due to the weight of the vehicle, the engine power transferred to the wheels, the speed and potential range, and the noise generated.

Physical Impacts

The physical impact of vehicles on dunes and beaches relates primarily to the compaction and rutting of the beach sediments. The creation of access tracks through vegetation and over dunes results in localised damage to dune vegetation through crushing of plants and breaking of rhizomes, which in turn leads to reduced root production and consequently decreases in the floral ground cover and its associated abundance and biodiversity (Luckenbach & Bury 1983; Rickard *et al.* 1994; Stephenson 1999; Kutiel *et al.* 1999, 2000; Groom *et al.* 2007; Thompson & Schlacher 2008; Kelly 2014; Dewidar *et al.* 2016). The loss of plant cover in dunes can impact soil structure directly through increased soil densities, reduction of soil moisture, reduced infiltration, extension of diurnal soil temperature ranges and reduction of organic carbon content (Wilshire *et al.* 1978; Dewidar *et al.* 2016). Vegetation loss in response to ORV driving has also been linked to alteration of localised atmospheric conditions and soil chemistry (McAtee & Drawe 1981) leading to alteration of natural foredune profiles and formation of embryonic foredunes, increased dune deflation rates, loss of sediments to the swash zone, destabilisation and increased vulnerability to wind erosion (Brodhead & Godfrey 1977; Griggs & Walsh 1981; Anders & Leatherman 1987a, 1987b; van der Merwe 1988; Priskin 2003; Thompson & Schlacher 2008, but see also Houser *et al.* 2013). Similarly, rutting of the beach surface by ORV and was shown to significantly reduce the aeolian transport of sand from the beach to the dunes (Austin, undated; Houser *et al.* 2013). Such changes are significant for beaches and dunes as they affect conditions that enable coastal vegetation to grow and regenerate. Further studies indicated that once the initial damage to dune vegetation has been done, effects are perpetuated by other ORV users who perceive the tracks as legitimate, thereby leading to cumulative impacts (Lindberg & Crook 1979; Priskin 2004).

Impacts on Biodiversity

[2] The term off-road vehicle refers collectively to four-wheel-drives, trail bikes, and all-terrain vehicles such as quad bikes and dune buggies.

Vehicle use on the high shore and in the dunes has been linked to decreases in productivity of shorebirds that feed, roost and nest there (Burger 1991, 1994; Lord *et al.* 2001; Verhulst *et al.* 2001; Schlacher *et al.* 2013a). Impacts relate to modification of key behavioural traits that are crucial to their survival and reproduction, namely (1) changes to foraging behaviour, shifts in feeding times and decreased food intake (Stolen 2003; Thomas *et al.* 2003; Weston & Elgar 2005a,b; Schlacher *et al.* 2013a); (2) decreased parental care when disturbed birds spend less time attending the nest, thus increasing exposure and vulnerability of eggs and chicks to predators; (3) decreased nesting densities in disturbed areas through crushing of nests and eggs; and (4) declines in fledgling numbers, direct collision and disturbance whilst feeding or roosting resulting in population shifts to less disturbed sites (Buick & Paton 1989; Hubbard & Dugan 2003; Williams *et al.* 2004; Cherry 2005; Tarr *et al.* 2010; Meager et at. 2012). Incidental crushing of beach invertebrate macrofauna by ORVs (see later) would also decrease food availability to foraging littoral birds (Schlacher *et al.* 2013).

Marked declines in herbaceous and perennial plants, arthropods, lizards and mammals in ORV-used areas have also been reported, with heavily-used areas having virtually no native plants or wildlife remaining (Luckenbach & Bury 1983; van Dam & Van Dam 2008). Negative effects were even measurable in areas experiencing relatively low levels of ORV activities (Luckenbach & Bury 1983). Wheel ruts (even as shallow as 5 cm) left by ORVs have also been shown to be detrimental to the dispersal of turtle hatchlings (van der Merwe *et al.* 2012), as they spend considerable time navigating through these, thereby increased exposure to predation, dehydration and energy expenditure during this initial stage of dispersal (Hosier *et al.* 1981;). Lights from night-driving ORVs have also been shown to affect the occurrence of Loggerhead turtle nests, incubation periods and emergence success of turtle hatchlings in North Carolina (Nester 2006).

Macrobenthic invertebrates (e.g. worms, molluscs, crustaceans) play a key role in the trophic structure of sandy beaches (McLachlan & Brown 2006), supporting higher-order consumers such as shorebirds and surf-zone fishes, and contributing to nutrient recycling on beaches (Soares *et al.* 1997). These macrofauna typically occupy the sand matrix of the intertidal zone (high- and mid-shore) where most vehicle traffic is concentrated (Schlachter & Thompson 2007) and are thus potentially vulnerable to impacts by ORVs through direct crushing of organisms (Wolcott & Wolcott 1984; van der Merwe & van der Merwe 1991; Barros 2001; Moss & McPhee 2006; Schlachter *et al.* 2007a; Davies *et al.* 2016, amongst others), destruction or loss of habitat through compaction of sand (Dewidar *et al.* 2016) or crushing of alga wrack, leaf litter and drift wood on and above the driftline where organisms feed and live (Steinback & Ginsberg 2003). As the shear stress of ORVs can penetrate up to 30 cm into the sand (Atkinson & Clark 2003; but see also Davies *et al.* 2016) any invertebrates living in the upper layers of the beach would be expected to be negatively impacted by vehicle passes.

Numerous studies have shown that macrobenthic assemblages on ORV-impacted beaches had significantly lower species diversity and reduced abundance, resulting in substantial changes in community structure and composition, particularly on the middle and upper shore where vehicle traffic was concentrated (Schlacher *et al.* 2008a). On beaches with high ORV traffic, the high shore areas may be completely devoid of macroinvertebrates. Schlacher & Thompson (2007) reported negligible impacts of

species whose distribution is centred below the effluent line, suggesting they occupy a "spatial refuge" from ORV traffic. In contrast, Davies *et al.* (2016) recently reported that even lowshore communities were affected, particularly on narrow beaches where drivers were forced to traverse a greater percentage of the beach face. Species occurring of the swash zone may also be more susceptible to vehicle traffic (van der Merwe & van der Merwe, 1991), implying that even occasional vehicle passes could inflict mortality to sensitive species.

Vehicle impacts would be expected to differ substantially between species depending on their burrowing depth, intertidal position, robustness of the exoskeleton and the compactness of the sediments (Wolcott & Wolcott, 1984; van der Merwe & van der Merwe, 1991; Schlacher *et al.*, 2007a). In South Africa, van der Merwe & van der Merwe (1991) showed that surf clams (*Donax serra* and *D. sordidus*) and whelks (*Bullia rhodostoma*) are less vulnerable to ORV impacts if buried in compact sand (see also Stephenson 1999), with individual whelks being robust enough to withstand being run over by vehicles even when placed on the beach surface. However, if juvenile surf clams and soft-bodies crustaceans such as the mysid *Gastrosaccus psammodytes* were exposed on or near the surface of the sand, damage increased significantly. Macroinvertebrates on the upper shore (in particular the isopod *Tylos capensis*) are highly susceptible to traffic impacts because of the softer sand and the tendency for ORV drivers to follow in the same tracks. As with turtle hatchlings, *Tylos* become trapped in the tracks thereby increasing their susceptibility to being crushed by passing vehicles.

Numerous studies undertaken on specific indicator species have likewise demonstrated both the sub-lethal and lethal impacts of ORVs. For example, both ghost crabs (*Ocypode* species) and surf clams (*Donax deltoids*) had lower densities and decreased body sizes at beaches with ORV traffic (Moss & McPhee 2006; Steiner & Leatherman 1981; Schlacher *et al.* 2007; Schlacher *et al.* 2008; Thompson & Schlacher 2008). Sheppard *et al.* (2009) reported that ORVs significantly impaired the burrowing performance and some aspects of the body condition of surf clams thereby potentially increasing mortality by causing displacement to less favourable habitats by swash, and intensifying the risk of predation and desiccation. ORV-effects on ghost crabs include decreased home ranges, changed burrowing behaviour and burrow architecture, reduced densities, altered population structures and a shift in burrows distribution across the shore (Moss & McPhee 2006; Maccarone & Mathews 2007; Hobbs *et al.* 2008; Lucrezi & Schlacher 2010; Schlacher & Lucrezi 2010; Lucrezi *et al.* 2014, amongst others).

In many of the studies mentioned above, the magnitude of the impacts could be directly related to the type of vehicles involved, traffic volume, vehicle speed and driver behaviour. For example, the impacts from slow speed access along the foreshore in a straight path differ from vehicles travelling at high speed in dune areas, or turning across the beach face. Different beaches will have different capacities to withstand the impacts of vehicles. Nonetheless, a recent study identified that even low-level vehicle traffic negatively impacts the physical environment of the beach, and the ability of macroinvertebrates to survive in this habitat in the face of the disturbance (Davies *et al.* 2016). Such changes to these communities can have knock-on effects on higher-order consumers such as shore birds and surf-zone fish.

Other impacts of ORV driving on the biodiversity of sandy beaches and dune systems include habitat fragmentation from vehicle-induced dune breaches resulting in disruption of vegetation and accelerated sea or wind erosion. Extensive vehicle tracks through the dunes can result in previously contiguous areas of beach/dune habitat being converted into isolated patches of vegetation, which in turn can lead to an increased ecological vulnerability (Jalava 2004). There is also the potential for vehicles to act as vectors that spread alien or invasive pest plant species. This can occur by the physical transportation of seeds or plant material into new areas or by disrupting the existing indigenous vegetation cover to such an extent that new or invasive species can become established where they previously may not have survived (Sargent 2012).

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