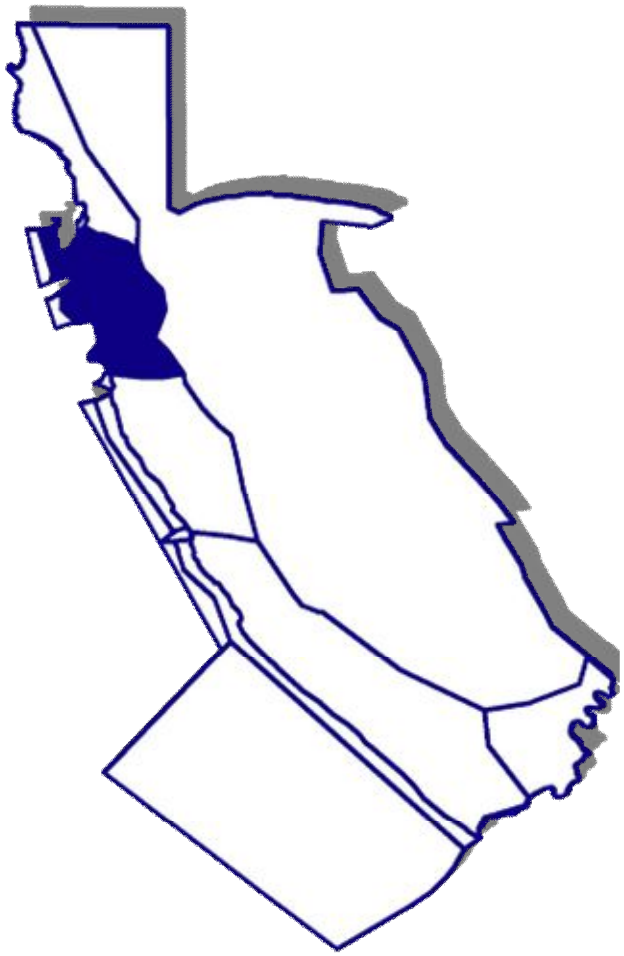

Environmental Management Programme Report for Namdeb's Mining Licence 45 (Elizabeth Bay)

November 2018

NAMDEB

A Namibia De Beers Partnership

Environmental Management Programme Report for Namdeb's Mining Licence 45

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Acknowledgements

This report is a team effort which required input from a multitude of people at Namdeb. Thanks to all.

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Abbreviations and glossary

AA	Anglo American
ADT	Articulated Dump Truck
BP	Before Present
CTF	Contractor Treatment Facility
DEA	Directorate of Environmental Affairs
DIFS	Dry Infield Screening plant
DMS	Dense Medium Separation
EMP	Environmental Management Plan
EMPR	Environmental Management Programme Report
EMS	Environmental Management System
ESA	Early Stone Age
HT	High Tension
IUCN	International Union for the Conservation of Nature (former World Conservation Union)
kV	kilovolt
LSA	Later Stone Age
MA1	Mining Area 1
MET	Ministry of Environment and Tourism
MFMR	Ministry of Fisheries and Marine Resources
ML	Mining Licence
MME	Ministry of Mines and Energy
MSE	Middle Stone Age
MUN	Mine Workers Union of Namibia
MVA	Mega-volt ampere
MWh	Megawatt hour
Nemcom	Namdeb Executive Management Committee
RAC	Red Area Complex
SBP	Strategic Business Plan
SCM	Southern Coastal Mines
SME	Small and Medium Enterprises
SSSI	Site of Special Scientific Interest
TAC	Total Allowable Catch
WIFS	Wet Infield Screening plant

Figures and tables

Chapter 1 Summary

1.1 Introduction

A series of eight Environmental Management Programme Reports linked to Namdeb's licence areas forms the backbone of Namdeb's Environmental Management System (EMS). This report is an update of the 1997 EMPR for ML45 (Elizabeth Bay mining licence area). As this is not a conventional environmental assessment for a new project, the assessment process and structure of the report have been adapted. The main report is deliberately concise and refers to supplementary information in a comprehensive annex.

1.2 Mining and exploration activities

Exploration and mining of the shallow near-surface diamond deposits and accreted beach areas at Elizabeth Bay are presently on-going, with the mine scheduled to operate until end of 2018. Dry-mining operations with excavators and dump trucks, wet-infield screening and transport of ore to the main treatment plant encompass the mining activities.

Figure 01. Elizabeth Bay is the largest embayment along the southern Namib coast south of Grosse Bucht near Lüderitz.

1.3 The natural environment

Elizabeth Bay is a large, south-facing embayment on the Namibian west coast in the arid Namib Desert. The bay comprises a large, originally dissipative sandy beach, rocky headland and an inshore reef. Rocky shore, sandy beach and seafloor are inhabited by marine communities typical of similar West Coast habitats. Kelp beds associated with the inshore reef provide shelter for breeding rock lobster and other marine fauna, and the bay is occasionally frequented by whales and other cetaceans. The beach is partly fringed by *Salsola nollothensis* hummocks, while rocky terrestrial areas support a rich assemblage of plant species. This includes many protected species, as well as ten southern Namib coastal endemics, some of which, such as *Limonium dyeri, Marlothiella gummifera, Lithops optica* and *Synaptophyllum juttae,* are restricted to Namdeb's licence areas. A small breeding colony of the red-listed Damara Tern has been recorded near the beach and brown hyenas frequent the site. Some 15 Sites of Special Scientific Interest, mostly fossil sites, have been identified in ML45.

Figure 02. The area around the mining site is not devoid of animal life as these tracks show.

Figure 03. Remains of the old "Zentralwäsche" bear witness of the mining activities at Elizabeth Bay during the 1930s.

1.4 The socio-economic environment

In 2017 Namdeb contributed N$ 3.14 billion in the form of corporate tax, royalties and export levies to state revenues. Elizabeth Bay mine employs 373 people, 37% of these permanently.

Many sites of historic importance occur in the Elizabeth Bay mining licence, one already developed as one of the most important tourism destinations in southern Namibia – the mining ghost town at Kolmanskop, with the historic mining town at Elizabeth Bay being visited less frequently. Elizabeth Bay has been designated an archaeological hotspot.

1.5 Environmental management to date

Namdeb's Environmental Section with currently seven full-time staff is responsible for all aspects of environmental protection, such as planning, performance

reporting, assurance, impact monitoring and stakeholder engagement. One environmental officer is dedicated to the Elizabeth Bay, Bogenfels and Douglas Bay licence areas), referred to by Namdeb as Northern Coastal Area. All Namdeb's operations are ISO14001:2015 certified and follow De Beer's and Anglo American's corporate standards.

1.6 Environmental assessment

The effects of mining, seawall building, beach accretion and associated pond creation as well as oversize disposal by marine exploration on marine habitats and associated biota are key environmental impacts in ML45. This is particularly important as these target some of the same areas and are therefore cumulative, as well as being further exacerbated by the effects of commercial fishing activities. The disturbance of natural areas on land by stripping and stockpiling are other important environmental impacts in this area.

1.7 Environmental management plan

The Environmental Management Plan outlines overall environmental tasks, provides management actions for all high and significant impacts and describes rehabilitation activities and required monitoring during operations and at closure.

1.8 Annex

The annex summarises the authors' credentials, presents all applicable legislation and provides an impact register, a list of reviewed literature and Namdeb's environmental policies and procedures applicable to environmental management in ML45.

Figure 04. Small hummocks created by the everlasting winds characterise the vegetation in ML45.

Chapter 2 Introduction

A series of eight Environmental Management Programme Reports linked to Namdeb's licence areas forms the backbone of Namdeb's Environmental Management System (EMS). This report is an update of the 1997 EMPR for ML45 (Elizabeth Bay mining licence area). As this is not a conventional environmental assessment for a new project, the assessment process and structure of the report have been adapted. The main report is deliberately concise and refers to supplementary information in a comprehensive annex.

2.1 Background

The backbone of Namdeb's environmental management is a series of eight comprehensive Environmental Management Programme Reports (EMPRs) linked to each of Namdeb's mining licence areas. These were compiled during 1995-1997. Management actions identified and described in these reports were in subsequent years supplemented by external Environmental Impact Assessments, Namdeb internal risk assessments and amendments to environmental assessments for altered projects. The resulting management actions have been incorporated in an environmental management database which is the core tool of Namdeb's Environmental Management System (EMS).

Implementation, additions, amendments and closing of management actions happen continuously to keep the EMS up-to-date. Some 20 years have passed since the first EMPRs and subsequent EIA reports were compiled. There is now a need to consolidate, update and review all these documents. Environmental management at Namdeb is centred on the ISO14001 certified Environmental Management System. This EMPR will form part of Namdeb's EMS.

2.2 Diversions from traditional approach to environmental assessment reports

Because this report is a revision of an existing EMPR and not linked to a new project, the approach prescribed in Namibia's Environmental Management Act (Act 7 of 2007) has been adapted to the current situation. Nevertheless all components of an environmental assessment are included. Scoping is included in this EMPR not as a separate report, but in the form of an impact/risk assessment workshop, which ensured that no new environmental impacts were overlooked. Stakeholder engagement forms part of Namdeb's continuous environmental management (see chapter 6) and no specific public participation process was undertaken for this EMPR review. The regular engagement with stakeholders, however, also includes visits to the mine and Interested and Affected Parties are therefore well informed about Namdeb's activities and have ample opportunity to

provide input. As all mining and related activities described in this report are currently on-going and have been authorised by environmental clearances, no assessment of alternatives was undertaken.

Furthermore, as there is a wealth of information backing this EMPR, this report is deliberately concise and describes the most pertinent aspects that need to be understood by a reader who may not be familiar with the mining operations and the environment in which the activities take place. The report provides the current status of environmental aspects at Namdeb and a view of anticipated activities within the next three years.

Relevant supplementary information, such as legal requirements and statutory aspects, corporate policies, guidelines and reporting, as well as more detailed descriptions of the assessed impacts are therefore provided in an annex. The structure of the report is illustrated in the figure below and the table of contents. The consultants who compiled this report have undertaken environmental baselines, assessments and monitoring for Namdeb for decades and have a combined experience of over 40 years in this area. They are therefore well familiar with all aspects relevant to this assignment (Annex 1).

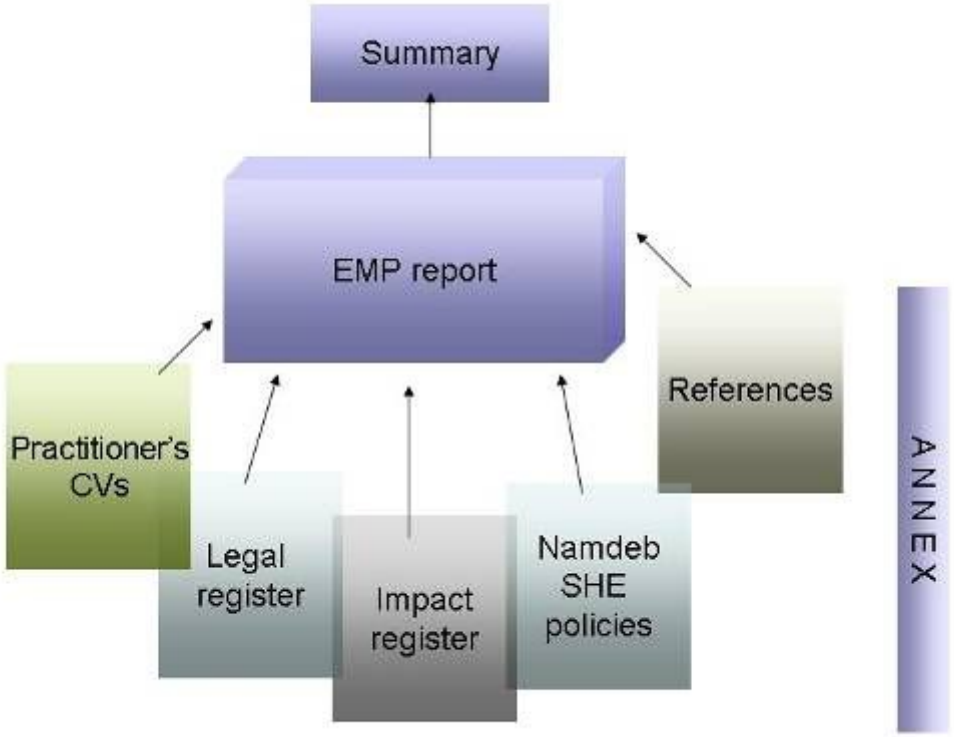

Figure 05. Structure of the Environmental Management Programme (EMP) report.

2.3 Locality, company, legal and statutory requirements

Namdeb Diamond Corporation (Pty) Ltd mines alluvial diamonds in the south-western part of Namibia, now in the Tsau//Khaeb (Sperrgebiet) National Park. The

company is equally owned by the Government of the Republic of Namibia and De Beers Centenary forming Namdeb Holdings. Namdeb Holdings owns Namdeb and De Beers Marine Namibia. Namdeb is lead by the Chief Executive Officer (CEO), and operations are governed by the OPSCO team (mine managers, strategic projects and mineral resources), headed by the Chief Operating Officer (COO). OPSCO and departmental heads form the Namdeb Executive Management Committee (Nemcom) which reports directly to the Namdeb Holdings Board. The Environmental Manager reports to the department head Mineral Resources and Environment.

Namdeb Holdings holds nine mining licences on land and offshore; Namdeb holds eight of these licences. Mining Licence 45 is positioned south of Lüderitz, largely land-based, but also includes an approximately 5km strip offshore.

This EMPR is a requirement of the Minerals Act (1992, Clause 14), Minerals Agreement of 1994 and the Environmental Management Act (Act 7 of 2007). These and all other legislation relevant to this report are provided in Annex 3.

The Ministry of Environment and Tourism's park management plan (2013) zones the ML45 into managed resource protected area, habitat/ species protected area, national park, wilderness, strict nature reserve and protected landscape.

The marine portion of ML45 falls into the Namibian Islands Marine Protected Area (Currie et al. 2008).

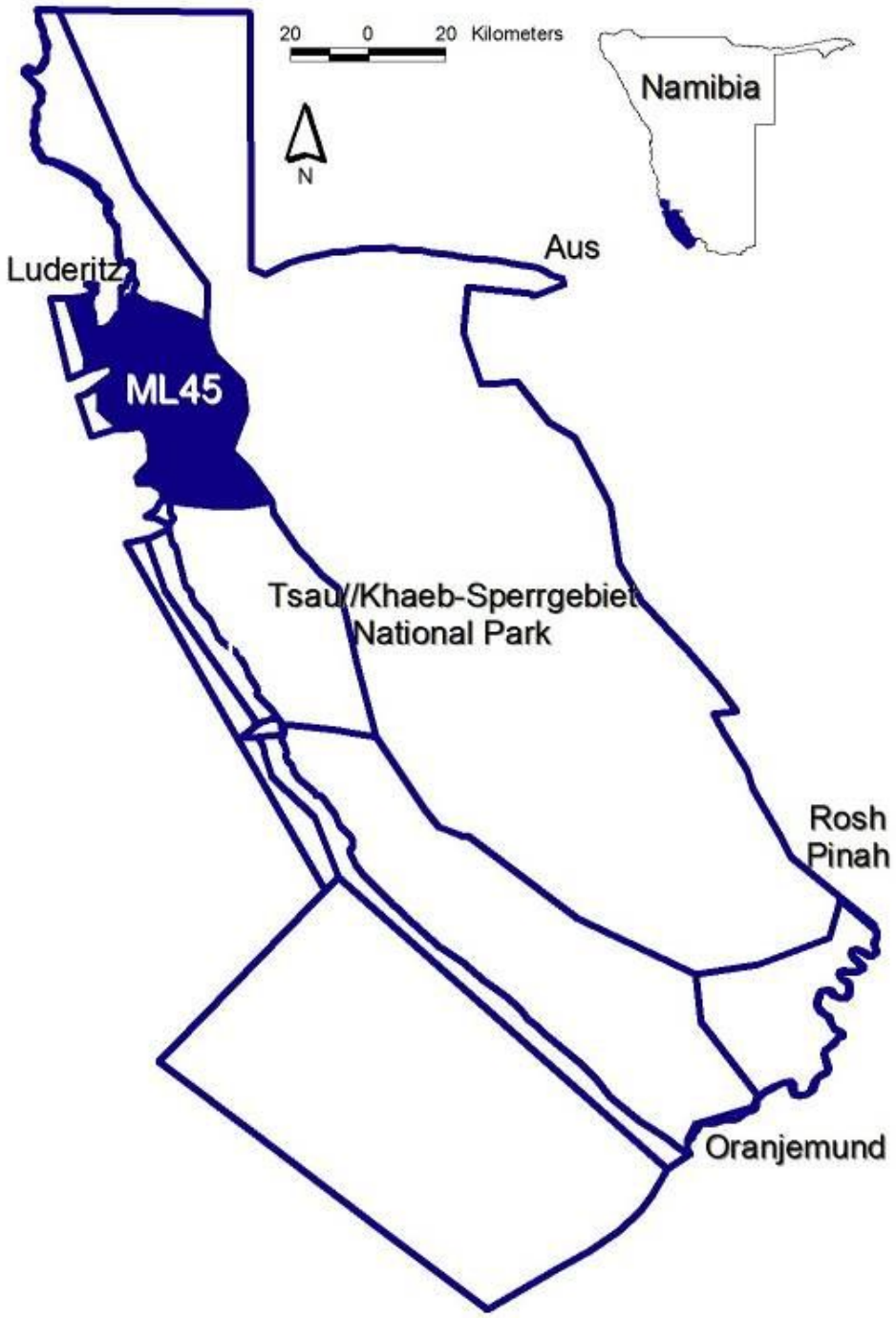

Figure 06. The position of mining licence area 45 in Namibia and the Tsau//Khaeb (Sperrgebiet) National Park.

Chapter 3 Description of activities

Exploration and mining of the shallow near-surface diamond deposit and accreted beach areas at Elizabeth Bay are presently on-going, with the mine scheduled to operate until end of 2018. Dry-mining operations with excavators and dump trucks, wet-infield screening and transport of ore to the main treatment plant encompass the mining activities.

Within the different stages of a life cycle of a mine, exploration, operation and closure apply to ML45 (Elizabeth Bay). Elizabeth Bay Mine has seen several phases of mining since the first diamonds were discovered in 1908. The man-made landscape surrounding the modern mining operations is thus a mosaic of historic and recent mining. The ore deposit is a shallow body of conglomerate, sandstone and superficial layers of deflation grits of approximately 8x3.5km extent and located in a north-south trending sand corridor. The coarse grits have been identified as diamond-bearing and are relatively close to the surface (Namdeb 1997). The diamondiferous deposits are variable, consist of cemented and loose material in close proximity, and often rest on a clay footwall. These materials are difficult to separate and therefore pose numerous challenges during treatment. Overburden (aeolian sand) thickness in the current mining area ranges between 5 and 16m, with an average of 12m, and the area lies below sea level (Pisces 2010).

Most mined out areas in this deflation valley, where the bulk of the excavations took place, have been covered naturally by sand movement in the aeolian transport corridor. The modern mining operations started in 1991, but mining was suspended for 2 years in 2010-2012 during the economic slow-down. The current Life of Mine is until end of 2018.

3.1 Exploration

3.1.1 Land-based

Exploration at Elizabeth Bay took place in newly accreted beach areas in the Southern Resource Extension between March and May 2018 using a sonic drilling campaign to identify diamond reserves. A total of 53 holes was drilled at a 100x100m line spacing. All holes were drilled to bedrock/footwall, clay/footwall or sand. No further exploration is planned for the remainder of the 2018, when the mine is scheduled to close.

3.1.2 Marine exploration

ML45 also includes a marine portion in which exploration and remote mining activities take place. These overlap with those referred to in detail in the EMPRs

for ML128A and 128B. For consistency, the following classification is used in the EMPRs:

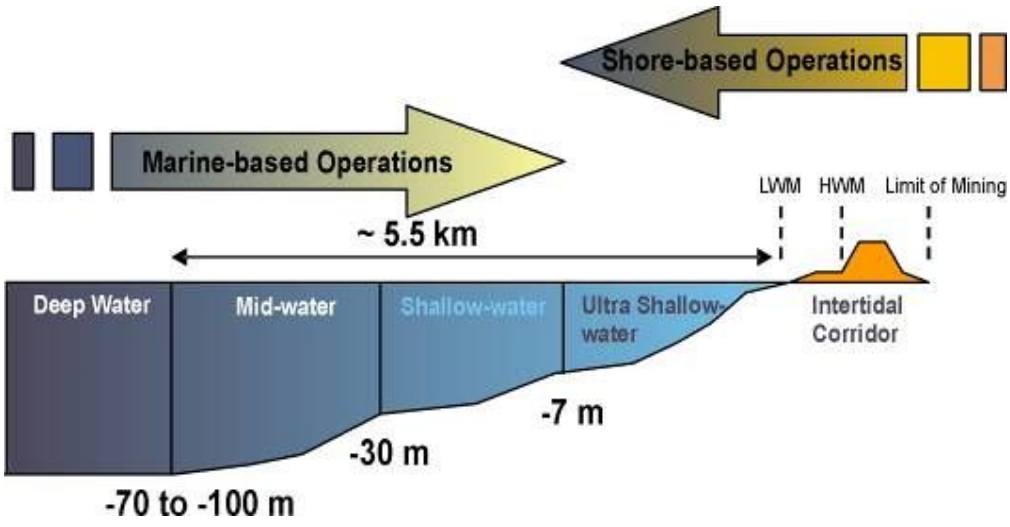

Figure 07. Marine water depth classification used in the EMPRs.

3.1.2.1 Seismic and bathymetric surveys

As mining in deeper water cannot proceed until economically viable accumulations of diamond-bearing gravel have been located with some certainty, Namdeb focussed their efforts during 2007 and 2008 on delineating the offshore geology by conducting a large-scale multibeam bathymetry survey over the entire mid-water area. This was supplemented in 2011 with a seismic survey. Seismic surveys are undertaken from a small (8.6m) fibreglass monohull boat, fitted with two outboard engines to investigate the seafloor in the shallow water and ultra-shallow water (up to -30m below sea level). Following processing and interpretation of the geophysical data in 2012 a regional geological drilling campaign was undertaken beyond -30m depth in 2013. This opened up several new areas in the mid-water region. Based on the results of the seismics and drill samples, further sampling campaigns were undertaken in late 2014, with further campaigns in 2015 and 2016. A sampling campaign is scheduled for late 2018. More high resolution geophysics and fill-in sampling is planned to complement resource development.

3.1.2.2 Sampling

Vessel-based geological drilling and sampling had been undertaken in 2013 to 2015 in the midwater area of ML45 (beyond -30m below sea level) since 2011, with subsequent geological modelling and resource evaluation being underway. Future sampling intends to investigate an area off Elizabeth Bay.

Table 01. Midwater areas in ML45 sampled (m^2) since 2011.

Year	No. of samples	Area sampled m^2	Tool	Vessel
2011	22	110	Borer	Explorer
2013	173	865	Borer	Explorer
2014	378	1,890	STR2	Explorer
2015	114	570	STR2.1	Explorer
2016	20	100	STR2.1	Explorer
2017	0	--		
2018	0	--		

A variety of tools were developed and implemented during the course of the sampling operations undertaken since 1999. These are described briefly below:

Megadrill: a drill sampling bit typically 3.6m in diameter; during an intensive bulk-sampling programme between 15–25 sample holes can be drilled per day, equating to an area of 153–255m^2 per day.

Borer: a subsea sampling tool, which comprises a 2.5m diameter drill bit operated from a drill frame structure, which is launched through the moon pool of the support vessel and positioned on the seabed. The tool has a 5m² footprint and can be implemented in water depths up to 180m. The drill frame structure has a base of 6.5x6.5m, stands 23m high and weighs 147t. The drill bit can penetrate unconsolidated sediments up to 8m depth above the rock or clay footwall. A sample spacing of as little as 20m can be achieved by the dynamically positioned vessel. Depending on sea conditions and the soil's geotechnical conditions, up to 60 samples can be successfully taken per day.

STR2: a drill bit with six slots of equal dimensions, which is fitted onto the tool in the drill frame structure of the sampling vessel. The tool similarly has a footprint of 5m².

STR2.1: a reinforced version of the STR2, which was developed to sample areas with thin overburden and competent footwall. The bit with six slots, of which four have the same dimensions as the STR2 and two slots being slightly larger. The tool similarly has a footprint of 5m².

Any further sampling in the mid-water areas would likely be undertaken by a contracted vessel the *MV The Explorer*. With an overall length of 114.4m and a gross tonnage of 4,677t, the vessel is equipped with sampling tools as described above, which are operated from a drill frame structure launched through the moon pool of the support vessel and positioned on the seabed.

Figure 08. The sampling vessel *MV Explorer*.

Figure 09. The 2.5m diameter drill bit within the drill frame structure.

3.1.2.3 Diamond-gravel processing

The sediments extracted by the sampling tool are fluidised with strong water jets and sucked up riser pipes to the support vessel using compressors to create pressure differentials. The material is discharged onto a series of screens, which separate the oversize (>16mm) and undersize fractions (<1.3mm). All oversized and undersized tailings, which comprise almost 90% of the material pumped to the surface, are immediately discharged back to the sea on site.

The gravel fraction of interest (1.3-16mm plantfeed) is fed through a comminution circuit to fragment the shell, clay and conglomerate components, before being mixed with a high density ferrosilicon (FeSi) slurry and pumped into a Dense Medium Separation (DMS) plant. Low density materials (floats) are separated and discarded overboard. Most of the FeSi is magnetically recovered for re-use in the DMS plant.

The remaining high density fraction is dried and passed through an X-ray sorting machine to separate the diamonds, which fluoresce under X-ray illumination. Non-fluorescent material is discarded overboard and the fluorescent fraction is automatically sealed in cans for transport to shore and final hand sorting. In total, of the material pumped to the surface, over 99% is therefore returned directly to the sea.

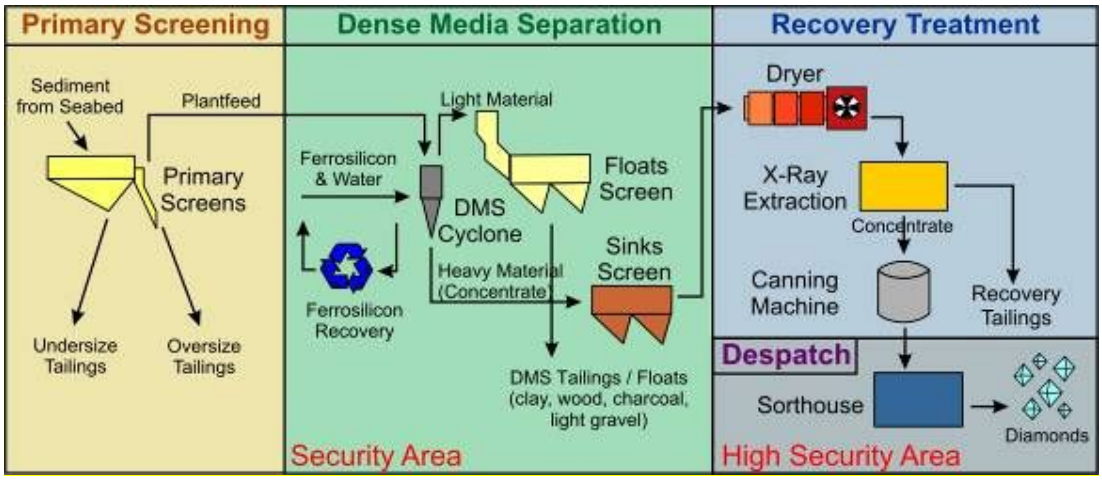

Figure 10. Simplified flowchart of the stages and processes during shipboard processing of marine diamond gravels.

3.1.2.4 Resource development, delineation and definition

Data collected to date has revealed numerous targets, which have been grouped on the basis of their geological complexity into distinct geological zones. Through an Advanced Exploration Study the identified targets would be tested and measured against specific resource development criteria to:

- ◊ Determine their resource potential;
- ◊ Assess their prospectivity using available and applicable technology to test the deposits; and

- ◊ Determine their economic potential through an assessment of the sampleability, mineability and processability of the different deposits.

The resource would then be delineated through identification and development of concepts to economically and sustainably exploit the selected targets. Ultimately the resource will be defined through the development and evaluation of options and the selection of the optimal solution to exploit the selected targets.

Further exploration approaches will include:

- ◊ Sonic coring
- ◊ Geophysical surveys
- ◊ Drilling and sampling following development of appropriate tools and
- ◊ Test mining.

A suitable sampling tool is being developed to investigate specific offshore areas in ML45.

3.2 Mining

3.2.1 Excavation of ore

Mining activities at Elizabeth took place largely in the southern beach areas, called the Southern Resource Extension (SRE). However, due to unfavourable economics the Wet Infield Screening and mining in the Southern Resource Extension area closed in May 2018. Mining then continued in the south central and central north areas. Drilling and blasting activities stopped in August 2018. In the south central and central north areas ore was excavated in a conventional dry mining operation involving excavation, loading and hauling directly to the Main Treatment Plant. However, all mining activities were stopped in September 2018 as Elizabeth Bay was going into 'care and maintenance'. Although mining has stopped in the beach areas dewatering still continues as part of the care and maintenance activities.

The volumes moved are substantial and approximately 1.8 million tons of fines are disposed annually into the bay (Table 1) (N. Andrews, pers. comm. September 2018). These have resulted in beach accretion of approximately 300-1200m in places. The mining in the south central and central north areas is undertaken by a contractor who owns and maintains the earth-moving fleet (P. La Grange, pers. comm. August 2018).

Table 02. Budgeted volumes of material stripped, transported, treated and disposed at Elizabeth Bay Mine (tons) (ROM = run of mine, MTP = main treatment plant, WIFS = wet infield screening plant).

ML45 (tons)	**2017**	**2018**
Overburden stripped	5,852,100	1,553,414
Backfill		684,706
Accretion		934,525
ROM to MDP	1,541,118	1,706,774
Ore treated	2,983,886	2,355,264
Load & haul to WIFS	1,442,768	648,490
Coarse tailings	493,158	546,168
Fine tailings MTP	1,047,960	1,160,606
Fine tailings WIFS	692,529	311,275
Total fine tailings	1,740,489	1,471,882

3.2.2 Infield screening

The Wet Infield Screening plant (WIFS) has been placed on care and maintenance. However, should economic conditions become favourable it will be started up again. When operational, material from the Southern Resource Extension area is pre-screened and produces four stockpiles with product of +400mm, -400+65mm, -64+6mm and -6mm+1.4mm size fraction. All coarse gravel is transported to the main treatment plant and fine tailings are disposed in the sea.

Table 03. Earth-moving fleet in 2018.

No.	Earth-moving fleet
7	40t articulated dump trucks
1	Front end loaders
1	Track dozer
1	Tyre dozer
2	Hydraulic excavators
1	Water tanker
1	Fuel bowser
1	Motor grader
16	Light vehicles

3.2.3 Treatment of ore

During normal mining activities, ore is transported from the mine areas with haul trucks to the main treatment plant. Currently only stockpiles, X-ray material and spillages are fed to the main treatment plant as mining was stopped in September 2018. When WIFS is operational the +400mm and -400mm+65mm fractions are fed into the primary crusher, while the -64mm+6mm goes to a secondary stockpile, to be fed into the primary crusher and the -6+1.4mm to the Dense Medium Separation plant (DMS). Run-off mine material to MTP is mainly fed through the primary crusher and the auxiliary tip scalper. Oversize (+90mm) from the auxiliary tip scalper will be fed through the primary crusher. The material is then processed through MTP and scrubbed, screened and crushed to -6+1.4mm DMS product.

The DMS product is then further concentrated through X-ray facilities in the recovery. The final concentrate is then transported to the Red Area Complex (RAC) in Southern Coastal Mines for final diamond recovery.

The treatment plant uses seawater which is pumped via a seawater intake jetty, with screening and de-sanding facilities, positioned at the north-eastern section of the bay (Elizabeth Bay Point). Process water is currently not recycled.

The only chemical used in the process is 200t of Ferrosilicon (FeSi) in the DMS per year. The majority is recovered and recycled, but in 2008, for example, some 45% was lost, part of this contained in the coarse tailings going to the dump and part with the fines into the sea (Pisces 2010). Although FeSi is not biodegradable, it is neither hazardous, dangerous or considered a marine pollutant (Lillicrap 2011); its affect on the marine ecosystem has been assessed as negligible (Penney et al. 2007; Pisces 2008).

The undersize material (fines <1.4mm) is pumped onto the beach, the oversize (coarse tailings) is disposed on the tailings dump. The dump has a maximum height of 82.5m, with a natural angle of repose of 34 degrees. The treatment process uses seawater and this is supplied via a pump station and pipelines at the northern end of the bay.

By December 2018 the main treatment plant will also be placed on care and maintenance.

Figure 11. The main treatment plant at Elizabeth Bay viewed from the tailings dump east of the plant.

3.2.4 Infrastructure and services

The mining operations and earth-moving fleet are supported by technical services and workshops, waste management, administrative, safety and security personnel. These occupy several buildings at the main plant site and in Lüderitz.

3.2.4.1 Transport: roads, machine and vehicle maintenance

The main access road to the mine turns off the B4 public road near Kolmanskop. There is a network of haul and service roads at the mine site. Those that have been inactive for some time are now partially covered by barchan dunes.

Most vehicle and machine maintenance is carried out at the main plant site where there are large earth-moving workshops, wash-bay, oil separator and fuel station with appropriate bunding. Fuel is supplied by truck and stored in two 83m^3 diesel tanks. The total diesel demand was budgeted at 3.54 million litres in 2018. Diesel consumption is less due to the closure of WIFS in May 2018 and stopping of mining activities in September 2018.

3.2.4.2 Telecommunications and water and energy supply

A fibre optic line from Oranjemund to Lüderitz links Elizabeth Bay to the communication network. The line enters at the southern end of the bay and exits along the main access road. All lines are above-ground on single, wooden poles, except where they cross the roads and the dune field in the south.

The power to the mine is supplied by Nampower via a 66kV single overhead line from the Nampower Namib substation, north-east of Kolmanskop to the plant site at Elizabeth Bay. Here two transformers step down the voltage to a 6.6kV network to supply the mine sites, pumps at the jetty, dewatering pumps in the southern

extension area and the WIFS pond and the various infrastructure at the main treatment plant site. A total of 27,306MWh is required by the mine in 2018.

Freshwater is supplied by Namwater, via a T-off from the Koichab pan water pipeline to Lüderitz to two header tanks and then gravity fed to a potable water reservoir at the mine. The total water consumption in 2017 was 2,033m^3 (C. Fortuin, September 2018).

Seawater is pumped from the sea by six orbit pumps to the desanding reservoir. Kelp is screened off at the desanding reservoir and the reservoir is flushed at regular intervals. Water is pumped from the desanding reservoir to the main reservoir from where it is distributed to the plant.

3.2.4.3 Waste management

Elizabeth Bay mine has its own scrap yard, soft refuse and asbestos disposal site. Waste oil is stored in tanks and collected by Vivo Energy Namibia for recycling. Other hydrocarbon waste is stored in a bunded area in drums. Redundant batteries and tyres are stored in the scrap yard. Batteries are collected and sold back to the supplier. Fluorescent tubes are crushed and stored in drums, as are oil filters. These are transported and disposed at the Walvis Bay hazardous waste disposal site. Scrap was cleared on an ongoing basis until September 2018 by Davy's Scrap World, a local scrap contractor. The remaining scrap and other waste (tyres, piping, cables, etc.) are stored on site pending rehabilitation of the site.

A biofilter-trickling plant at the main plant site treats the sewage from the ablutions at offices, workshops and change rooms. With the closure of WIFS the use of the mining offices and ablution facilities has been discontinued. The WIFS area has one septic tank.

3.2.4.4 Security

The entrance gate to the mine is located near the historic Kolmanskop mining town, some 20km east of Lüderitz. The gate operates 24 hours for mining activities, but visitors are restricted to 8 hours during the day.

3.2.4.5 Accommodation

Nobody lives on the mine site and all personnel commute daily from Lüderitz. Namdeb owns 19 free standing houses and 54 flats in Lüderitz. One of the large houses at the Elizabeth Bay village has been restored and maintained by Namdeb and is temporarily used as a base for contractors.

3.2.4.6 Inactive infrastructure

Historic infrastructure (Elizabeth Bay village, old plant and remains of historic mining up to 1948) at Elizabeth Bay, the historic mining town Kolmanskop and the historic structures at Grillental will remain in the Elizabeth Bay licence area.

Figure 12. A lot of mining history is scattered throughout ML45 – the old mining village at Elizabeth Bay (top), remains of the German "Zentralwäsche" plant and associated buildings (bottom left) and the infrastructure at Grillental (bottom right) are some examples.

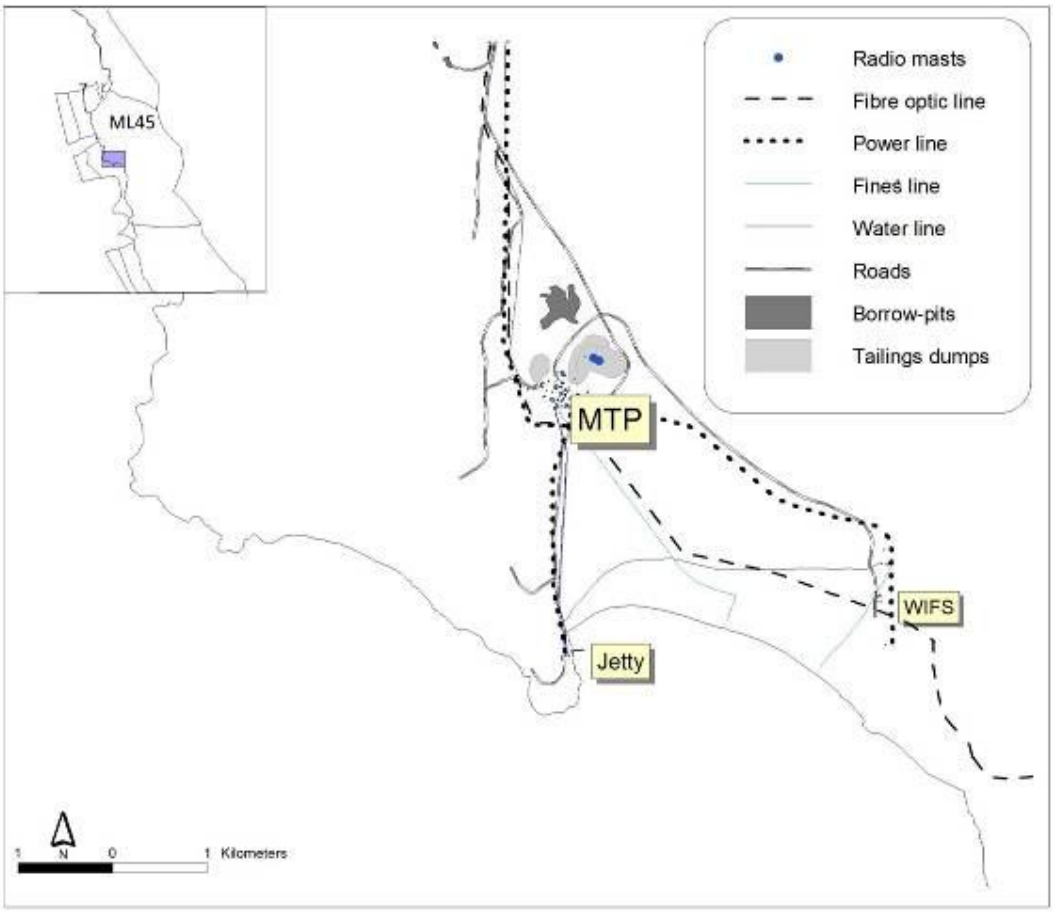

Figure 13. Lay-out of Elizabeth Bay mine and position of the mine in ML45 (MTP= main treatment plant, WIFS= Wet Infield Screening Plant).

WIFS is currently on care and maintenance. Inactive structures also include the old liberation plant, the exploration plant and the Dry Infield Screening plant (DIFS).

3.3 Marine mining

Contractors operate in the shallow-water areas of ML45, using diver-operated suction hoses to extract the target ores either directly from the shore or from custom-built vessels to extract the target ores. Contractors can select a maximum of 20 mining and 20 prospecting blocks at a time from areas pre-determined by Namdeb. These mining blocks are registered for variable periods depending on the economic viability of the blocks. Contractors operate in different areas at different times, so all areas with shallow water blocks and beach mining blocks are indicated on the map below. Although all these areas are provisionally available to the contractors, restrictions on environmentally sensitive areas would apply. The contractors follow all Namdeb's security, health and environment policies and procedures, and an contractor-adapted set of safety procedures.

Activities in the marine portion of ML45 overlap to some extent with those in the adjoining licences ML128A and B. These activities are therefore also described here.

3.3.1 Test mining

Following analysis of the drill samples and establishment of a potential resource, further bulk sampling and/or test mining would be conducted to confirm the economic viability of the resource. Test-mining would be undertaken by a seabed crawler, deployed off a dedicated, contracted mining vessel. The vessel will likely have an overall length of 150m and a gross tonnage of over 9,000t, and be equipped with a track-mounted subsea crawler capable of working to depths up to 200m below sea level. The crawler, which would be fitted with highly accurate acoustic seabed navigation and imaging systems, and equipped with an anterior suction system, would be lowered to the seabed and controlled remotely from the surface support vessel through power and signal umbilical cables. Water jets in the crawler's suction head would loosen seabed sediments, and sorting bars would filter out oversize boulders. The sampled sediments would be pumped to the surface for shipboard processing. The area of seabed to be sampled by crawler can only be determined following analysis of drill samples and development of a resource model.

Figure 14. A typical mining vessel (left) and seabed crawler (right).

Test mining is envisaged for ML45 in the near future as ongoing exploration and resource delineation have identified potential test mining targets in the area off Elizabeth Bay in the inshore portions of ML45.

The test mining programme will guide the preferred mining solution. This will serve to inform the detailed design specifications, resource factors and final technical and economic inputs. These are:

- ◊ Mining rates achievable in the geology in question,
- ◊ Mining extraction factor,
- ◊ Processing factor,
- ◊ Mining / geology configurations, and
- ◊ Mining solution utilisation.

3.3.2 Production mining

Details on the vessels or tools that will ultimately be implemented for production mining operations in the marine portion of ML45 cannot at present be provided as these have not yet been finalised. Research and development of appropriate sampling and mining tools will form part of the conceptual studies and prefeasibility and feasibility phases of the project following development of the inferred resource. Namdeb has committed to maintaining on-going communication with key stakeholders on the progress of exploration and mining operations in the marine environment. Namdeb will engage with stakeholders once the mine plan has been finalised.

3.3.3 Shore-based diver mining

Shore-based diver mining (surf-zone, up to 10m depth) is currently undertaken by a single contractor (Khaxatsus Diamond Mining) at Elizabeth Bay point. Divers are supported from land with a compressed air line and use drag suction hoses to pump up gravel. The gravel is screened with rotary trommel screens to -8mm to +1.8mm concentrate on the beach and then transported to a treatment facility fitted with jigs near the Elizabeth Bay seawater intake. Oversize forms a small tailings dump, usually < 1 m height and positioned below the high water mark, and undersize is returned to the sea. Diamonds are extracted and sorted manually here. Land-based divers operate generators to run pumps and compressor and access the sites on existing tracks. Future operations may also focus on an area opposite Possession Island.

Kelp cutting had been employed by contractors in the past, but then prohibited for environmental reasons until it was demonstrated that the local impact of the divers was of relatively short duration, as the kelp grew back within 4-8 months (Pisces 2008).

Mining rates for shore-based operations are in the region of 0.25m^3 of gravel supplied to the classifier per hour. Because of the limitations imposed by sea conditions, operations are restricted to an average of 5-6 days per month. As an approximate estimate, a shore unit processes only about 70m^3 of gravel per year. As shore-based divers cannot excavate a gravel depth much more than 0.5m, this equates to an area of approximately 35m^2 worked per year.

3.3.4 Vessel-based diver mining

The current vessel-based diver contractor (Alma Marine Trust) employs four vessels with screening facilities on board. A typical boat-based operation consists of a 14-18m vessel with a 6- to 8-man crew, of which 2-3 are divers. The vessels, which operate in -7 to -30m depth, are equipped with centrifugal pumps that operate one or two suction hoses, with the duration of their activities limited to daylight hours for 3-10 diving days per month. Divers, operating on surface air supplies equipped with underwater communications, guide the suction nozzles into gullies, potholes and basin areas to retrieve gravel. On board jig screens classify the material to a concentrate (-12 to +2mm size) with over- and undersize tailings discarded over board directly at the mining site. The concentrate is transported to the Contractor Treatment Facility (CTF) in Lüderitz for final diamond recovery.

Mining from smaller vessels is highly weather dependent and usually limited to no more than 21-days per month, or as dictated by weather windows. Mining rates are comparatively low, ranging from 100-500m^2 for a single diver-assisted mining vessel and averaging a total of ~8,000m^2/year for all diver-assisted operations in ML45. This equates to ~5,200t of sediment excavated annually per vessel, of which ~90% is discarded directly overboard at the mining site

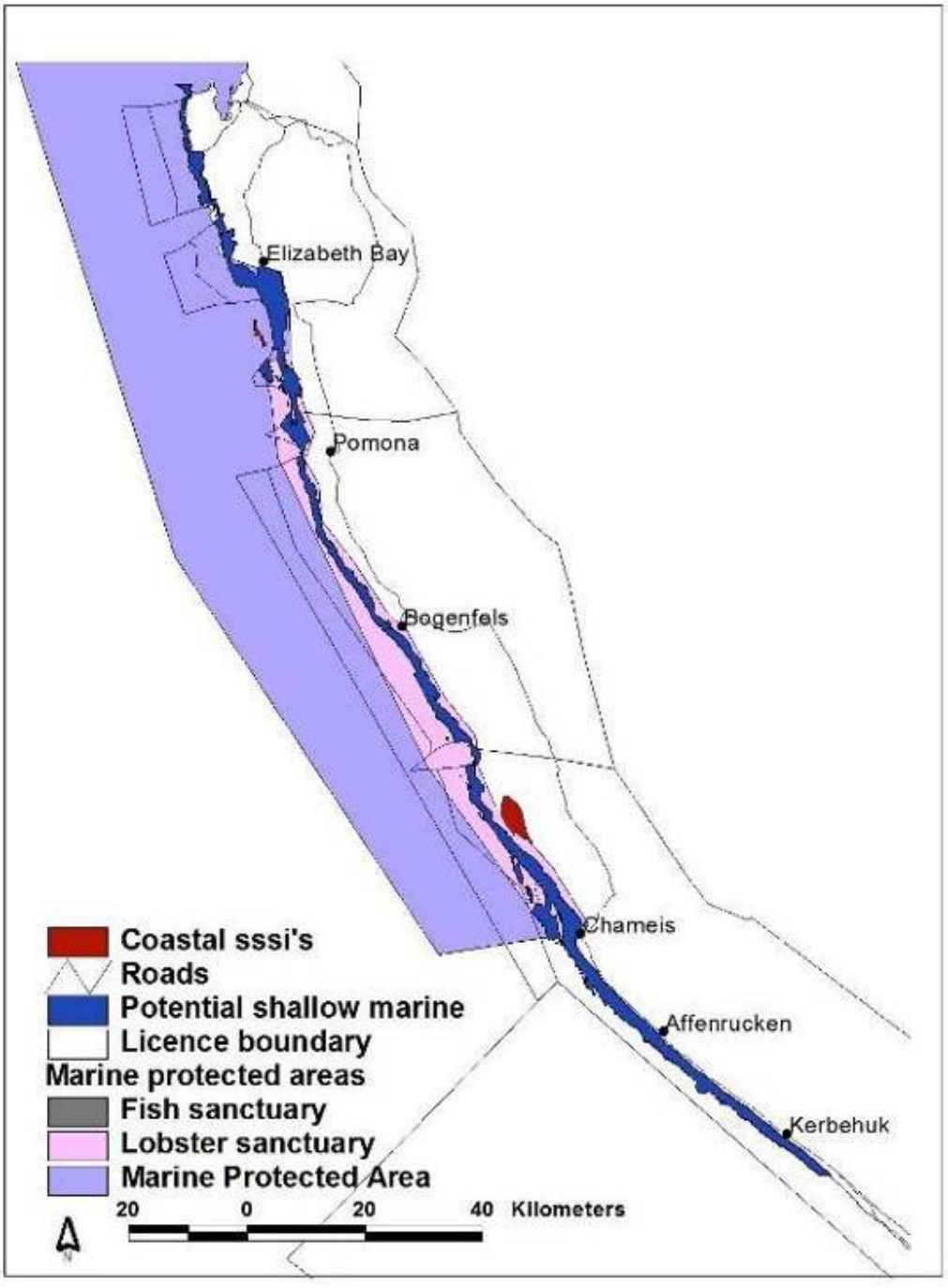

Figure 15. Potential marine contractor mining areas ("potential shallow marine") in relation to Marine Protected Area and Sites of Special Scientific Interest (sssi's) such as islands, seal and bird breeding sites.

3.3.5 Remote-tool operations

A second contractor (African Bounty) employs a 29m-long, 163-ton vessel (the Ocean Dolphin) in water depths of about 17-50m. It is fitted with a crushing and screening plant (-12 to +2mm size), Dense Medium Separation and X-ray facilities thus generating the final product onboard. The gravel is extracted with a suction hose fitted to a 700kg heavy mining tool which is deployed over the stern of the vessel. Over-and undersize are discarded over board at the mining site. Mining rates by remote-tool operations are higher than for diver operations, averaging a total area of ~1,500m^2 annually in ML45. This equates to ~4,050t of gravel excavated annually, of which ~99% is discarded directly overboard at the mining site.

Table 04. Vessels of shallow water mining contractors in August 2018.

Vessel	Size	Crew	Operation
MV Ester	< 25t	6	Shallow marine – diver mining
MV Rachel	<25t	6	"
MV Abigail	< 25t	6	"
MV Thundercat	45t	8	"
MV Ocean Dolphin	163t	12	Shallow marine – remote tool

3.3.6 Contractor Treatment Facility

Marine diving and vessel contractors transport their screened material to a treatment plant in Lüderitz – the Contractor Treatment Facility (CTF). The plant has screening, Dense Medium Separation (DMS) and X-ray facilities. The plant uses seawater for processing and the process water is pumped back into the sea. The material, pre-screened by the contractors, is treated to -12mm to +1.4mm size fraction, and finally hand-sorted. Undersize is temporarily stored in sort tailings bins, oversize in tailings bins. The tailings bins are transported to Elizabeth Bay and treated at the Main Treatment Plant. The tailings remaining from sorting are stored temporarily, re-introduced into the CTF plant and finally sorted by Namdeb. The tailings are then discarded with the other tailings on the Elizabeth Bay tailings dump.

Freshwater, electricity, and waste services are provided by the Lüderitz municipality. Scrap is transported to Elizabeth Bay. CTF has a slipway where the small marine contractors maintain their vessels.

3.4 Rehabilitation

Rehabilitation at Elizabeth Bay focuses on infrastructure demolition and pollution remediation, i.e. waste management. Landscape rehabilitation can to a large extent rely on natural processes, but the currently active mining area and a large borrow-pit to the north of the plant site will require some reshaping of landforms. Based on present planning, a pond will remain at closure. Its final status and future land use will need to be agreed with stakeholders.

Restoration of biodiversity is required where rocky habitats have been impacted, largely through quarries for road material (borrow-pits) along the main access route and possibly where beach hummocks have been eliminated by mining (Burke 2015b).

Figure 16. Beach hummocks frame the northern section of the bay, some were affected by mining.

Rehabilitation to date included demolishing redundant infrastructure when it was replaced by new units and backfilling of some mined out areas.

As active rehabilitation of the marine environment below the low water mark is neither feasible, nor necessary, no seabed rehabilitation and biodiversity restoration programmes are in place. Recovery within the highly dynamic shallow water area occurs rapidly and naturally (Pulfrich & Penney 2001; Pulfrich et al. 2003).

Provisions are made to continue monitoring of the impacted marine ecosystems beyond mine closure as part of the aftercare programme.

Chapter 4 The natural environment in ML45

Elizabeth Bay is a large, south-facing embayment on the Namibian west coast in the arid Namib Desert. The bay comprises a large, originally dissipative sandy beach, rocky headland and an inshore reef. Rocky shore, sandy beach and seafloor habitats are inhabited by marine communities typical of similar West Coast habitats. Kelp beds associated with the inshore reef provide shelter for breeding rock lobster and other marine fauna, and the bay is occasionally frequented by whales and other cetaceans. The beach is partly fringed by *Salsola nollothensis* hummocks, while rocky terrestrial areas support a rich assemblage of plant species. This includes many protected species, as well as ten southern Namib coastal endemics, some of which, such as *Limonium dyeri, Marlothiella gummifera, Lithops optica* and *Synaptophyllum juttae,* are restricted to Namdeb's licence areas. Brown hyenas frequent the site and a small breeding colony of the red-listed Damara Tern has been recorded near the beach. Some 15 Sites of Special Scientific Interest, mostly fossil sites, have been identified in ML45.

The licence area is positioned in the southern Namib Desert, which comprises parts of the Desert – and Succulent Karoo Biomes. The Succulent Karoo Biome is a global biodiversity hotspot (Myers et al. 2000) and managing impacts on biodiversity is therefore critical. Overall, the southern Namib coastline has been identified as environmentally sensitive because of abundance of bird breeding sites, seal colonies and associated predators, such as brown hyena.

In more detail, environmentally sensitive areas in the Elizabeth Bay mining area are:

- Coastal dune hummocks,
- Rocky outcrops and vegetated sand and gravel plains,
- Lichen field,
- Bird breeding sites (e.g. Damara Tern breeding colony in the mining area),
- Artesian well,
- Large valleys serving as wildlife corridors,
- Salt pans,
- Rocky shores, subtidal reefs and sandy beaches,
- Kelp beds,
- Seal colonies,
- Whale calving/breeding area (potentially),
- Historic and archaeological sites, and
- Sites of Special Scientific Interest (mainly fossil sites).

4.1 Climate

Elizabeth Bay licence area falls into a transitional area between the Desert and Succulent Karoo Biomes (Rutherford 1997), which is characterised by extremely

low rainfall (annual mean rainfall at Lüderitz 16.4mm), regular fog (between 50-75 days per year in the Lüderitz area) and year-round strong, southerly winds (77% frequency in summer, 57% in winter, Van der Merwe 1983). Easterly, warm bergwinds occur occasionally in winter, often producing sandstorms (Zoutendyk 1992). Temperatures are moderate (mean annual temperature 16ºC at Lüderitz) and evaporation much lower than inland (around 2,600mm per annum).

4.2 Geology, geomorphology and palaeontology

Geological history in the Elizabeth Bay licence area spans over 1,500 million years with the oldest metasedimentary rocks (mainly gneiss) of the Namaqua Metamorphic Complex exposed as rocky outcrops on the Lüderitz peninsula, towards the east and in a narrow strip to the south along the coast. Slightly younger rocks of the Gariep group (900-570Ma) adjoin to the south-east. Igneous complexes of the post-Gondwana break-up are presented by Schwarzer Berg at the southern border of the licence area. Other remnants of the Cretaceous period (145-65Ma) are silcretes remaining from erosion and subsequent silica precipitation, which have remained in some areas, sometimes capping weathered bedrock of the African surface or older marine deposits.

During the early Tertiary (60-45Ma) formidable rivers drained the inland areas towards the sea at several places, forming the Proto-Kaukausib in the licence area (Pickford & Senut 2000). There are Mid Miocene aeolian and flood plain deposits in the Elizabeth Bay - Grillental area, which are rich in fossils. These include now extinct ancestors of snail, ostrich, rodent, plant, ruminant and carnivore species and even a rhinoceros species (Pickford & Senut 2000). The large sediment deposit at Elizabeth Bay is a combination of Eocene marine, Miocene fluvial and lacustrine and more recent aeolian deposition (Burger et al. 2009).

Figure 17. Former sedimentation processes are well preserved in this typical example of the Elizabeth Bay Formation – now identified as a Site of Special Scientific Interest.

Some 15 Sites of Special Scientific Interest have been identified in ML45, largely related to important fossil finds (Pickford & Senut 2000) and characteristic diamond deposition sites (Burke 2015a).

Elizabeth Bay mine is positioned in one of the five main Aeolian transport corridors along the southern Namib coast, which identifies wind-driven processes as the main geomorphological force in this area.

4.3 Landforms, soils and hydrology

Mobile dunes, coastal dune hummocks, salt pans, sandy valleys, shallow dry river courses, gravel and sand plains and rocky outcrops are the prominent landforms in the licence area. These landforms continue out to sea as submarine ridges, islands, exposed rocks and headlands (Pisces 2010).

Littoral sands dominate along the coast and calcareous, sandy or gravelly soils further inland. They are poorly developed with no evident soil profile and no agricultural potential (Coetzee in Mendelsohn et al. 2002). Wind-blow sands cover many of these desert pavements. Springs, often associated with coastal salt pans occur in the licence area, but many are brackish. An artesian freshwater well is positioned in the mining area and often frequented by wildlife.

4.4 Flora and vegetation

4.4.1 Vegetation

The vegetation is characterised by a fog-dependent flora adapted to endure strong winds and sand-blasting conditions. The Lüderitz peninsula has been identified as a centre of plant endemism in Namibia (Maggs et al. 1998), which includes the rocky habitats to the south and south-east of Lüderitz towards Elizabeth Bay.

Three main vegetation types can be distinguished in the Elizabeth Bay area: Salsola hummocks, barchan grassland and Lüderitz plain dwarf shrubland (Burke 2006). The latter grades into the deflation valley and sand corridor.

Lüderitz plain dwarf shrubland in the Elizabeth Bay area forms small hummocks, with the dwarf succulent shrub *Brownanthus marlothii* being the most frequent component. Many other shrub species (e.g. *Ectadium latifolium, Salsola* sp.), grasses (e.g. *Stipagrostis geminifolia*), bulbs and annuals occur. Several plant species of conservation importance (red-listed, protected, Cites or narrow endemic) such as *Eberlanzia sedoides* and *Fenestraria rhopalophylla* occur.

The rocky areas support many protected plant species such as the succulents *Cephalophyllum, Conophytum, Crassula, Eberlanzia, Fenestraria, Juttadinteria, Psammophora* and even *Lithops* species and also a variety of plants endemic to the Sperrgebiet (e.g. *Brownanthus namibensis, Ectadium latifolium, Euphorbia verruculosa, Eremothamnus marlothianus, Marlothiella gummifera* and *Synaptophyllum juttae*) (Burke 2006).

The vegetation to the west and north of the mine on rocky landforms, as well as the Salsola hummocks on the beach and in the deflation valley have therefore been identified of conservation importance (i.e. sensitive), because of their role as storm barriers and habitat for fauna. There is a localised lichen field in the licence area close to the access road to the mine which is also environmentally sensitive.

Many additional vegetation types occur in the remaining licence area, away from the mining operations, with the Grillental corridor shrubland identified of very high conservation importance, because of concentrations of species with very limited geographical range, such as *Namibia cinerea* (Burke 2006).

4.4.2 Plant endemism

The Sperrgebiet is characterised by a remarkably high level of endemism (Burke 2004), to the extent that some species only occur in Namdeb's licence areas. This is the case for 14 species, while another 11 plant species occur mainly in Namdeb's licence areas (more than 65% of their range). Considering that the entire, or more than 65% of these species' range, in the case of near-endemics, of the world population of these plants occur in Namdeb's licence areas, special consideration needs to be given to protecting these plants. These endemics are mostly coastal species with a narrow distribution range limited to Namdeb's section of the southern Namib coastline and adjoining inland areas. Although some are abundant within their range (e.g. *Limonium dyeri*) Namdeb's licence areas are the only place in the world where they occur.

Ten southern Namib coastal endemic species occur in areas affected by the activities at Elizabeth Bay, either along the access roads or near the mining area. This includes species endemic to Namdeb's licence areas (*Limonium dyeri, Marlothiella gummifera, Lithops optica* and *Synaptophyllum juttae)*, as well as the near-endemics *Crassula elegans* subsp. *namibensis*, *Eremothamnus marlothianus, Euphorbia verruculosa, Pelargonium sibthorpiifolium, Pteronia spinulosa, Tylecodon schaeferianus* and *Zygophyllum hirticaule*.

Figure 18. These four plant species only occur in Namdeb's coastal licence areas and grow in the vicinity of activities related to mining at Elizabeth Bay – from top left clockwise *Limonium dyeri, Lithops optica, Synaptophyllum juttae* and *Marlothiella gummifera*.

4.5 Wildlife

4.5.1 Invertebrates

Although information on invertebrates is scanty, a high level of endemism (i.e. range-restricted species) is expected in many invertebrates groups. For example amongst spiders and their relatives (arachnids and myriapods) a large number of species have been found which are endemic to the Lüderitz peninsula and it was suggested that some intertidal spiders could be affected by sediment disposal into the sea (Griffin 1993b).

In terms of terrestrial insect fauna, the coastal habitats have been identified as environmentally sensitive as many endemic species are expected to be associated with these habitats (Marais 1993).

4.5.2 Reptiles and amphibians

Some 27 species of reptiles and amphibians are likely to occur in the Elizabeth Bay licence area, with another 13 possible (Griffin 1993a). This includes the flagship amphibian desert rain frog *Breviceps macrops*, Namaqua dwarf adder *Bitis schneideri* and the Nama or Berger's padloper *Homopus bergeri*.

4.5.3 Mammals

Gemsbok *Oryx gazella*, springbok *Antidorcas marsupialis*, steenbok *Rhaphicerus campestris*, black-backed jackal *Canis mesomelas*, brown hyena *Hyena brunnea* and Cape fur seals *Arctocephalus pusillus pusillus* are the larger mammals more frequently sighted in ML45. The coast to the north and south of Lüderitz supports the highest recorded concentration of the red-listed brown hyena, linked to the large seal colonies at North and South Long Islands, Wolf Bay and Atlas Bay which provide their food source. Brown hyenas also frequent the Elizabeth Bay point area (Wiesel 2002).

Larger valleys terminating at the coast provide important animal corridors (Wiesel 2002). Large populations of small rodents occur on the inselbergs and plains, supporting predators such as carnivores, snakes and birds of prey.

4.5.4 Birds

Coastal and pelagic seabirds are an important wildlife component in this area. Protected nesting and breeding sites on land are provided at Wolf and Atlas Bays, Lady's Rock and North Reef Island. Possession, Long and Albatross Islands, which lie offshore of the licence area support large breeding populations of seabirds (Kemper 2010). Possession Island is ranked third most important seabird breeding locality along the Namibian coast, based on overall number of birds, diversity and the presence of African Penguins *Spheniscus demersus* and Cape Gannets *Morus capensis* (Williams 1993).

A small population (10 breeding pairs reported in 2009) of near-threatened Damara Terns *Sternula balaenarum*, a Namibian endemic, nests in hummocks near the beach (Braby 2009). Their most important feeding area is in shallow water in the bay (Simmons 2002). Many other coastal and wetland birds, including African Black Oystercatcher *Haematopus moquini*, flamingos, sanderlings, sandpipers, plovers and gulls frequent the Elizabeth Bay beach (Kemper et al. 2007). Foraging in the shallow and midwater areas are also terns, gulls, Cape Gannets, cormorants, petrels and African Penguin (Kemper et al. 2007). Of these Cape Gannet is listed as critically endangered, African Penguin, Bank Cormorant *Phalacrocorax neglectus*, Cape Cormorant *Phalacrocorax capensis* as endangered and the Greater and Lesser flamingos *Phoenicopterus roseus, Phoenicoparrus minor*, Caspian Tern *Hydroprogne caspia*, Damara Tern, African Black Oystercatcher, White-chinned Petrel *Procellaria aequinoctialis* and Hartlaub's Gull *Chroicocephalus hartlaubii* are listed as vulnerable or near-threatened (Simmons et al. 2015).

4.6 Marine environment

Biogeographically, the southern Namibian coastline falls into the cold temperate Namaqua Province, which extends from Cape Point to Lüderitz (Emanuel et al. 1992). The marine ecology of the ML45 coastline is shaped by coastal, wind-induced upwelling and is characterised by cold surface waters, high biological productivity, and highly variable physical, chemical and biological conditions (Barnard 1998). The Lüderitz upwelling cell is the most intense upwelling cell in the Benguela. Unlike most other seasonal upwelling cells along the southern African coast, the Lüderitz cell is a semi-permanent feature with the seaward extent reaching nearly 300km offshore. Marine communities are largely ubiquitous throughout the southern African West Coast region, being particular only to substrate type or depth zone. These biological communities consist of many hundreds of species, often displaying considerable temporal and spatial variability (even at small scales).

Elizabeth Bay is one of only three log-spiral bays on the southern Namibian coastline. The bay is about 4km wide, comprising a sandy beach with a rocky headland forming the western arm and rocky shores backed by sand dunes of the southern Namibian desert forming its eastern shoreline. Although historically a dissipative beach with a diverse invertebrate macrofaunal community, disposal of fine tailings onto the beach over the past two-and-a-half decades have resulted in a coarsening of beach sediments, a concomitant steepening of the beach and alteration of the beach state to intermediate and reflective. This in turn has resulted in a decline in diversity, abundance and biomass of the beach macrofauna, which have changed from a mollusc-dominated community to one dominated by short-lived peracarid crustaceans.

As part of the Environmental Management Plans for the various mining projects within ML45, annual monitoring surveys have been undertaken since 2004 of both sandy beach and rocky shore communities (Pulfrich & Branch 2014a, 2014b).

The communities of rocky intertidal habitats in Elizabeth Bay have similarly been affected by the fines discharges. In particular, the sheltered shores within the bay have a distinctive community composition significantly different from sheltered shores north of Elizabeth Bay due to persistent reductions of grazers, proliferation of ephemeral algae and increased dominance by filter feeders (particularly *Mytilus*

galloprovincialis and the reef-building polychaete *Gunnarea gaimardi (=G. capensis*) and the and-tolerant anemone *Bunodactis revnaudi*. Since the upgrade of the mine in 2004 these effects have also become evident at semi-exposed and exposed shores within the bay, the most critical being the fact that the exposed rocky shores to the south of the bay became completely covered by sediments. Outside the confines of the bay, the rocky shores are inhabited by marine communities typical of similar West Coast habitats. In general, sheltered shores are diverse with a relatively low biomass, whereas exposed and semi-exposed shores harbour a high biomass with low species diversity (Bustamante et al. 1997).

Research on subtidal organisms along the Namibian coastline has been limited, and current knowledge is restricted to reef communities in <30m depth in the area around Lüderitz (Tomalin 1993; Parkins & Branch 1996, 1997; Pulfrich 1998a, 1998b, 2007a, 2007b; Pulfrich & Penney 1998, 1999, 2001; Pulfrich 2007a, 2007b, 2012). In ML45, rocky subtidal habitats in the nearshore areas are dominated by kelp beds (*Laminaria pallida* and *Ecklonia maxima*), which play a major role in absorbing and dissipating much of the wave energy reaching the shore, thereby providing important semi-exposed habitats for a wide diversity of both marine flora and fauna. Growing beneath the kelp canopy and epiphytically on the kelps themselves are a diversity of understorey algae which provide both food and shelter for predators, grazers and filter-feeders associated with the kelp bed ecosystem. These plants and animals all have specialised habitat and niche requirements, and together form complex communities with highly inter-related food webs. The sublittoral invertebrate fauna is dominated by suspension and filter feeders, such as the ribbed mussel *Aulacomya atra* and Cape Reef worm *Gunnarea gaimardi*, a variety of sponges, and sea cucumbers. The dominant grazer is the sea urchin *Parechinus angulosus*. Key predators include the commercially important rock lobster *Jasus lalandii*, various isopods, echinoderms (starfish, feather and brittle stars), and gastropods (*Nucella* spp. and *Burnupena* spp.).

The structure and composition of benthic communities in offshore unconsolidated sediments off southern Namibia is primarily a function of water depth and sediment grain size (Steffani & Pulfrich 2004a, 2004b; 2007; Steffani 2007a; 2007b, 2009). In general, species diversity, abundance and biomass increase from the shore to 80m depth, with communities being characterised equally by polychaetes, crustaceans and molluscs. Further offshore to 120m depth, the midshelf mudbelt is a particularly rich benthic habitat where biomass can attain 60g/m^2 dry weight (Christie 1974; see also Steffani 2007b). Outside of this rich zone biomass declines again. Typical species occurring at depths of up to 60m included the snail *Nassarius* spp., the polychaetes *Orbinia angrapequensis*, *Micronephtys* (*=Nephtys) sphaerocirrata*, several members of the spionid genera *Prionospio*, and the amphipods *Urothoe grimaldi* and *Ampelisca brevicornis*. The bivalves *Tellina gilchristi* and *Dosinia lupinus orbignyi* are also common in certain areas. All these species are typical of the southern African West Coast (Christie 1974; 1976; McLachlan 1986; Parkins & Field 1998; Pulfrich & Penney 1999b; Goosen et al. 2000; Steffani & Pulfrich 2004a; 2007; Steffani, unpublished data).

In contrast to the species-poor surf-zone fish communities off the exposed beaches in ML43 (Meyer et al. 1998), species richness and abundance are relatively high in the sheltered and semi-exposed surf zone areas of ML45, with over 20 species from 17 different families being reported (Clark et al. 1998). The most abundant species included harders, silversides and False Bay klipfish, although white stumpnose, elf and St Joseph sharks were also caught.

The bay is also occasionally frequented by whales and other cetaceans. Within Elizabeth Bay, the area beyond the outer edge of the surf-zone is the calving area and migration corridor for the southern right and humpback whales, respectively. Southern right whales occur in the area between June and November with about five calves born annually (Roux et al. 2001, 2011).

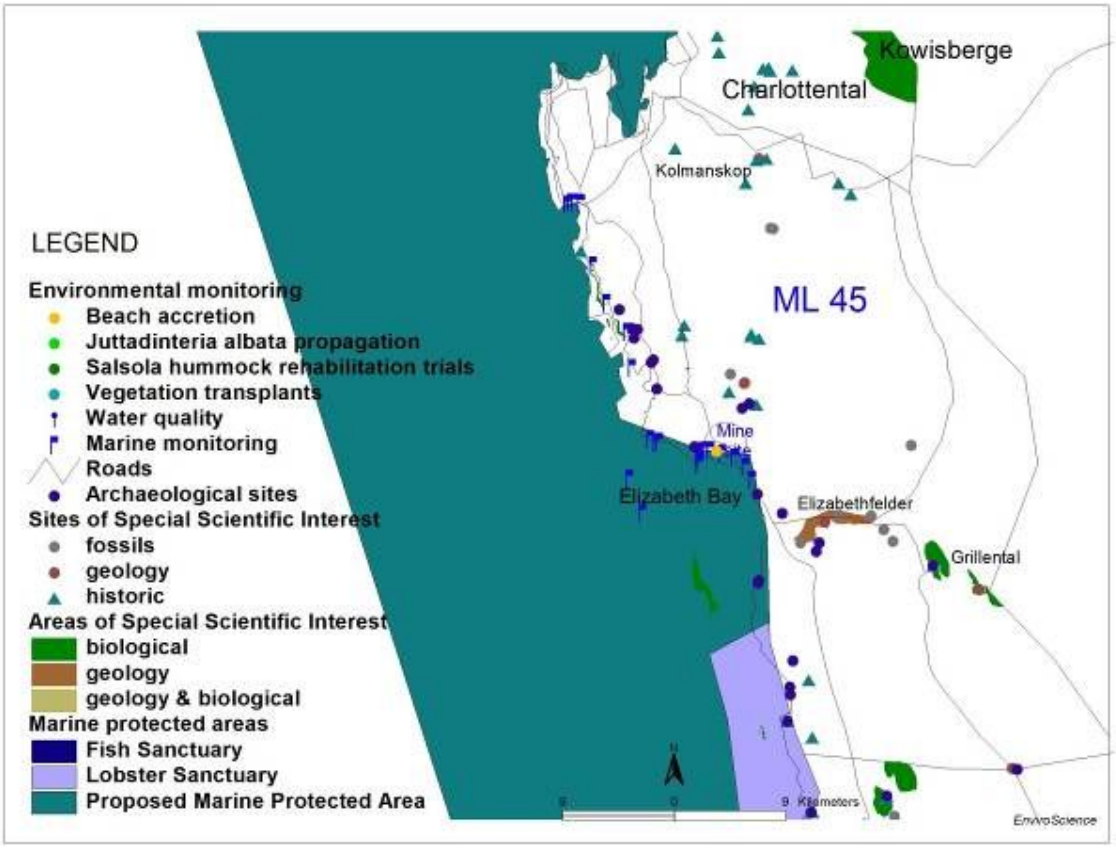

Figure 19. Environmentally sensitive areas in the Elizabeth Bay licence area.

Chapter 5 The socio-economic environment

In 2017 Namdeb contributed N$ 3.14 billion in the form of corporate tax, royalties and export levies to state revenues. Elizabeth Bay mine employs 373 people, 37% of these permanently.

Many sites of historic importance occur in the Elizabeth Bay mining licence, one already developed as one of the most important tourism destinations in southern Namibia – the mining ghost town at Kolmanskop, with the historic mining town at Elizabeth Bay being visited less frequently. Elizabeth Bay has been designated an archaeological hotspot.

5.1 Economic contribution

Mining makes a significant contribution to Namibia's Gross Domestic Product (GDP). In 2017 mining contributed 12.2% directly and 12.8% in real value to GDP (Chamber of Mines 2017). It also contributes to infrastructure and community development and employed 9,643 individuals permanently, 6,373 through contractors and 889 individuals on a temporary basis in 2017 (Chamber of Mines 2017). Mining accounts for 50% of exports from Namibia on average. It is the dominant economic sector in the Karas Region where Namdeb operates. Although employment rates are slightly above the national average, besides the formal sector (mining, fishing, agriculture) there are few other opportunities for employment, as subsistence farming is very marginal in this arid region. Developments in other sectors (e.g. tourism, manufacturing) progress very slowly.

Namdeb's turnover in 2017 was N$ 11.5 billion with a corporate tax bill of N$ 1.92 billion, royalty tax amounting to N$ 1.15 billion and export levies to N$ 71 million (Chamber of Mines 2017).

In addition to the direct contribution to Namibia's economy, Namdeb has a profound positive effect on secondary industries through suppliers, contractors and service providers supported by the diamond mining business. For example in 2014, N$ 123 million were spent on local goods and services by Northern Coastal Mines.

5.2 Human resources

5.2.1 Employment and benefits

Permanent employees at Namdeb receive a monthly package including basic salary, holiday leave allowance and car allowance. Additional benefits are

accommodation (either free, or in form of a housing allowance), leave, medical aid, provident fund, funeral benefits, education grants and removal expenditure.

Table 05. Namdeb employees in 2018 in Northern Areas (L. Profijt, pers.comm. August 2018).

Grade	Employees
A-band	2
B-band	72
C-band	53
D-band	9
E-band	1
Total	**137**

Table 06. Contractors personnel statistics 2018 in Northern Areas (L. Profijt, pers.comm. August 2018).

Contractor	Employees
Blasting & Excavation (B&E)	179
G&J	6
Gecko drilling	17
JK Plastics	3
RBS	7
Southey's	10
Tyre Corp	1
Welwitschia	13
Total	**236**

Over 74% of Namdeb's employees are members of the Mine Workers Union of Namibia (MUN). The Union is represented on human resources committees, home loan and medical schemes.

5.2.2 Work hours and shifts

Office-based personnel at Namdeb work 8 hours daily 5 days a week. Shifts at Elizabeth Bay mine are organised according to a 3-shift rotating continuous operation for Namdeb employees. This is based on a 12-hour shift, two weeks on and one week off-cycle.

Contractors follow their own shift patterns, which are 21 days on, 10 days shore leave for vessel-based employees, five days per week for surf-zone mining and two weeks on and one week off for B&E mining. Other contractors on site work 8 hours daily, Monday to Friday (7h30-16h30).

Bus transport from Lüderitz to the Elizabeth Bay Mine is adapted to this shift cycle. An additional trip on the morning and afternoon transports the office-based employees. Beach and marine contractors only operate during the summer months.

5.2.3 Skill development and training

Employees at Elizabeth Bay Mine qualify for all Namdeb training programmes offering technical and non-technical training. There are no special training needs for Elizabeth Bay. Namdeb provides bursaries to promising, young Namibians for studies in technical disciplines and it has a graduate trainee programme, which offers graduates job experience and on-the-job training.

5.2.4 Health, safety, medical care and emergency response

There is one qualified full-time paramedic available at the First Aid station at Elizabeth Bay. Namdeb has an HIV/AIDS awareness and training programme. Occupational health amongst staff is monitored regularly for exposure to noise and dust.

Namdeb has a disaster plan and staff trained and allocated to implement an appropriate response in an emergency (e.g. fire, floods, accidents, environmental incidents and terrorism). Elizabeth Bay Mine has retained OHSAS certification since 2008. In 2017 two lost time injuries were reported at Northern Coastal Mines.

5.2.5 Education

Children of Namdeb staff in Lüderitz can be enrolled at the secondary school or one of the three primary schools.

5.3 Land use

Elizabeth Bay licence area falls into the Tsau//Khaeb (Sperrgebiet) National Park. The mining area in ML45 was zoned as managed resource protected area, the area outside the disturbed area as national park. The Grillental area was zoned as strict nature reserve and adjoining wilderness area in the management plan for the park (Ministry of Environment and Tourism 2013). Areas linked to the seal colonies were zoned as habitat/species management area and some areas along the road between Lüderitz and Aus as protected landscape.

The marine part of the licence falls into the Namibian Islands Marine Protected Area (Currie et al. 2008).

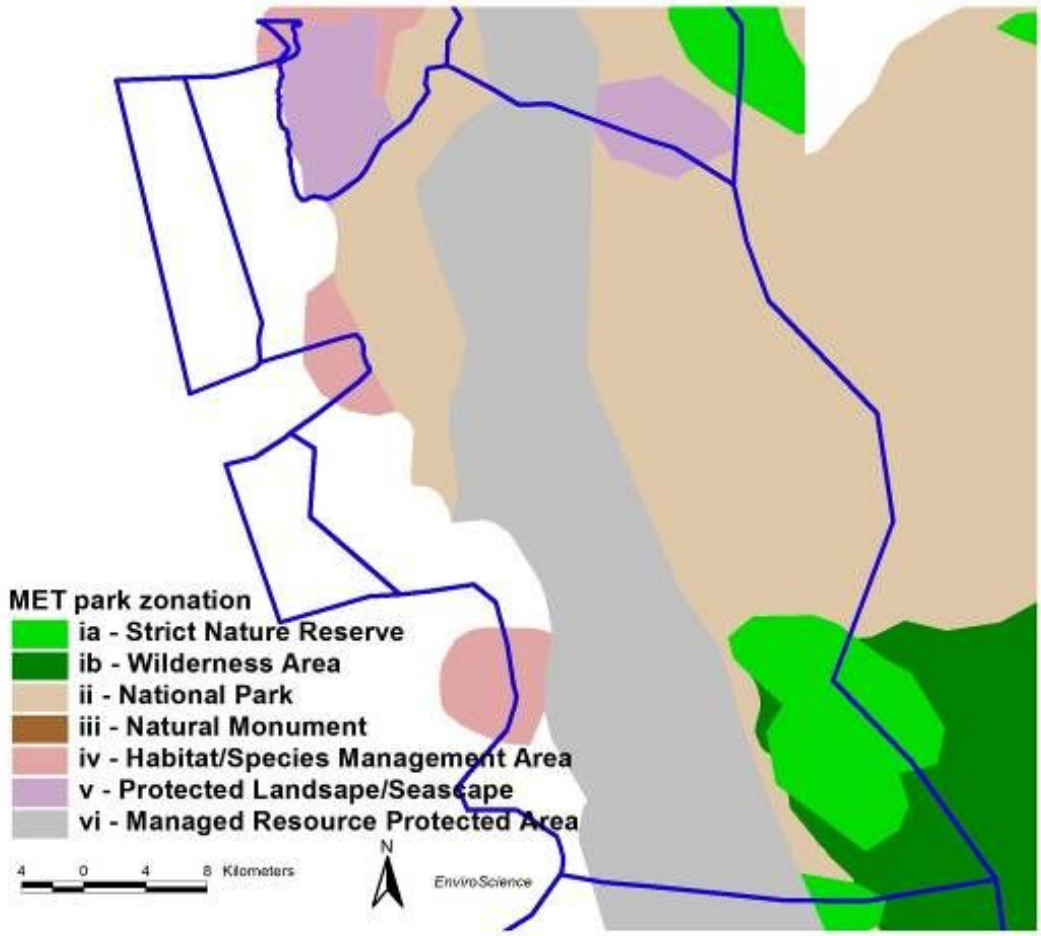

Figure 20. Zoning of the Tsau//Khaeb (Sperrgebiet) National Park in ML45 (MET 2013).

5.4 Cultural heritage

Elizabeth Bay may have already been of interest to early man because of potentially washed up cetaceans (e.g. whales), seal pups and rocky shores with abundant mussels and limpets (Noli 1995). Many Early to Later Stone Age sites, generating material such as a whale skeleton, knives, blades, scrapers and handaxes, and the largest shell midden known from the Namibian coast (unfortunately lost to mining during the 1980s), as well as an artesian well with Early and Middle Stone Age artefacts substantiate this hypothesis (Noli 2002). The Elizabeth Bay area has therefore been identified as an archaeological hotspot (Noli 1995; Hart & Halcett 1999). Although only middens and graves are protected by the National Heritage Act, other artefacts are also of interest, but would need to be left in place to be interpreted in the right spatial and stratigraphic context.

Historical artefacts were created during the start of the first diamond mining operations radiating out from the initial diamond discovery outside of Lüderitz in 1908. Mobile screening plants were used during these early days, remains of which can still be found at Unverhofft and in the northern part of the central deflation valley. There are also remains of houses, narrow-gauge railway lines,

graves and various mining equipment such as classifiers (Noli 1995, 2002). A large processing plant was established near Elizabeth Bay point in 1924 (Schneider 2008).

Of great historic interest in the remaining licence area are the mining "ghost" towns at Kolmanskop and Elizabeth Bay village, already popular tourist destinations, and the water pump station and related buildings at Grillental.

5.5 Corporate social responsibility

The Debmarine – Namdeb Foundation was formed in 2015 with the vision of being a community partner in socio-economic development. For the year ended December 2017 the Foundation spent some N$ 3.4 million on different projects in its focus areas of education (17%), conservation and biodiversity (44%), youth empowerment (22%) as well as other projects (sport (6%) and disaster relief (11%)). In addition, Namdeb approved over N$ 260,000 under a separate social responsibility programme, largely supporting sports events and access to opportunities, 88% of which are in the Karas region (I. Hucke-Mcfarlane, August 2018).

Namdeb also has a social closure team which is developing strategies and programmes to deal with the social aspects of mine closure (C. Neels, pers. comm. August 2018).

In northern coastal areas (ML45) Namdeb sponsorships during the period 2015-2017 amounted to N$ 1,382,280 (N. Paulus, August 2018). This included support to schools, sports, social and environmental events and brown hyena research. During 2018, so far some N$ 186,000 have been allocated to brown hyena research, the crayfish festival, a palaeontological expedition, national clean-up and schools.

Chapter 6 Environmental management to date

Namdeb's Environmental Section with currently seven full-time staff is responsible for all aspects of environmental protection, such as planning, performance reporting, assurance, impact monitoring and stakeholder engagement. One environmental officer is dedicated to the Elizabeth Bay, Bogenfels and Douglas Bay licence areas, referred to by Namdeb as Northern Coastal Area. All Namdeb's operations are ISO14001:2015 certified and follow De Beer's and Anglo American's corporate standards.

Environmental management at Namdeb today encompasses an intricate machine of components relying on and informing each other to address the challenges posed by mining diamonds profitable while taking cognisance of environmental protection. For the purpose of this EMPR the headings in the diagram below structure this section. All aspects described below apply to ML45, as well as Namdeb overall.

Figure 21. The main components of environmental management at Namdeb.

6.1 Planning

Environmental impact assessments undertaken by external environmental practitioners, internal risk assessments undertaken by Namdeb environmental staff and specialist baseline studies are the tools used to inform project planning at Namdeb.

6.2 Performance reporting

Corporate environmental management at Namdeb requires reporting at a multitude of levels internally to De Beers and Anglo American peers, the Namdeb Executive Management Committee (Nemcom scorecard), the General Management Team and the Mineral Resources and Environmental Management Department and externally to the authorities. The figure below provides a summary of the key reporting tools.

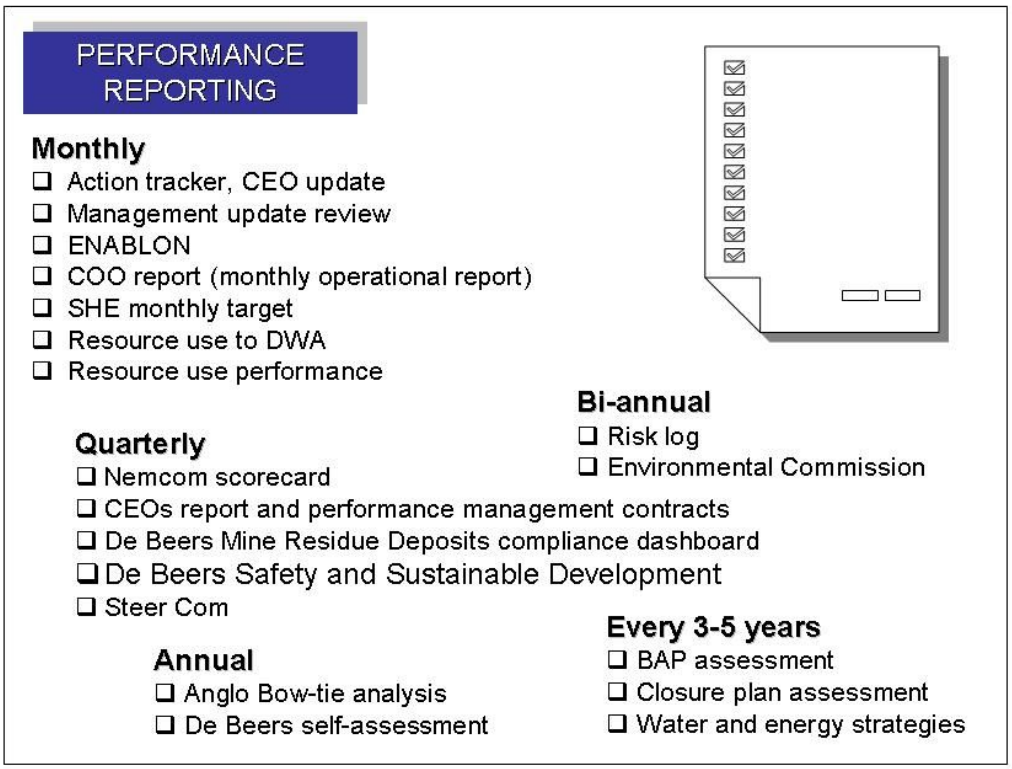

Figure 22. Elements of environmental performance reporting at Namdeb (BAP = Biodiversity Action Plan, CEO= Chief Executive Officer, COO= Chief Operational Officer, DWA= Department of Water Affairs, ENABLON= corporate reporting tool, SHE= Safety, Health and Environment).

ENABLON is Anglo American's computerised environmental platform which facilitates regular updates on-line and thus provides a real-time status of all Anglo-American / De Beers operations.

6.3 Assurance

Environmental performance at Namdeb is certified by auditors, externally and internally and backed by compliance visits from the authorities (e.g. Department of Water Affairs and Forestry) and corporate head office.

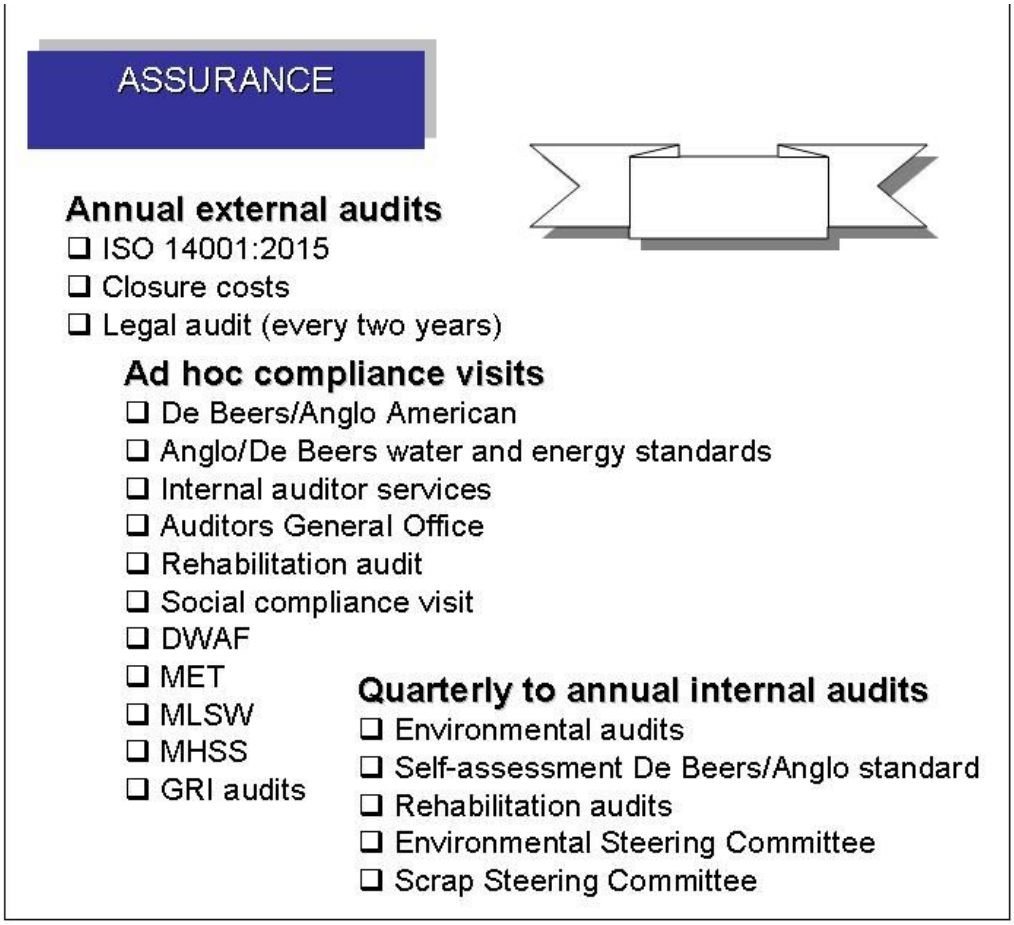

Figure 23. Environmental audits and certification at Namdeb (DWAF= Department of Water Affairs and Forestry, GRI= Global Reporting Initiative, MET= Ministry of Environment and Tourism, MLSW= Ministry of Labour, MHSS= Ministry of Health and Social Services).

All Namdeb's operations are ISO14001:2015 certified. ML45 obtained its first certificate in 2000 and has maintained certification since then. Namdeb transitioned to the new ISO14001:2015 standard in May 2018.

6.4 Impact monitoring

Monitoring of resource use and environmental impacts go hand-in-hand. These are some of the critical functions of Namdeb's environmental section.

6.4.1 Resource use

Namdeb environmental staff regularly collates data on consumption of

- Seawater and freshwater,
- Fuel,
- Energy, and
- Selected chemicals used in processing.

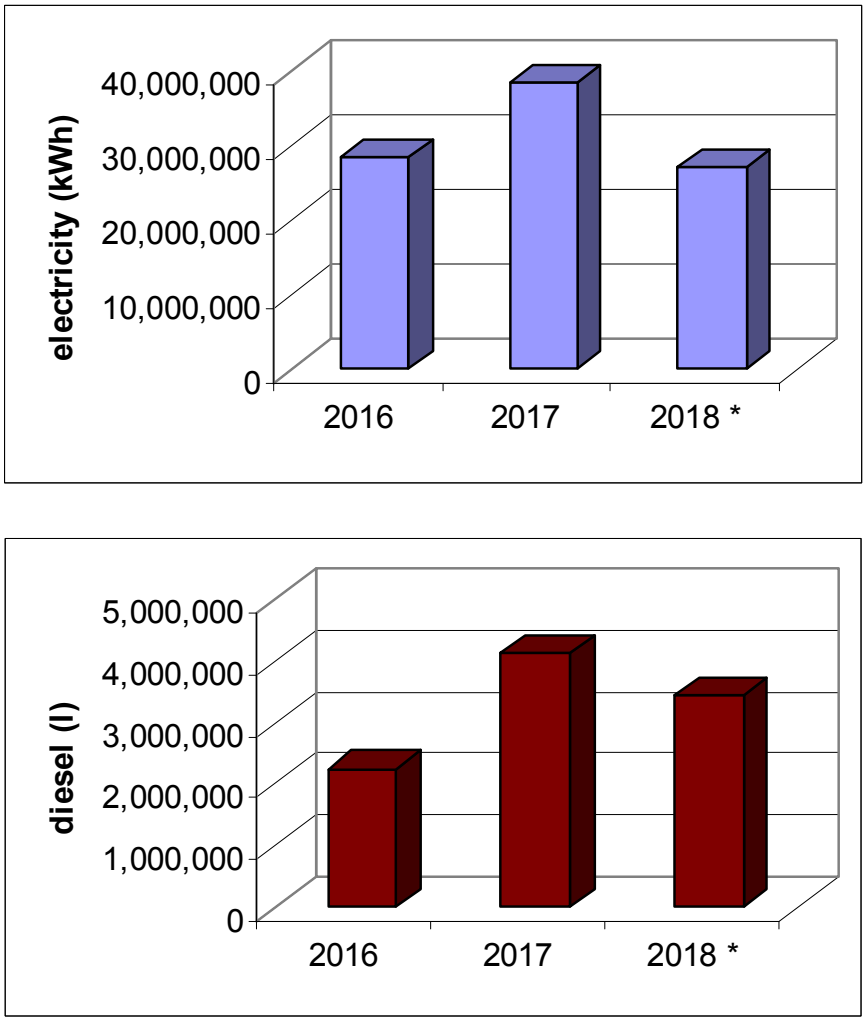

Figure 24. Energy and diesel consumption at Elizabeth Bay mine during the period 2016-2018 (* = budgeted figure, other figures are actual consumption).

Increased mining activity in 2017 resulted in higher consumption of energy, diesel, seawater and Ferrosilicon.

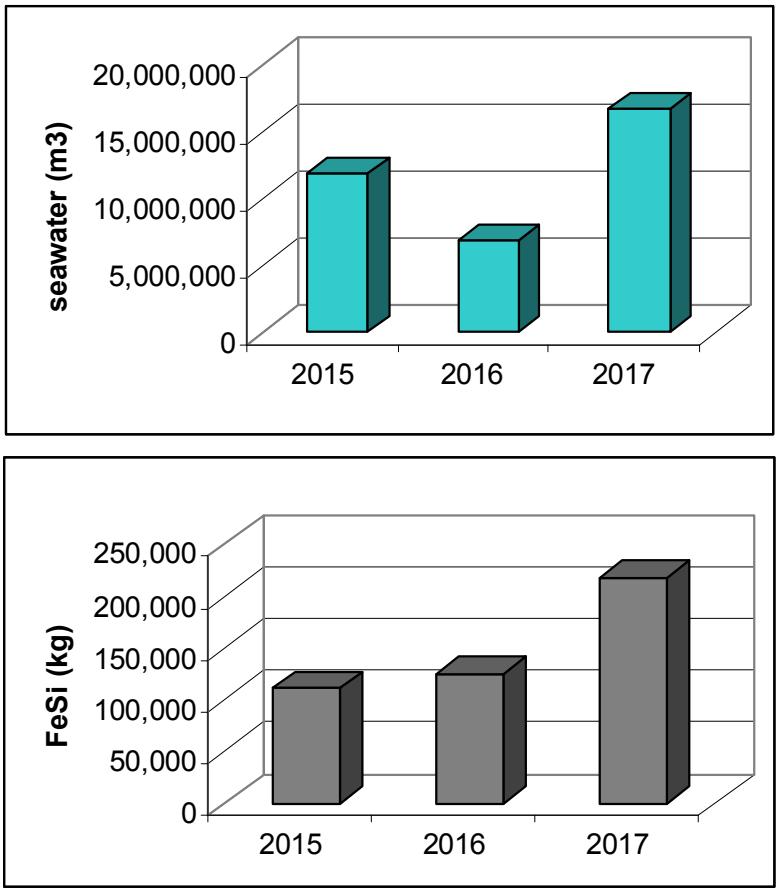

Figure 25. Seawater and Ferrosilicon consumption at Elizabeth Bay mine during the period 2015 - 2017.

6.4.2 Pollution monitoring

Regular pollution monitoring in ML45 focuses on water quality of effluent water and carbon emissions. Staff's exposure to dust and noise is monitored when the need arises.

As part of the water disposal permit issued by Department of Water Affairs (DWA), sewage and oil water separator effluent samples are taken quarterly and sent for analysis. The results are forwarded to the Ministry of Agriculture and Forestry on an annual basis.

Table 07. Pollution monitoring at Elizabeth Bay Mine.

Component	Monitoring points	Parameters	Frequency
Fresh water quality	Effluent water (raw sewage before and after chlorination)	Microbiological and chemical analysis	Quarterly
Carbon emissions	Determined from diesel, oil and electricity consumption		Monthly
Dust		Dust suppression measures	On a needs basis
Noise		Noise level	On a needs basis

6.4.3 Impacts on biodiversity

In 1992, Namdeb launched its first coastal biological monitoring program in Elizabeth Bay with the principal objective of investigating the long-term effects of the fine tailings on the composition of rocky intertidal and subtidal communities in the vicinity. Rocky intertidal and subtidal sampling was conducted annually until 1998, when the monitoring programme was discontinued. Annual sampling of rocky habitats was resumed in 2004.

The Elizabeth Bay beach was first sampled in 1993 (McLachlan & De Ruyck 1993), when two transects - a southern and central site on the Elizabeth Bay beach - were surveyed. This was expanded the following year to include further sites on the Elizabeth Bay beach, as well as reference sites at Grosse Bucht to the north (McLachlan et al. 1994). With upgrade of the mine in 2004, it was considered appropriate that biological sampling of the Elizabeth Bay beach be re-introduced, with the survey conducted in 2004 serving as a 'baseline' and the subsequent 2008 survey serving as the first monitoring survey to assess the impacts of increased fine sediment discharges from the plant. Annual monitoring of the beach macrofaunal communities was implemented following temporary cessation of discharges in 2009 and in preparation for the mining of the Southern Resource Extension Area.

A marine monitoring programme of benthic macrofaunal communities in unconsolidated sediments was initiated in 2008 as part of Namdeb's mid-water operations. A further baseline survey, prior to test mining of the Purple, Bogenfels and Channel features in the offshore portions of ML43, ML44 and ML45, was undertaken in December 2015.

Namdeb has supported the Brown Hyena Research project since 1999. Some of the projects' activities have generated important insights on brown hyena casualties, movements and behaviour in the National Park related to mining impacts. Brown hyena beach counts are undertaken by Namdeb environmental staff ad hoc and reported to the brown hyena research project.

Namdeb supported the marine predator monitoring (Southern Right whales and selected birds (African Penguin, Bank Cormorant and Cape Gannets)) project in 2015.

The marine life sightings programme at the Ministry of Fisheries and Marine Resources is also supported by Namdeb.

6.4.4 Footprint

Accumulating sediments have completely covered about 750m of rocky coastline in the western corner of the bay, and affected a further 2,000m in the south-eastern corner. This constitutes 55% of the available rocky shore in the west of the bay (measured from the base of the original western shoreline (CSIR 2001) to the southern-most tip of Elizabeth Point: 26°55´29.63˝S, 15°11´19.69˝E1), and 66% of the available rocky shoreline in the south-east of the bay (measured from the base of the original eastern shoreline (CSIR 2001) to the southeastern-most tip of the Bay: 26°56´48.45˝S, 15°13´49.06˝E) (Pulfrich 2018).

The low water spring tide mark on the Elizabeth Bay beach is regularly surveyed to track accretion within the bay. Likewise, bathymetric surveys have been regularly undertaken in the bay to monitor sediment accumulation since 1990.

Progradation in the western corner of the beach amounts to ~550m beyond the original shoreline, whereas the eastern portion of the bay has accreted by ~1,100m.

6.5 Stakeholder engagement

Effective environmental management cannot be achieved in isolation. Engaging stakeholders and creating awareness is therefore an important function of Namdeb's environmental staff. In addition to *ad hoc* public consultations related to impact assessments for specific projects, Namdeb has two regular, external channels for information exchange – the Marine Scientific Advisory Committee and the Namdeb Stakeholder Forum.

[1] Using an overlay of the CSIR 2001 shoreline on a GoogleEarth Image.

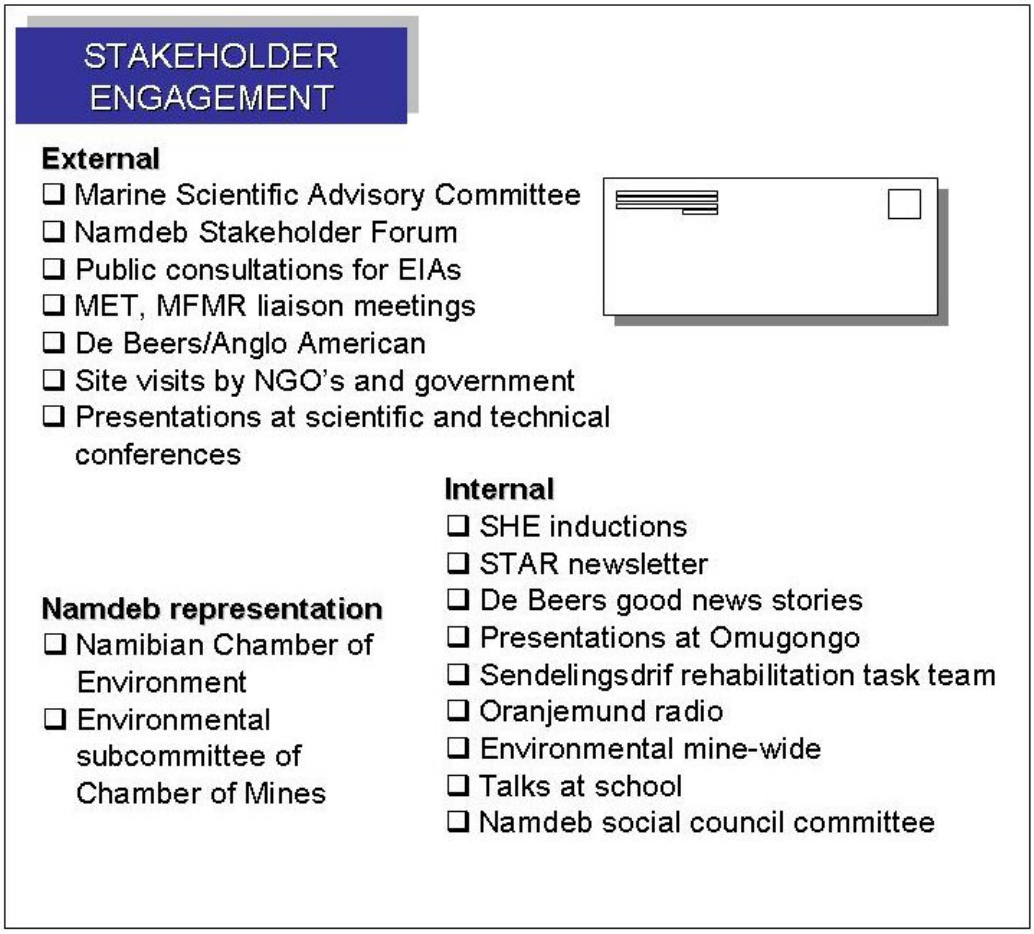

Figure 26. Stakeholder engagement, training and awareness in environmental matters at Namdeb (EIA= Environmental Impact Assessment, MET= Ministry of Environment and Tourism, MFMR= Ministry of Fisheries and Marine Resources, NGO= non-governmental organisation, SHE= safety, health and environment).

Awareness for environmental matters is created through environmental inductions which form an integral part of the compulsory Safety, Health and Environment (SHE) inductions for all staff and contractors accessing Namdeb's operations. Contributions are also made to regular newsletters and presentations. Namdeb is represented on many working groups dealing with environmental matters affecting Namdeb's licence areas. Namdeb has committed to maintaining on-going communication with key stakeholders on the progress of exploration (including marine exploration) and mining operations in ML45.

Chapter 7 Environmental assessment

The effects of mining, seawall building, beach accretion and associated pond creation as well as oversize disposal by marine exploration on marine habitats and associated biota are key environmental impacts in ML45. This is particularly important as these target some of the same areas and are therefore cumulative, as well as being further exacerbated by the effects of commercial fishing activities and marine mining by other licence holders. The disturbance of natural areas on land by stripping and stockpiling are other important environmental impacts in this area.

7.1 Approach

Environmental risks at Namdeb are continuously reviewed and updated, depending on magnitude of the new disturbances to the environment, following the formal environmental assessment process or, in the case of minor changes to existing mining and exploration activities, internal risk assessments undertaken by Namdeb's environmental staff. To ensure that all environmental risks are covered, all these reports were reviewed, discussed and re-assessed, where necessary, at a risk assessment workshop with Namdeb's Environmental Section in Oranjemund 22-23 September 2015. Activities were reviewed in 2018 and the risk matrix updated accordingly. Following an agreed assessment methodology, environmental risks were summarised in an impact matrix for each licence area for the natural and socio-economic environment.

7.2 Assessment methodology

Namdeb has to follow Anglo American's corporate procedures, one of which is a pre-scribed risk assessment, referred to as the 5x5 matrix. This 5x5 matrix also underlies the assessment process for environmental aspects in the computerised EMS (IsoMetrix). The Anglo 5x5 matrix includes the standard criteria "extent", "duration" and "likelihood" which form part of all environmental impact assessment procedures. "Magnitude/severity" is described as "receiving environment/ ecosystem context". An overall significance rating is calculated from the ratings of these individual criteria by averaging the score of extent, duration and receiving environment and multiplying this with the score for likelihood (Table 8 and 9). During the assessment at Namdeb descriptive criteria were added for the assessment of visual and social impacts and for resource use, as these were inadequately catered for in the 5x5 matrix.

Table 08. Environmental assessment criteria from Anglo 5x5 matrix.

Score	Extent	Duration	Likelihood
1	Affecting small area (metres)	Days or less	Rare (7.5%)
2	Limited area (hundreds of metres)	Weeks	Unlikely (15%)
3	Extended area (kilometres)	Months	Possible (30%)
4	Sub-basin scale (marine: regional)	Years	Likely (60%)
5	Whole basin (marine: international)	Permanent	Almost certain (99%)
	Receiving environment		
1	Highly altered with no sensitive habitats and no biodiversity value/ no ecosystem services value		
2	Altered with little natural habitat and low diversity value/low ecosystem services value		
3	Largely natural habitat/moderate biodiversity value/moderate ecosystem services value		
4	Sensitive natural habitat with high biodiversity value/high ecosystem services value		
5	Sensitive natural habitat with very high biodiversity value/very high ecosystem services value		

Table 09. Significance levels based on the Anglo American risk assessment matrix.

Score	Significance
1-5	Low
6-12	Medium
13-20	Significant
21-25	High

This assessment process does not provide for assessing the reversibility of the potential impact. This has been added as an additional criterion in the impact register (Annex 3).

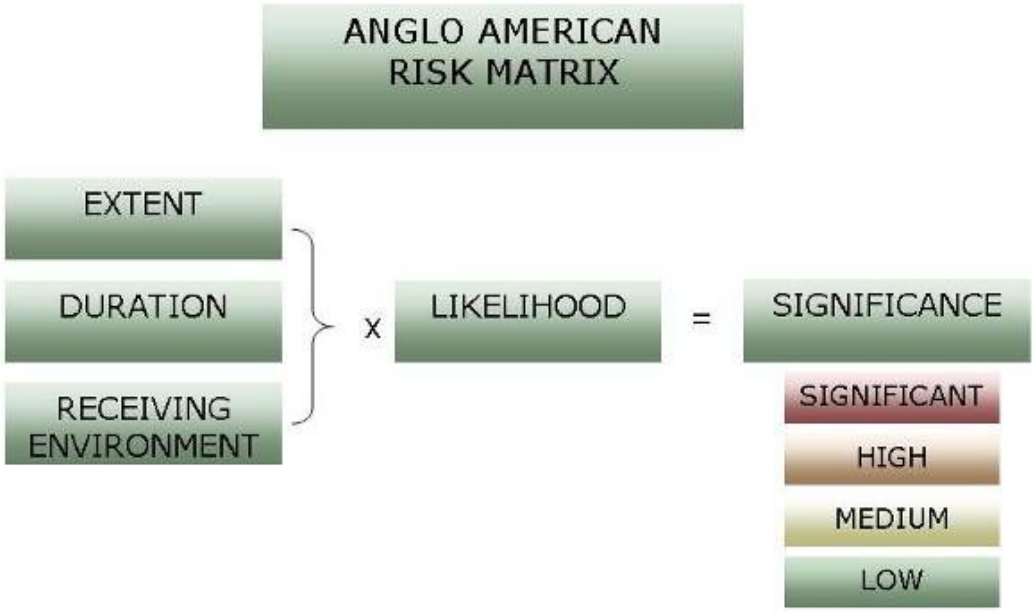

Figure 27. The algorithm used in the Anglo-American risk matrix.

7.3 Environmental risks and their significance

Description of all high and significant impacts is provided in Annex 3. Mitigation measures are included in the Environmental Management Programme (EMP) for all high and significant impacts, and some medium and low impacts where mitigation is very effective and presently applied.

Table 10 shows the main negative impacts on the natural environment associated with exploration and mining activities in ML45. This is a summary of the detailed impact assessment undertaken using the Anglo 5x5 risk matrix. In this overview activities with identical risk ratings were combined, where feasible, and impacts have been divided into nine main impact categories. More detailed descriptions of individual impacts are provided for significant impacts in the impact register (Annex 3). No "high" impacts were identified, but a fair number of impacts were rated "significant".

The effects of seawalls, accretion and associated pond creation and oversize disposal by marine exploration on marine habitats and associated biota are key environmental impacts in ML45. The disturbance of natural areas on land by stripping and stockpiling are other important environmental impacts in this area.

Table 10. Summary of rating of negative environmental impacts on the natural environment associated with activities in ML45 based on 5x5 Anglo risk matrix.

ML45	Habitat loss	Habitat change	Loss of biota	Effect on biota	Water quality	Soil quality	Air quality	Natural resource use	Visual
EXPLORATION									
Drilling, trenching and sampling pits disturbed areas	M								
MINING									
Stripping in natural areas and transport of material	S		S	M			M		
Seawalls and accretion	S	S	S	M	M				
Pond creation		S							
Stockpiling of screened material in natural areas	S		S						M
Stockpiling of screened material in disturbed areas	M								
Infield screening	M		M						
Coarse tailings disposal									S
Fines disposal to sea		M			M				
Blasting				M			M		
Ferrosilicon losses with tailings					L				
MARINE EXPLORATION AND CONTRACTOR MINING									
Geophysical surveying				L					
Seabed mining by marine contractors			S						
Oversize disposal to sea during marine exploration			S						
Oversize disposal to sea by marine contractors			M						
Oversize disposal on land by marine contractors			M						
Fines disposal to sea by marine contractors					L				
Effect of marine mining and exploration on NIMPA	L		M						
SERVICES AND INFRASTRUCTURE									
Road maintenance in natural areas	S		S				M		S
Dust on existing, unpaved roads				M			M		
Machine and equipment maintenance					M	M			
Fuel supply					M	M			
Energy supply and consumption	S		M				L	S	S
Erection and dismantling of temporary powerlines			M						

ML45	Habitat loss	Habitat change	Loss of biota	Effect on biota	Water quality	Soil quality	Air quality	Natural resource use	Visual
Fibre optic lines and radio towers									S
Pipelines			M						
Fencing inside National Park		M	L						S
Reportable hydrocarbon spill near water source					S	M			
Reportable hydrocarbon spill mine site					M	M			
Solid waste management									M
Waste management on vessels					S				
Natural resource use by marine exploration and contractor mining								M	
Loss of equipment from vessel	L	L							
Air support to mining vessels				L					

Table 11. Summary of positive and negative impacts on the socio-economic environment related to activities in ML45.

SOCIO-ECONOMIC	Positive	Social structure
Positive		
Contribution to Namibian economy	S	
Increased skills and employment	S	
Development of technology	S	
Improved scientific knowledge (geology, biodiversity and heritage)	S	
Community support and awareness	S	
Sustained employment	S	
Sustained social services	S	
Negative		
In-migration		M
Labour migration system		M

7.4 Cumulative effects

7.4.1 External factors

7.4.1.1 Commercial fishing

Commercial fishing has a considerable effect on fish populations. In this context the rock lobster industry is of particular relevance to ML45. This makes it difficult to separate the impacts of mining on fish populations from those of commercial fishing and has resulted in a several-decade standing and still continuing debate between the mining and fishing sector.

The commercial rock lobster fishery in Namibia is based in Lüderitz, but the most important southern fishing grounds are located off Kerbehuk in ML43 and areas around Plumpudding Island and Chameis are occasionally fished (J. Calaca, Rock lobster fisherman, pers. comm.). The inshore areas of ML45 are seldom fished by the commercial fleet.

7.4.1.2 Climatic variations

The marine environment is most severely affected by changes in climate, which could result in sea level rise, shifts in large currents, changes to the physical conditions of seawater and effects on local climate. Which way these climatic changes will manifest themselves is still poorly understood, but there is a potential that these either intensify or alleviate the impacts of changes to the coastline resulting from mining. While a sea level rise would facilitate natural rehabilitation of the mined areas, a possible change in local weather patterns, such as storm patterns and wind regimes may have the opposite effect.

7.4.1.3 Other marine mining

The Elizabeth Bay mining licence is offshore directly adjoined by another Namdeb mining licence, ML128A and 128B, but also by licence areas held by Samicor. Activities in these adjoining offshore licences affect many of the same marine habitats such as subtidal reefs.

Namdeb's and other marine operators' activities, as well as the fishing sector have created a steady in-flux of job-seekers to Lüderitz, which puts strains on the local municipality and existing social structures and services.

7.4.2 Namdeb internal factors

There is sediment disposal from multiple sources along the southern Namibian coast, which is all transported northwards by the long-shore drift of the Benguela current. This may also contribute to sedimentation at Elizabeth Bay.

Seafloor mining and sediment disposal often occurs repeatedly in the same areas. If a minimum of five years is allowed for natural recovery of marine communities, this is likely not an issue in the ultra-shallow and shallow water areas. The marine

habitats affected by fines disposal are also targeted by contractor mining, so there are multiple, overlying impacts in the marine environment. Return of the Elizabeth Bay shoreline to its original position is, however, estimated to take in the order of 290 years (Geoff Smith, WSP, pers. comm.).

7.5 Shortcomings

7.5.1 Assumptions

The impact assessment was based largely on the mine planning information received up to September 2018. The mining environment changes continuously and this assessment is thus a snap-shot in time. Subsequent changes have not been assessed.

7.5.2 Uncertainties

While assessing impacts, some gaps in knowledge were identified. These are:

- ◊ Effects of mobilised mining-related sediments on the offshore reefs, and
- ◊ Namdeb's contribution to the overall health of the marine ecosystem.

An attempt should be made to investigate the effects of sediments on the offshore reefs, while the unravelling of natural versus mining-induced variation in the marine ecosystem is an on-going process, which is addressed by Namdeb's marine monitoring programme.

There is also still a lack of baseline information on some biodiversity components. Biodiversity information in the marine environment is largely from offshore areas, although some information to ~30m depth does exist (Pulfrich & Penney 2001).

Limited information is presently available for process-related ecological functions, such as

- ◊ Natural recovery potential of all impacted habitats and vegetation types in response to different disturbances related to mining,
- ◊ Effective restoration methods for all sensitive habitats impacted by mining requiring restoration (e.g. rocky areas outside the sand corridor),
- ◊ Ecosystem function and services facilitating restoration (e.g. soil properties and processes and microclimatic parameters),
- ◊ Contribution of other environmental impacts such as climate change and overfishing, and
- ◊ The links between marine ecosystems and terrestrial ecosystems. Many linkages are recognised (intertidal communities serve as food-source for waders and shore birds, fish in bay serve as food source for Damara Terns, penguins and gannets), but potential changes related to mining activities have not been quantified.

Supporting the marine predator project and Damara Tern studies is therefore a commendable step. Contributing to overarching programmes such as biodiversity monitoring undertaken by the Ministry of Environment and Tourism in the Tsau//Khaeb (Sperrgebiet) National Park would be another opportunity to help closing knowledge gaps.

Chapter 8 Environmental management plan

The Environmental Management Plan outlines overall environmental tasks, provides management actions for all high and significant impacts, describes rehabilitation activities and the required monitoring during operations and at closure.

Environmental management tasks are organised according to overall tasks which are necessary for the implementation of the EMP, then significance and within these according to aspects. These management actions need to be seen in the context of an existing environmental management system which has been in place for over 20 years and where all measures applicable to common environmental aspects such as waste management, pollution control and protection of habitat, fauna and flora are well entrenched and routine. The management actions in this EMPR therefore focus on new aspects and prioritising existing management actions.

Objectives applicable to all management tasks in this EMP are described below and are not repeated for each task. Impact descriptions are provided in the impact register in Annex 3. All policies and procedures directly referred to in this EMP are provided in Annex 5, while the full suite of standard policies and procedures related to environmental management and applicable to all licence areas is included in the EMPR for ML43. The management objectives link directly to Namdeb's environmental policy.

The management objectives for this EMP are to:

- Protect the environment including pollution prevention and conserving natural habitats, flora and fauna and cultural heritage,
- Have no net loss of significant biodiversity,
- Avoid, substitute or reduce fresh water consumption and reduce carbon emissions from the 2004 baseline,
- Integrate waste management practices to reduce the generation of waste and the impact on the environment,
- Determine and evaluate fulfilment of the compliance obligations,
- Continually improve the effective implementation of the environmental management system,
- Enhance environmental performance,
- Complete internal audits and effectively implement corrective action for nonconformities identified,
- Effectively and expediently report incidents, complete investigations and implement controls,
- Execute rehabilitation programs during mining operations and make provision for mine closure,
- Support environmental research and sustainable development initiatives that are relevant to our business,
- Create environmental awareness amongst our employees, suppliers, contractors and partners,

- ◊ Include the consideration of environmental issues in all business strategies and initiatives,
- ◊ Assess and, where practicable, reduce the environmental impact of the company's activities, products and services,
- ◊ Incorporate life-cycle considerations for significant procured goods and services and control and influence our suppliers and contractors,
- ◊ Consult and engage with interested parties on critical environmental matters of mutual concern,
- ◊ Make available suitable and adequate resources to achieve our environmental objectives, and
- ◊ Report on environmental performance publicly and provide assurance to shareholders.

The following legislation is directly applicable to the management actions (detail in Annex 2) and their link to particular management actions is indicated by the corresponding number (column "legal"):

1. Mineral Act 1992
2. Minerals Amendment Act 8 of 2008
3. Namdeb's minerals agreement
4. Environmental Management and Assessment Act 7 of 2007 and regulations
5. Namibian Constitution Section 95(l)
6. Labour Act 6 of 1992, Act 11 of 2007, and amendment of 2012
7. Water Act 54 of 1956
8. Water Resources Management Act 11 of 2013
9. Forest Act 12 of 2001
10. Nature Conservation Ordinance 4 of 1975
11. National Heritage Act 27 of 2004
12. Marine Resources Act 27 of 2000 and regulations
13. Prevention and combating of pollution of the sea by oil Act 6 of 1981
14. Convention on Biological Diversity 2002
15. Ramsar Convention on Wetlands of International Importance especially as Waterfowl habitat, 1971
16. United Nations Framework Convention on Climate Change 1992

The responsibility for implementation of all mitigation measures lies with the Environmental Manager. All tasks are on-going activities.

OVERALL ENVIRONMENTAL TASKS	
Aspect	**Mitigation and control measures**
Implementation of EMP	◊ Incorporate all high and significant management actions in new IsoMetrix EMS database ◊ Identify new management tasks, discuss and explain to all environmental staff with particular attention to rehabilitation ◊ Make financial provision for potentially new management actions
Awareness	◊ Adapt environmental inductions to include new environmental aspects and management actions (PR-EV-15) ◊ Broadcast new environmental measures in all available forms of regular communications (briefs, monthly topic, etc.)
Reporting	◊ Follow ISO14001, MET, Group (Anglo American and De Beers), Namdeb internal reporting standards (PR-EV-22, PR-EV-23) ◊ Improve environmental data capture, storage and retrieval
I&APs	○ Present relevant key features of updated EMPR at Namdeb regular stakeholder fora (PR-EV-16)
Improved management of closure	◊ Allocate operational costs to monitor and demonstrate natural recovery of the seabed through pre- and post-mining benthic faunal and seabed surveys ○ Provide sufficient funds for a post-closure environmental survey (seabed and/or benthic faunal survey) in the event that on closure or premature closure, the benthic monitoring programme has not been completed or has not been able to demonstrate sufficiently that natural recovery processes are occurring

SIGNIFICANT ENVIRONMENTAL RISKS		
Aspect	**Mitigation and control measures**	**Legal**
Mining		
Seawall maintenance and accretion from fines disposal	◊ Monitor and model the impact of accretion on the coastline ◊ Establish maximum extent of discharged sediment and erosion from seawalls transported by Benguela Current under different mining scenarios ◊ Continue marine monitoring ◊ Integrate mine rehabilitation and mine plans to ensure that mined out areas are rehabilitated to agreed standard	12, 14
Pond creation	◊ Establish feasibility of alternative use for remaining pond(s) ◊ Consult with key stakeholders to develop and agree on final rehabilitation requirements	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 14
Coarse tailings disposal	◊ Coarse tailings to be deposited at designated tailings disposal site ◊ Final shaping see rehabilitation of tailings dump	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 14
Stockpiling of excavated material in natural areas	◊ Clearly demarcate and put off limits all environmentally sensitive areas where practical (archaeology, flagships populations, hyena and bird breeding sites, etc.) ◊ Use disturbed area for stockpiling, where possible ◊ Shape stockpiles (which are agreed to with stakeholders in rehabilitation plan) to low, rounded "hills", if remaining in the area	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 14, 15
Seabed mining by small marine contractors (diver assisted)	◊ Keep easily retrievable records of the contractor-mining target areas and tracking of contractor mining activities	12, 14
Tailings disposal to sea during marine exploration (remote tools)	◊ Keep easily retrievable records of the co-ordinates of contractor-mining target areas and tracking of contractor mining activities ◊ Avoid disposal of tailings on reefs, where practical	12, 14
Services and infrastructure		
Road maintenance in natural areas	◊ Rehabilitate borrow-pits when no longer in use or material is exhausted	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 14
Energy supply and consumption	◊ Power lines no longer in use to be dismantled, unless identified fur future use ◊ Energy-saving measures to be introduced wherever possible ◊ Use of renewable energy sources encouraged wherever possible	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 14, 15, 16
Fibre optic lines	◊ Fibre optic lines and radio towers to be dismantled,	1, 2, 3, 4, 5, 7, 8, 9,

and radio towers	unless identified for future use	10, 11, 14, 15
Fencing	◊ All fences to be removed as soon as feasible	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 14, 15
Reportable hydrocarbon spills near water source (e.g. E-Bay pan area)	◊ Clean-up of spill as soon as possible following Namdeb policy PO-EV-07 and procedure PR-EV-07 ◊ Monitor water quality near and away from pollution source to establish whether mitigation required ◊ If so, mitigation could be cut-off trenches, pumping of polluted water, removal of polluted soil or other suitable measure	1, 7, 8, 15
Waste management on vessels	◊ Adopt standard waste management practices	12, 13, 14

MEDIUM ENVIRONMENTAL RISKS		
Aspect	**Mitigation and control measures**	**Legal**
Mining		
Fines disposal to sea from land	◊ Keep easily retrievable records of volumes of fines disposal ◊ Include these in regular reporting	12, 13
Oversize disposal to sea by vessel-based marine contractors	◊ Avoid disposal of tailings on reefs where practical ◊ Keep easily retrievable records of the co-ordinates of contractor-mining target area and tracking of contractor mining activities	12, 13
Oversize disposal by shore-based contractors	◊ No disposal of tailings above the high water mark	12, 13
Services and infrastructure		
Dust on existing, unpaved roads	◊ Apply dust suppression in areas where this could also affect human health and the environment	6
Machine and equipment maintenance	◊ Place bunding, drip trays and/or liners in all areas where oils and lubricants could be spilled ◊ Remove polluted soil to closest contaminated soil stockpile site ◊ Remediate contaminated soil ◊ Use a dedicated wash-bay for machine and vehicle cleaning	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 14
Fuel supply	◊ Place bunding beneath fuel tanks ◊ Use bunded areas for re-fuelling ◊ Maintain accurate inventories of fuel volumes	1, 2, 3, 4, 5, 7, 8
Pipelines (water, fuel, fines)	◊ Follow PR-EV-18 in emergencies	
Reportable hydrocarbon spill on mine site	◊ Follow procedure PR-EV-07	1, 2, 3, 4, 5, 7, 8
Natural resource use by marine exploration and contractor mining	No actions	12, 16
Social		
In-migration	No actions	

LOW ENVIRONMENTAL RISKS		
Aspect	**Mitigation and control measures**	**Legal**
Exploration		
Marine geophysical surveys	Develop a procedure to minimise impacts to marine mammals during geophysical surveys. This would include: ◊ Onboard Marine Mammal Observers (MMOs) appointed to conduct visual scans for the presence of cetaceans around the survey vessel prior to initiation of any acoustic impulses, ensure compliance with mitigation measures during seismic geophysical surveying and reduce the chances of the vessel colliding with a marine mammal ◊ Pre-survey scans to be limited to 15 minutes prior to the start of survey equipment ◊ "Soft starts" to be carried out for any equipment of source levels greater than 210 dB re 1 µPa at 1m over a period of 20 minutes to give adequate time for marine mammals to leave the vicinity ◊ Terminate the survey if any marine mammals show affected behaviour within 500m of the survey vessel or equipment until the mammal has vacated the area ◊ The geophysical surveying largely to be undertaken between December and May, thereby avoiding the main migration period of baleen whales from their southern feeding grounds into low latitude waters. During the transition periods in June and November, surveying would be possible with stricter mitigation measures. As no seasonal patterns of abundance are known for odontocetes occupying the proposed exploration area, a precautionary approach to avoiding impacts throughout the year is recommended ◊ Ensure that PAM (passive acoustic monitoring), which detects marine mammals through their vocalisations, is incorporated into any surveying taking place between June and November	12
Mining		
Ferrosilicon losses tailings	◊ Maximise Ferrosilicon recycling	1, 2, 3, 4, 5, 7, 8
Services and infrastructure		
Loss of equipment from marine vessel	◊ All lost equipment must be accurately recorded in a hazards database, and reported to maritime authorities ◊ Every effort should be made to recover or remove lost equipment	12, 13
Air support to mining vessel	◊ All aircraft to maintain a minimum height of 1000 m within a radius of one nautical mile from each islands' low water mark in Namibian Marine Protected Area, except in the case of a medical emergency and for research purposes	12

ENVIRONMENTAL MONITORING DURING OPERATION		
Aspect	**Parameter**	**Frequency**
Freshwater		
Water quality	Sewage effluent (raw, before and after treatment)	Quarterly
	Water treatment (before and after treatment)	Quarterly
Biodiversity		
Marine ecosystems	Macrofauna and- flora and physical parameters on rocky shore, sandy beach habitat and subtidal habitats, where applicable	Annually
Invasive aliens	Emergence of invasive alien plants on mine sites	Minimum: annually

The management tasks listed below are directly transferred from the rehabilitation plan of Elizabeth Bay Mine (Burke 2015b) ("identified for future use" assumes agreement with the authorities).

REHABILITATION AND CLOSURE		
Aspect	**Rehabilitation tasks**	**Comments**
Infrastructure		
Buildings, plants and accessory infrastructure	◊ All buildings and structures except in Lüderitz, Elizabeth Bay village and Kolmanskop which are of cultural/historic significance, to be demolished, unless identified for future use ◊ Demolition process separates asbestos and polluted material to be handled and disposed separately ◊ Steel also to be dismantled separately	Structures in Lüderitz, Elizabeth Bay village and Kolmanskop to remain
Service infrastructure	◊ Dismantle water pipelines, telephone lines, power lines, pump stations, reservoirs and other service infrastructure, unless identified for future use	
Pollution remediation		
Remaining polluted soil	◊ Dispose together with polluted demolition waste or remediate	
Asbestos	◊ Buried asbestos to remain, demolition asbestos disposed at asbestos landfill near Uubvlei	
Other waste	◊ Hazardous and other waste to be removed off site	
Landscape rehabilitation[2]		
Biodiversity restoration[2]		
Natural regrowth	◊ Monitoring of vegetation re-establishment on disturbed and rehabilitated surfaces	
Invasive alien plants	◊ All infestations identified, eradicated and re-emergence managed	
Aftercare		
	◊ See "Environmental monitoring at closure"	

[2] All landscape rehabilitation and biodiversity restoration tasks are to be reviewed and agreed with stakeholders.

ENVIRONMENTAL MONITORING AT CLOSURE			
Aspect	**Parameter**	**Frequency**	**Comments**
Marine monitoring			
Physical parameters	Shoreline Particle size distribution Beach slope angle Wave height and frequency Effluent line crossing Water table depth	Annually	Monitoring for five years or until completion criteria for biological parameters are reached, if <5 years
Biological parameters	Rocky shore ecosystems Sandy beach ecosystems	Annually	Monitoring for five years or until completion criteria are reached, if <5 years
Restoration monitoring			
Natural regrowth on and stability of restored areas	Vegetation (plant species cover, richness, composition and structure) and erosion	Annually, during vegetation season	Monitoring for five years or until completion criteria are reached, if <5 years
Invasive alien plants	Re-emergence of invasive alien plants	Annually during vegetation season	Until no more alien plants emerge
Water quality			
Sewage effluent		Annually	Until final sewage treatment finished

Chapter 9 Annex

The annex summarises the authors' credentials, presents all applicable legislation, and provides an impact register, a list of reviewed literature and Namdeb's environmental policies and procedures applicable to environmental management in ML45.

Annex 1. The environmental practitioners

Antje Burke

Academic qualifications

1993: **Dr rer nat** (Ph D), Major: **Landscape Ecology**, Minors: Botany, Geography; Westfälische Wilhelms-Universität, Münster, Germany
1987: Diplom (M Sc equivalent), Major: **Geography**, Minors: Botany, Geology
1984: First degree (B Sc equivalent): Geography, Botany, Geology

Dr Burke has 30 years of professional experience in environmental research and management in Namibia, Germany, Israel, South Africa and Botswana. She has coordinated coordinated and participated in over 50 Environmental Impact Assessments, Management Plans, Audits, Sectoral Reviews and Natural Resource Assessments in Namibia – the majority in the mining and infrastructure sector. She is author of over 70 scientific publications, 50 of these in peer-reviewed, international journals and books, and over 100 popular and educational publications and is a scientific reviewer for eleven international journals. Dr Burke is a scientist widely recognised in her field of expertise. Her strong research background in environmental sciences, combined with in-depth practical experience, has enabled her to always maintain an exceptionally high standard, but unique and realistic approach in all her assignments.

Andrea Pulfrich

Academic qualifications

1995: **Dr rer nat** (Ph D), Major: **Fisheries Biology**, Minors: Oceanography, Aquaculture; Department of Fisheries Biology of the Institute for Marine Science at the Christian-Albrechts University, Kiel, Germany.
1987: MSc (Zoology), University of Cape Town, South Africa.
1983: BSc (Hons) (Zoology), University of Cape Town.
1982: BSc (Zoology and Botany), University of Natal, Pietermaritzburg.

Dr Pulfrich is the director of Pisces Environmental Services and has 29 years of professional experience in marine and coastal environmental sciences. Since its founding in 1998, Pisces Environmental Services has successfully completed a broad variety of assignments, ranging from technical field surveys and baseline data collection and environmental assessments, to sophisticated statistical analyses, reporting and public presentation of results. The Company has acquired a reputation among its clients for reliable, efficient, and result-orientated work. A great number of studies have been published in the internationally reviewed scientific literature. Through its links with research and government institutions, universities and industry, the Company keeps pace with advancements in marine sciences and technology, thereby applying up-to-date information and methodologies to its products.

Annex 2. Legislation and statutory requirements

Legislation	Applicability
MINING LEGISLATION	
Mineral Act, 1992	Rehabilitation requirements, environmental status prior to mining/prospecting, pollution control measures, liability for pollution
Minerals (Prospecting and Mining) Amendment Act, 8 of 2008	Requirement of EMPR
Diamond Act 13 of 1999 and regulations, GN 84 of 31 March 2000	Permits for handling diamonds
Environmental clause of Namdeb's Minerals Agreement	Requirement of EMPR
ENVIRONMENTAL LEGISLATION	
Environmental Management and Assessment Act 7 of 2007; List of activities that may not be undertaken without Environmental Clearance Certificate, GN 29 of 2012; Environmental Impact Assessment Regulations, GN 30 of 2012	Requirements for and process of environmental assessments
Draft Regulations for Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA), 2008 and Draft procedures and guidelines for Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP), 2008	Contents of strategic environmental assessments, Environmental Impact Assessments and Environmental Management Plans
Namibian Constitution Section 95(l)	Use of natural resources, protection of environment, biodiversity and ecosystems
Hazardous Substances Ordinance, 14 of 1974	Declaration and handling of hazardous substances
Labour Act 6 of 1992, Regulations relating to the health and safety of employees at work, GN 156, GG 1617 of 1 August 1997	Protection of employees from hazardous substances, incl. asbestos
Atmospheric Pollution Prevention Ordinance, 11 of 1976, prohibition of the import of ozone depleting substances, GN 281, 31 December 2010	Permitting of fuel burning appliances, prohibition of ozone-depleting substances
Atomic Energy and Radiation Protection Act, 5 of 2005; 1A.1 Radiation Protection and Waste Disposal Regulations, GN 221 of 18 November 2011	Handling, transport and disposal of radioactive substances
Road Traffic and Transport Act, 22 of 1999 and regulations GN53 of 2001	Transportation of dangerous goods
Water Act, 54 of 1956	Permitting for industrial effluents
Water Resources Management Act, 11 of	Protection, development and management

2013 (not in force yet)	of water resources; licencing water abstraction, protection of groundwater, water pollution control, obstruction of watercourses, control and use of wetlands
Soil Conservation Act, 76 of 1969	Prevention of soil erosion, no regulations, not enforced
Forest Act, 12 of 2001	Protected trees, permit for mining in forested areas and cutting of trees and shrubs within 100m from river, stream or watercourse
Nature Conservation Ordinance, 4 of 1975	Protected species
National Heritage Act, 27 of 2004	Heritage site protection
MARINE LEGISLATION	
Marine Resources Act, 27 of 2000; 18.1 Regulations relating to the exploitation of marine resources, GN 241 of 7 December 2001; 18.2 Regulations relating to Namibian Islands' Marine Protected Area, GN 316 of 31 December 2012	Protection of marine habitats and animals
Marine Traffic Act 2	No abandoning of ships
Prevention and Combating of Pollution of the Sea by Oil Act, 6 of 1981	Liability, combating and prevention of oil pollution
Wreck and Salvage Act, 5 of 2004	Procedures related to salvage of ships, aircraft and life, preventing damage to marine life
Namibian Ports Authority Act 2 of 1994	Establishment of Namibian Ports Authority and management of ports and lighthouses, protection of the environment in its jurisdiction
Territorial Sea and Exclusive Economic Zone of Namibia Act 3 of 1990	Definition territorial sea and exclusive economic zone
POLICIES AND OTHER	
National Policy on Coastal Management 2012	Protect, maintain and restore health and biological diversity of ocean and coastal ecosystems
Explosives Act, 26 of 1956	Import, storage and transport of explosives
Fire Brigade Services Act, 5 of 2006 and regulations 2010	Maintenance of fire brigade services
Petroleum Products and Energy Act, 13 of 1990; 5H.1 Petroleum Products Regulations, 2000 and Notice of Application of Specifications and Standards, GN 54 of 2016	Distribution and price control
Red data lists	Plant and animals species classified as vulnerable, threatened or endangered
Oranjemund town business registration regulations, 2013	
Oranjemund town noise control regulations, 2013	Noise control in Oranjemund town
Electricity Act 4 of 2007	Environmental Impact Assessment for

	electricity installations
Electricity Regulations: Administrative, GN 13 of 16 February 2011	
Electricity Control Board: Namibian electricity safety code, GN 200 of 12 October 2011, Electricity Control Board: Namibian Electricity Safety Code, Amendment, GN 234 of 2012, technical rules, GN 47 of 2016, economic rules, GN 46 of 2016	Electricity generation licences
INTERNATIONAL CONVENTIONS AND PROTOCOLS	
Convention on Biological Diversity, 1992	Protection of biodiversity
United Nations Framework Convention on Climate Change, 1992 13.1 Kyoto Protocol, 1997	No legislation promulgated yet to meet proposed guidelines
Montreal Protocol on substances that deplete the ozone layer, 1987; Amendments 1990 and 1992, Vienna Convention for the protection of the ozone layer 1985	Prohibition of ozone depleting substances
Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat, 1971	Protection of declared wetlands
Law of the Sea Convention, 1982 (United Nations)	Territorial sea limits up to 12 nautical miles, innocent passage through territorial sea, exclusive economic zone, conservation and management of living resources, protection of marine environment
Protocol on Shared Watercourse Systems in the SADC Region	Coordinated and environmentally sound development of shared water resources, basin management committees
International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)	Regulations for prevention of pollution by oil, noxious liquid substances, harmful substances, sewage and garbage
Convention on International Trade with Endangered Species (CITES)	Internationally accepted list of plant and animals species under trade restrictions

Annex 3. Impact register.

All impacts rated "significant" (S) and "high" (H) require management and these impacts are listed in the impact register. A description of the impacts is included below and management actions are described in the Environmental Management Plan (chapter 8). Many activities result in various impacts. In this case, if at least one impact is rated significant, the activity will require management. Not significant impacts associated with this activity are then also included in the description. Because this is an update of a previous EMPR, the descriptions are deliberately concise and activities receiving the same impact ratings have been combined, where feasible.

A 4-scale rating has been included here for reversibility (none, low, medium, high) assuming that the management actions for this activity are implemented and thus reflecting an impact assessment with mitigation.

The activities are organized according to overarching categories exploration, mining and services and infrastructure.

Exploration

Impact category	Description	Significance	Reversibility
	Exploration drilling, trenching and sample pits in natural areas		
Loss of habitat and biota	Clearing of vegetation and creation of access roads	Significant	Medium
Visual	Cleared areas do not fit into natural surroundings	Significant	High

Mining

Impact category	Description	Significance	Reversibility
	Overburden stripping of unmined areas and transport of material		
Loss of habitat	Clearing of vegetation at mine site and through creation of access roads	Significant	Medium
Loss of biota	Clearing of vegetation at mine site and through creation of access roads	Significant	Medium
Dust impact on biota	Driving along unpaved roads and excavation of material at mine site deposits dust on vegetation and soil	Significant	Low
Archaeology and fossils	Uncovering of archaeological and fossil sites	Medium positive	Not applicable

	Seawalls and accretion		
Change in marine habitat	Physical change in intertidal habitat, increase in surf-zone turbidity compromising water quality	Significant	Medium
Loss of marine habitat	Smothering/loss of rocky intertidal/subtidal habitats, reduction in diversity, changes in community composition	Significant	Low
Loss of marine biota	Loss of invertebrate macrofauna due to burial by seawall sediments, disturbance or loss of Tylos	Significant	Medium
Effects on biota	Cascade effects of turbidity on higher order consumer (shore birds, surfzone fish)	Medium	High
Effect on rock lobster stocks	Loss or deterioration of habitat affecting the rock lobster stocks	Medium	High
	Stockpiling of excavated and screened material in natural areas		
Loss of habitat and biota	Stockpiles in natural areas eliminate vegetation and associated biota	Significant	Medium
Visual	Stockpiles do not fit into natural surroundings	Medium	High
	Seabed mining by marine contractors		
Loss of marine biota	Disturbance and loss of biota in mined sediments	Significant	High
	Oversize disposal to sea during marine exploration		
Loss of marine biota	Smothering of reef biota by tailings, change in community composition	Significant	High

Services and infrastructure

Impact category	Description	Significance	Reversibility
	Road maintenance in natural areas		
Loss of habitat and biota	Establishment of new borrow-pits in undisturbed areas eliminates vegetation and associated biota	Significant	Medium
	Energy supply and consumption		
Loss of habitat	Power lines and their maintenance tracks through	Significant	Medium

Impact category	Description	Significance	Reversibility
	the Sperrgebiet National Park eliminate vegetation and associated biota.		
Loss of biota	Bird fatalities through power lines could affect red data species such as Ludwig's bustard and flamingoes	Medium	High
Visual	Power lines through SNP detract from wilderness aspect	Significant	High
Resource use	Namdeb consumes a moderate portion of electricity available in Namibia (> 10%)	Significant	High
	Fibre optic lines and radio towers throughout the Sperrgebiet National Park		
Visual	Fibre optic lines and radio towers throughout the Sperrgebiet National Park are highly visible and detract from wilderness aspect	Significant	High
	Fencing inside national park		
Loss of biota	Wildlife incidents through animals running into fence	Medium	High
Change in habitat	Disruption of migration routes through high security fence	Significant	High
Visual	Fences in national park detract from wilderness aspect	Significant	High
	Reportable hydrocarbon spills near water source		
Water quality	Large hydrocarbon spills from re-fuelling, maintenance and faulty equipment can pollute surface and groundwater	Significant	Medium
	Waste management on vessels		
Water quality	Pollution of coastal waters through spilled hydrocarbons and litter	Significant	High

Annex 4. Literature

Barnard P. (ed.) (1998) Biological diversity in Namibia - a country study. Namibian National Biodiversity Task Force, Windhoek, 325 pp.

Braby J. (2009) The Damara Tern in the Sperrgebiet: Breeding productivity and the impact of diamond mining. Unpublished report to Namdeb Diamond Corporation (Pty) Ltd.

Burger J.U., Mbangula I., Awases Z.N. & Jacob J. (2009) The evaluation of the southern resource area at Elizabeth Bay. Namdeb Diamond Corporation, Report GE-EN-05/MRM Docs # 87281, 114 pp.

Burke A. (2004) A preliminary account of patterns of endemism in Namibia's Sperrgebiet, succulent karoo. Journal of Biogeography 31(10): 1613-1622.

Burke A. (2005) Land use plan for Namdeb's licence areas. Report for Namdeb, Oranjemund. DOCS#69438.

Burke A. (2006) The Sperrgebiet - Managing its biodiversity. EnviroScience & Namibia Nature Foundation, Oranjemund & Windhoek, 100 pp.

Burke A. (2015a) Sites of Special Scientific Interest in Namdeb's licence areas. Report for Namdeb Diamond Corporation, June 2015, 36 pp.

Burke A. (2015b) Rehabilitation plan for Elizabeth Bay Mine. Report for Namdeb Diamond Corporation, Feb. 2015, Windhoek, 59 pp.

Bustamante R.H., Branch G.M. & Eekhout S. (1997) The influences of physical factors on the distribution and zonation patterns of South African rocky-shore communities. South African Journal of Marine Science, 18: 119-136.

Chamber of Mines (2017) Annual review of the Chamber of Mines of Namibia. Windhoek.

Christie N.D. (1974) Distribution patterns of the benthic fauna along a transect across the continental shelf off Lamberts Bay, South Africa. Ph.D. Thesis, University of Cape Town, 110 pp & Appendices.

Christie N.D. (1976) A numerical analysis of the distribution of a shallow sublittoral sand macrofauna along a transect at Lambert's Bay, South Africa. Transactions of the Royal Society of South Africa 42: 149-172.

Clark B.M., Smith C.E. & Meyer W.F. (1998) Ecological effects of fine tailings disposal and marine diamond pumping operations on surf zone fish assemblages near Lüderitz, Namibia. AEC Unpublished Report. 46pp.

CSIR (2001) Elizabeth Bay monitoring project: 2000 review. CSIR report ENV-S-C 2001-037.

CSIR (2002) The effects of marine sediment discharge from extended mining operations at Elizabeth Bay. Report for Namdeb, Elizabeth Bay Mine Report ENV-S-C 2002-056.

Currie H., Grobler K., Kemper J. (eds) (2008) Namibian Islands' Marine Protected Area. Ministry of Fisheries and Marine Resources, Namibia, WWF South Africa & NACOMA, Swakopmund, 145 pp.

Emanuel B.P., Bustamante R.H., Branch G.M., Eekhout S. & Odendaal, F.J. (1992) A zoogeographic and functional approach to the selection of marine reserves on the west coast of South Africa. South African Journal of Marine Science 12: 341-354.

EnviroDynamics (2010) Socio-economic impact assessment Orange River Mines Life o Mine Extension Project. Report for CSIR-EIA, 66 pp.

Goosen A.J.J., Gibbons M.J., McMillan I.K., Dale D.C. & Wickens, P.A. (2000) Benthic biological study of the Marshall Fork and Elephant Basin areas off Lüderitz. Prepared by De Beers Marine (Pty) Ltd. for Diamond Fields Namibia, January 2000. 62 pp.

Griffin M. (1993a) Annotated checklist and conservation status of mammals, reptiles and

amphibians of the Sperrgebiet, southern Namib Desert, Namibia. Report to Namdeb, Oranjemund, 100 pp.

Griffin E. (1993b) A report on the non-acarine arachnids and myriapods of Diamond Area 1, Karas Region, Namibia. Report to Namdeb, Oranjemund, 16 pp.

Hart T. & Halcett D. (1999) An assessment of recent archaeological baseline surveys in the Sperrgebiet. Internal report prepared for NAMDEB by the Archaeology Contracts Office of the University of Cape Town.

Kemper J (2010) The Namibian Islands' Marine Protected Area (NIMPA): A baseline assessment of management effectiveness using the MPA-NAMETT. NACOMA specialist report, Namibia.

Kemper J., Underhill L.G., Crawford R.J.M. & Kirkman S.P. (2007) Revision of the conservation status of seabirds and seals breeding in the Benguela Ecosystem. In: Kirkman (ed). Final Report of the BCLME (Benguela Current Large Marine Ecosystem) project on top predators as biological indicators of ecosystem change in the BCLME: 325-342. Avian Demography Unit, University of Cape Town, Cape Town, South Africa.

McLachlan A. & de Ruyck A. (1993) Survey of sandy beaches in Diamond Area 1. Sperrgebiet specialist study for Namdeb's EMPRs. Internal report, 20 pp.

McLachlan A. (1986) Ecological surveys of sandy beaches on the Namib coast. Report No. 13, Institute for Coastal Research, University of Port Elizabeth, Port Elizabeth, 135 pp.

McLachlan A., Nel R., Bentley A., Sims R. & Schoeman D. (1994) Effects of diamond mine fine tailings on sandy beaches in the Elizabeth Bay Area, Namibia. Contract Report, pp 1-40.

Mendelsohn J., Jarvis A., Roberts C. & Robertson T. (2002) Atlas of Namibia. David Philip Publishers, Cape Town, 200 pp.

Meyer W.F., Ewart-Smith C., Nel R. & Clark B.M. (1998) Ecological impact of beach diamond mining on beach, rocky intertidal and surf zone biological communities in the Sperrgebiet. Report for Namdeb, Oranjemund.

Myers N., Mittermeier R.A., Mittermeier C.G., da Fonseca G.A.B. & Kent J. (2000) Biodiversity hotspots for conservation priorities. Nature 403: 853-858.

Namdeb (1997b) Environmental Management Programme Report. Elizabeth Bay Licence Area. Namdeb, Oranjemund. DOCS# 10872 and 11554

Namdeb (2014) Life of mine plan - mining operations. Section C for 2014. DOCS#112781.

Noli D. (1995) Reaching for the past. Ewi Namdeb, 4th quarter 1995: 16.21.

Noli D. (2002) Archaeological specialist study accompanying the Elizabeth Bay expansion study Environmental Impact Assessment, 7 pp.

Parkins C.A. & Branch G.M. (1998) The effects of diamond mining on the shallow subtidal zone: an assessment of the Elizabeth Bay fine tailings deposit, and contractor diamond divers, with special attention to rock lobster, Jasus lalandii. Report for Namdeb. University of Cape Town, Coastal Ecology Unit, 44 pp.

Parkins C.A. & Branch, G.M. (1997) The effects of the Elizabeth Bay fines deposit and contractor diamond diver activities on biological communities: intertidal and subtidal monitoring report. Report to Namdeb (Pty) Ltd.

Parkins C.A. & Field J.G. (1998) The effects of deep sea diamond mining on the benthic community structure of the Atlantic 1 Mining Licence Area. Annual Monitoring Report – 1997. Unpublished Report to De Beers Marine, April 1998, 44 pp.

Penney A.J., Pulfrich A., Rogers J., Steffani N. & Mabille V. (2007) Project: BEHP/CEA/03/02: Data Gathering and Gap Analysis for Assessment of Cumulative Effects of Marine Diamond Mining Activities on the BCLME Region. Final Report to the BCLME mining and petroleum activities task group. December 2007. 410pp.

Pickford M. & Senut B. (2000) Geology and palaeobiology of the Namib Desert. Mem.

Geol. Surv. Namibia 18, 155 pp. (date on cover 1999, but title page 2000).

Pisces (2008) Data gathering and gap analysis for assessment of cumulative effects of marine diamond mining activities on the BCLME region. Report for Benguela Current Large Marine Ecosystem Programme, project: BEHP/CEA/03/2, 422 pp.

Pisces (2010) Elizabeth Bay optimisation study – Amendment to the Environmental Impact Assessment and Environmental Management Plan for the Elizabeth Bay Mine Extension Project. Report for Namdeb, Tokai, 226 pp.

Pulfrich A. & Branch G. (2014) Using diamond-mined sediment discharges to test the paradigms of sandy-beach ecology. Estuarine, Coastal and Shelf Science 150: 165-178. DOI: 10.1016/j.ecss2013.08.002

Pulfrich A. & Branch G.M. (2014) Effects of sediment discharge from Namibian diamond mines on intertidal and subtidal rocky-reef communities and the rock lobster Jasus lalandii. Estuarine, Coastal and Shelf Science 150: 179–191.

Pulfrich, A., Parkins, C.A., Branch, G.M., Bustamante, R.H. & Velásquez, C.R. (2003) The effects of sediment deposits from Namibian diamond mines on intertidal and subtidal reefs and rock lobster populations. Aquatic Conservation: Marine and Freshwater Ecosystems 13: 257-278.

Pulfrich A. & Penney A.J. (1999a) Assessment of the impact of diver-operated nearshore diamond mining on marine benthic communities near Lüderitz, Namibia. Final Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia, 40pp.

Pulfrich A. & Penney A.J. (1999b) The effects of deep-sea diamond mining on the benthic community structure of the Atlantic 1 Mining Licence Area. Annual Monitoring Report – 1998. Prepared for De Beers Marine (Pty) Ltd by Marine Biology Research Institute, Zoology Department, University of Cape Town and Pisces Research and Management Consultants CC. pp 49.

Pulfrich A. & Penney A.J. (1998) Assessment of the impact of diver-operated nearshore diamond mining in the Luderitz area, Namibia: research results and future options. Report of Namdeb, Marine Biology Research Institute & Pisces, 11 pp.

Pulfrich, A. & Penney A.J. (2001) Assessment of the impact of diver-operated nearshore diamond mining on marine benthic communities near Lüderitz, Namibia. Phase III. Report to NAMDEB Diamond Corporation (Pty) Ltd, 50pp.

Pulfrich A. (1998a) Assessment of the impact of diver-assisted nearshore diamond mining on marine benthic communities in the Kerbehuk area, Namibia. Report to Namdeb Diamond Corporation,

Pulfrich A. (1998b) The effects of the Elizabeth Bay fines deposits and shore-based diamond diving activities on biological communities: intertidal and subtidal monitoring report 1998. Report for Namdeb, Oranjemund. Pisces & Marine Biology Research Institute, 37 pp.

Pulfrich A. (2007a) Survey of intertidal and subtidal rocky shore communities at Elizabeth Bay: Intertidal and subtidal monitoring report – 2007. Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia, 64pp.

Pulfrich A. (2007b) Baseline survey of nearshore marine benthic communities in the Bogenfels area, off southern Namibia. Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia, August 2007, 45pp.

Pulfrich A. (2012) Follow-up survey of nearshore marine benthic communities in the Bogenfels area, off southern Namibia. Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia, August 2012, 57pp.

Pulfrich A. (2018) Intertidal Rocky-Shore Communities of the Sperrgebiet Coastline: Consolidated Rocky-shores Monitoring Report – 2018. Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia. 114pp.

Pulfrich A., Parkins C.A. & Branch G.M. (2003) The effects of shore-based diamond diving on intertidal and subtidal biological communities and rock lobster in southern Namibia. Aquatic Conservation: Marine and Freshwater Ecosystems (Aquatic

Conserv: Mar. Freshw. Ecosyst. 13: 233-255.

Roux J-P., Braby R. & Best P.B. (2011) Southern right whales off Namibian and their relationship with those off South Africa. Paper SC/S11/RW16 submitted to IWC Southern Right Whale Assessment Workshop, Buenos Aires 13-16 Sept. 2011.

Rutherford M.C. (1997) Categorization of biomes. In: Cowling, R.M. Richardson, D.M., & Pierce, S.M. (eds.) The vegetation of southern Africa, pp. 91-98, Cambridge University Press, Cambridge.

Schneider G. (2008) Treasures of the diamond coast. A century of diamond mining in Namibia. Macmillan, Windhoek, 320 pp.

Simmons R. (2002) Avifauna of the proposed Elizabeth Bay mining sites: species composition, impacts and mitigation. Report for Namdeb and EnviroScience.

Simmons R.E., Brown C.J. & Kemper J. (2015) Birds to watch in Namibia: red, rare and endemic species. Ministry of Environment and Tourism and Namibia Nature Foundation, Windhoek. 320 pp.

Steffani C.N. & Pulfrich A. (2004a) Environmental Baseline Survey of the Macrofaunal Benthic Communities in the De Beers ML3/2003 Mining Licence Area. Prepared for De Beers Marine South Africa, April 2004., 34pp.

Steffani C.N. & Pulfrich A. (2004b) The potential impacts of marine dredging operations on benthic communities in unconsolidated sediments. Specialist Study 2. Specialist Study for the Environmental Impact Report for the Pre-feasibility Phase of the Marine Dredging Project in Namdeb's Atlantic 1 Mining Licence Area and in the nearshore areas off Chameis. Prepared for PISCES Environmental Services (Pty) Ltd, September 2004.

Steffani C.N. & Pulfrich A. (2007) Biological Survey of the Macrofaunal Communities in the Atlantic 1 Mining Licence Area and the Inshore Area between Kerbehuk and Lüderitz 2001 – 2004 Surveys. Prepared for De Beers Marine Namibia, March 2007, 288pp.

Steffani N. (2007a) Biological Baseline Survey of the Benthic Macrofaunal Communities in the Atlantic 1 Mining Licence Area and the Inshore Area off Pomona for the Marine Dredging Project. Prepared for De Beers Marine Namibia (Pty) Ltd. pp. 42 + Appendices.

Steffani N. (2007b) Biological Monitoring Survey of the Macrofaunal Communities in the Atlantic 1 Mining Licence Area and the Inshore Area between Kerbehuk and Bogenfels. 2005 Survey. Prepared for De Beers Marine Namibia (Pty) Ltd. pp. 51 + Appendices.

Steffani N. (2009) Baseline Study on Benthic Macrofaunal Communities in the Inner Shelf Region and Assessment of Mining Impacts off Chameis. November 2009. Prepared for Namdeb. pp. 45 + Appendices.

Tomalin B.J. (1993) Migrations of spiny rock lobsters, Jasus lalandii, at Lüderitz: Environmental causes, and effects on the fishery and benthic ecology. M.Sc. thesis, University of Cape Town, pp 1-99.

Wiesel I. (2002) Brown hyena specialist report for Elizabeth Bay Mine Extensions. Supplement to Environmental Impact Assessment.

Williams, A. (1993) Coastal and wetland and seabirds review. Report for Namdeb, Oranjemund, 45 pp.

Zoutendyk P. (1992) Turbid water in the Elizabeth Bay region: A review of the relevant literature. CSIR Report EMAS-I 92004.

Annex 5. Namdeb environmental policies and procedures referenced in this EMP

PO-EV-01
PO-EV-04
PO-EV-07 policy and procedures
PO-EV-08
PR-EV-15
PR-EV-16
PR-EV-22
PR-EV-23