ESIA AMENDMENT PROCESS FOR THE PROPOSED TSUMEB EXPANSION PROJECT

FINAL ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT REPORT

Tsumeb, Oshikoto Region, Namibia

Prepared for: Dundee Precious Metals Tsumeb
DOCUMENT INFORMATION

<table>
<thead>
<tr>
<th>Title</th>
<th>ESIA Amendment Process for the Proposed Tsumeb Expansion Project: Environmental Impact Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager</td>
<td>Eloise Costandius &amp; Conroy van der Riet</td>
</tr>
<tr>
<td>Project Manager e-mail</td>
<td><a href="mailto:ecostandius@slrconsulting.com">ecostandius@slrconsulting.com</a>; <a href="mailto:cvanderriet@slrconsulting.com">cvanderriet@slrconsulting.com</a></td>
</tr>
<tr>
<td>Author</td>
<td>Eloise Costandius (previous versions); Conroy van der Riet (2019 Revision)</td>
</tr>
<tr>
<td>Reviewer</td>
<td>Fuad Fredericks (previous versions); Andrew Bradbury (2019 Revision)</td>
</tr>
<tr>
<td>Keywords</td>
<td>Tsumeb, Dundee, Smelter, Upgrade, Optimisation, Impact Assessment</td>
</tr>
<tr>
<td>Status</td>
<td>Revised ESIA for public review</td>
</tr>
<tr>
<td>SLR Project No</td>
<td>734.04040.00008</td>
</tr>
<tr>
<td>Report No</td>
<td>4</td>
</tr>
<tr>
<td>Revision No</td>
<td>2</td>
</tr>
<tr>
<td>Report Date</td>
<td>28 June 2019</td>
</tr>
</tbody>
</table>

DOCUMENT REVISION RECORD

<table>
<thead>
<tr>
<th>Rev No.</th>
<th>Issue Date</th>
<th>Description</th>
<th>Issued By</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>March 2017</td>
<td>Report issued for public review</td>
<td>Eloise Costandius</td>
</tr>
<tr>
<td>1</td>
<td>March 2019</td>
<td>Report issued for public review and MET decision-making</td>
<td>Eloise Costandius</td>
</tr>
<tr>
<td>2</td>
<td>June 2019</td>
<td>Revised ESIA for public review</td>
<td>Conroy van der Riet</td>
</tr>
</tbody>
</table>

BASIS OF REPORT

This document has been prepared by an SLR Group company with reasonable skill, care and diligence, and taking account of the manpower, timescales and resources devoted to it by agreement with Dundee Precious Metals Tsumeb for part or all of the services it has been appointed by the Client to carry out. It is subject to the terms and conditions of that appointment. SLR shall not be liable for the use of or reliance on any information, advice, recommendations and opinions in this document for any purpose by any person other than the Client. Reliance may be granted to a third party only in the event that SLR and the third party have executed a reliance agreement or collateral warranty. Information reported herein may be based on the interpretation of public domain data collected by SLR, and/or information supplied by the Client and/or its other advisors and associates. These data have been accepted in good faith as being accurate and valid. SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work. The copyright and intellectual property in all drawings, reports, specifications, bills of quantities, calculations and other information set out in this report remain vested in SLR unless the terms of appointment state otherwise. This document may contain information of a specialised and/or highly technical nature and the Client is advised to seek clarification on any elements which may be unclear to it. Information, advice, recommendations and opinions in this document should only be relied upon in the context of the whole document and any documents referenced explicitly herein and should then only be used within the context of the appointment.
NON-TECHNICAL SUMMARY

INTRODUCTION TO THE PROPOSED PROJECT

The Tsumeb Smelter is currently owned and operated by Dundee Precious Metals Tsumeb (DPMT); a subsidiary of the Canadian based Dundee Precious Metals Inc. The smelter is located on the outskirts of Tsumeb in the Oshikoto Region of Namibia, approximately 2 km northeast of the Tsumeb town centre. The local setting of the Tsumeb Smelter is shown in Figure 1-1.

Metals have been mined at the Tsumeb mine for over a hundred years. Between 1961 and 1963 the original smelter was replaced with a new copper and lead smelter to process concentrate from the Tsumeb mine. In mid-1998 Goldfields Namibia, the holding company of Tsumeb Corporation Limited (TCL) went into liquidation and the Tsumeb Smelter was shut down. In 2000, the former TCL assets were taken over by Ongopolo Mining and Processing Limited (OMPL) and the copper and arsenic plants were re-commissioned. The cadmium plant was decommissioned and no lead processing has taken place since re-commissioning. In July 2006 the assets of OMPL were sold to Weatherly Mining International who owned and operated the plant for four years before selling it to Dundee Precious Metals Inc. (DPM) in 2010. In terms of the sales agreement, DPM is not considered liable for environmental contamination that took place prior to 2010.

Currently, it receives copper concentrate from El Brocal (Peru), Chelopec (Bulgaria), Codelco (Chile), Armenia and Opuwo (Namibia) for processing in the smelter.

Following the purchase of the smelter complex in 2010, DPMT have undertaken a series of upgrades and improvement projects in order to modernise the plant. Some of the major interventions include the following:

- Construction of a hazardous waste disposal facility (cell 1 – 2012 and Cell 2 - 2019);
- Improvement of the off-gas handling systems (2012-2013);
- Closure of the reverberatory furnace (2013);
- Installation of a 1,540 t/d sulphuric acid plant and associated acid storage and dispatch facilities (mid 2015);
- A new effluent treatment plant and sewage treatment plant (2015);
- Decommissioning of the arsenic plant (March 2017);
- Construction of new Pollution Control Dam (PCD) and re-lining of surface water trenches (2018 and ongoing).

The current Tsumeb Smelter comprises of one primary smelting furnace, the refurbished Ausmelt furnace. Blister copper is produced from the copper concentrate and delivered to refineries for final processing.

With additional custom concentrates available worldwide and areas for operational improvements identified, DPMT is proposing to expand their current operations in order to increase their concentrate processing capacity from approximately 240 000 to 370 000 tons per annum (tpa). The proposed expansion would be
contained within the existing facility footprint and would include the following components:

- Upgrading of the existing Ausmelt feed and furnace;
- Installation of a rotary holding furnace (RHF);
- Implementation of slow cooling of the RHF and converter slag;
- Upgrading of the slag mill to improve copper recovery and handle the increased tonnage from slow cooled slags;
- Option to install an additional Peirce-Smith (PS) converter; and
- Additional related infrastructure improvements (power supply, etc.).

New facilities will be designed, constructed, operated and maintained in line with good international practice.

The new project components and associated service infrastructure, together with the existing (approved) infrastructure/facilities, are collectively referred to as the ‘Tsumeb Smelter Upgrade and Optimisation Project’.

DPMT currently holds an Environmental Clearance Certificate (ECC) in terms of the Environmental Management Act (No. 7 or 2007; EMA) of Namibia for its operations at the Tsumeb Smelter. To allow for the proposed Expansion Project, an amendment of the original ECC and Environmental Management Plan (EMP) is required. This report focuses on the above additional components not covered in the current ECC and EMP.

The objective of this project and Environmental and Social Impact Assessment (ESIA) Amendment process is further to combine all of the separate ECCs currently held by DPMT and the commitments in the separate EMPS into one consolidated Environmental and Social Management Plan (ESMP) for all DPMT’s listed activities. This is beneficial, as impacts and related management and mitigation measures will be considered cumulatively and it would be easier to manage the environmental aspects if consolidated into one document linked to DPMT’s overarching management system. DPMT shall implement the management and mitigation measures as set out in the ESMP (Appendix K). If approval is granted and an Amended ECC issued, it would then serve as a consolidated ECC for the entire DPMT Smelter complex and would supersede the previous ECCs.

This ESIA report has been primarily compiled in order to amend the Environmental Clearance Certificate; however, as part of DPMT’s corporate commitments following equity investment by the European Bank for Reconstruction and Development’s (EBRD), DPMT has sought to align the ESIA report with the EBRD’s Performance Requirements (PRs). Separately to this ESIA process EBRD is reviewing overall E&S performance at Tsumeb.

**PROJECT MOTIVATION**

The project motivation is economic, with the project having the potential to directly and indirectly benefit the country and surrounding communities. The project would improve the smelter’s competitive position for securing feed materials and enhance the asset’s long term viability, therefore supporting the goal of moving overall plant performance to good international practice.

The Tsumeb smelter currently employs between 600 and 700 persons in Tsumeb, with many other services
directly dependent on DPMT operations. As the proposed project would largely relate to the optimisation of existing components and processes within the facility, it would not create a high number of new employment opportunities. Some opportunities would be created for contractors during the construction phase. The proposed upgrade and optimisation of the smelter and related increase in the throughput capacity of the smelter would promote long term efficiency and economic sustainability of the facility. By increasing the efficiency and sustainability of the facility, long term employment security would be ensured, together with downstream economic benefits to the town of Tsumeb.

In addition, the proposed expansion would increase the amount of foreign revenue generated by DPMT through value addition and provide benefits in a region with relatively high socio-economic needs. It should thus achieve in-principle compatibility with key Namibian economic policies and plans, provided environmental and other impacts can be adequately mitigated.

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT PROCESS

The Environmental Impact Assessment (EIA) is regulated by the Department of Environmental Affairs (DEA) within Ministry of Environment and Tourism (MET) in terms of the Environmental Management Act, 7 of 2007 and EIA Regulations of 2012.

The proposed Upgrade and Optimisation Project requires the amendment of some of the project components previously approved. Section 19 of the above mentioned EIA Regulations allows for an amendment of an ECC under section 39 of the Environmental Management Act, 2007.

Due to the significant potential environmental impacts associated with the general operations of a smelter of this nature and the ongoing public interest in the facility, MET: DEA requested that a full ESIA process (including a scoping phase and an assessment of impacts phase) be undertaken to assess the new project components. Impacts from the proposed expansion project components would be assessed as cumulative to the impacts experienced from the current Tsumeb Smelter operations.

In accordance with this legal framework the ESIA approach included the following:

- The scoping process was conducted to identify the environmental issues associated with the proposed project and to define the terms of reference for the required specialist studies (March 2016 – August 2016);
- Specialist studies were commissioned in accordance with the relevant terms of reference;
- The ESIA report was compiled on the basis of the findings of the specialist studies and distributed for public and authority review (April 2017);
- A Consolidated ESMP was prepared to elaborate on the mitigation objectives, include additional actions that were described in the ESIA report and consolidate previously approved ESMPs;
- A project specific public participation process was undertaken throughout the study. As part of this process the regulatory authorities and interested and affected parties (IAPs) were given the opportunity to attend information sharing meetings, submit questions and comments to the project
team, and review the background information document, scoping report and draft ESIA Report. All questions and comments that were raised by the authorities and IAPs have been included and addressed in this final ESIA Report. Based on comments received, a number of updates and additions were also made to specialist studies. These, however, did not result in major changes to the final outcome of the assessment findings.
FIGURE 1: LOCAL SETTING OF THE TSUMEB SMELTER COMPLEX
PROJECT OVERVIEW

The current proposed Upgrade and Optimisation Project was selected as the preferred option through a pre-feasibility study process and would increase production capacity from 240 000 tpa to 370 000 tpa. All new project components would be constructed within the current facility footprint and no greenfield areas would need to be cleared. The proposed expanded operations are illustrated in the process flow diagram in Figure 2. The new and upgraded components required in order to reach the increased throughput capacity include the following:

- Upgrading of the current Ausmelt concentrate and reverts feeders;
- Upgrading of the Ausmelt cooling system to a closed loop cooling water circuit;
- Design improvements to Ausmelt hoods and ladles;
- New RHF with shell dimensions of 4.7 m (diameter) by 15.2 m (long) and 70 m high steel stack;
- The option to install a third 13 x 30 ft Peirce-Smith converter is considered. The addition of a third converter would allow for the other two converters to be online while the third converter could be offline for maintenance;
- Slag slow cooling in pots or pits before crushing;
- Key changes/additions to the slag mill process include the following:
  - An upgrade of the milling and classification circuits;
  - Rationalization of flotation capacity by elimination of oxide rougher bank #2 and oxide cleaner cells;
  - Replacement of concentrate vacuum drum filter with a 4-leaf 6ft.(1.83m) diameter disc filter;
  - Addition of instrumentation in the grinding and flotation circuits and improved sampling practices to enhance metallurgical control and stability; and
  - Organizational changes suggested include measures to reinforce operator training and preventative maintenance to achieve 90% slag mill availability.
- Required utility upgrades include the following:
  - A new instrument air dryer;
  - Increase of the pump capacity for raw water from the old mine shaft;
  - Two additional light fuel oil supply pumps and piping to supply the RHF;
  - Two additional heavy fuel oil supply pumps and two heaters as part of the oil supply ring for the RHF burners;
  - Upgraded electricity supply system to be housed in a new electrical building.
- Implementation of a stormwater management project in order to improve stormwater infrastructure across the site.
- Improvements in the material handling area in order to manage wind-blown dust as well as to contain material spillages as well as seepage into groundwater during the rainy season.
ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FINDINGS

A number of specialist studies were conducted as part of the ESIA Amendment process. Specialists assessed potential impacts cumulatively to current baseline operational impacts. Specialist studies conducted the are the following:

- Waste Management;
- Surface Water;
- Groundwater;
- Air Quality;
- Noise;
- Socio-economic; and
- Community Health.

The main conclusion of the overall assessment was that the proposed upgrade and optimisation project would not create any additional new environmental and social impacts to those currently being experienced and that the proposed project would not result in any significant cumulative impacts.

Summaries of the key findings of the specialist studies are provided below.

WASTE MANAGEMENT

A review of current waste management activities at the smelter was undertaken and various recommendations made for management improvement. The main findings were the need for a formalised general waste landfill site and the improvement of waste sorting at the general waste handling area on site. Since the waste management review, DPMT has continued to formalise waste collection points by providing skips for the sorting and collection of different waste items. This is a positive development in terms of improving general waste management on the smelter site. The construction of a formal general waste landfill site is currently planned for 2019/2020.

The review also included calculations of the remaining life of the on-site hazardous waste disposal site. With the additional arsenic waste volumes to be produced and disposed it is likely that the entire permitted disposal site has an estimated life span of around 8 years from 2017. These calculations were based on the conservative assumption that all arsenic waste would be disposed of at this site and no other options for disposal are considered. DPMT are, however, focused on pursuing alternatives to long-term use of this facility and are currently investigating the feasibility of other disposal options. These include disposal to a potential future regional site in Namibia or to transport the wastes to hazardous waste sites in South Africa. DPMT are also currently investigating vitrification of the flue dust which would render it non-hazardous, resulting in a reduction in the volume of hazardous waste to be disposed of. Following successful laboratory trials, a pilot vitrification plant was commissioned in February 2019 which will be in operation for six months. The aim of the pilot plant is to test the viability of the technology on a larger scale in an industrial environment.
**Surface Water**

There are no natural surface water sources within the smelter property and the assessment thus relates to stormwater runoff. The proposed expansion would result in additional volumes of slag material being produced, which could require additional areas to be used for disposal of this material. Mitigation measures would thus be required in order to ensure that the stormwater system capacities would be sufficient to handle any additional contact runoff generated. The proposed expansion would not change the current situation with regards to runoff potential, assuming that the stormwater system has not been spilling into the Jordan River system after previous extreme rainfall events. The currently planned improved stormwater management measures include a ‘clean’ (non-contact) water diversion channel around the northern edge of the main smelter site in order to channel clean runoff away from the smelter site and to the Jordan River. This measure will improve the runoff from the site, as less water will flow into the smelter area and be retained in the ‘dirty’ (contact) water system at the site. Improved stormwater management measures in line with a stormwater management plan are currently being implemented in phases. Components already completed include the concrete lining of a portion of the stormwater channels through the site and the construction of a pollution control dam. With these measures in place, there should be only a small likelihood of any contact water leaving the site and reaching the Jordan River, approximately 1 km north of the site.

It is expected that the cumulative impact of the proposed expansion project on surface water runoff and quality would be of low significance. Key mitigation measures include the construction of additional infrastructure to manage contact water around the smelter expansion site and continuing with surface water monitoring at various sites along the Jordan River in order to monitor pollution levels.

**Groundwater**

The geohydrology of the area shows that groundwater flow is in a northerly direction from Tsumeb. Based on measured data for heavy metal and sulphate concentrations, the baseline groundwater quality before the proposed expansion indicates that the smelter site and historic mining operations has already impacted significantly on groundwater quality on site. The findings of an updated groundwater model study in 2018 showed that while polluted groundwater could potentially move offsite in a northerly direction, it is not expected to reach the irrigation farms to the north of the smelter site. This is largely related to the geology to the north of the smelter site providing a groundwater movement barrier.

Current groundwater quality impacts are largely attributable to historic activities and it is not expected that the proposed expansion project would cumulatively contribute significantly to these. In the unmitigated case, the significance of the impacts currently being experienced is considered as high. In the mitigated case, the significance can be reduced to medium, since the Group B Namibian drinking water standard and WHO drinking water quality limit could be reached with the implementation of mitigation measures.

Key recommended mitigation measures already included in the expansion project capital and operating costs relate to targeted groundwater treatment, rehabilitation of pollution dumps, improvement in drainage and erosion control, drilling of additional monitoring boreholes and undertaking regular monitoring of...
groundwater.

**AIR QUALITY**

The main emissions from the smelter site include sulphur dioxide (SO₂), sulphuric acid (H₂SO₄), particulate matter (PM₁₀ and PM₂.₅). There have been notable decreases in air emissions from smelter operations since DPM purchased the smelter. These can largely be ascribed to the commissioning of the sulphuric acid plant, decommissioning of the reverberatory furnace and ongoing improvements in the management of fugitive emissions.

The applicable monitoring standards for the parameters below are provided in Section 3.2 of this report.

**Sulphur Dioxide**

After commissioning of the sulphuric acid plant in 2015, ambient air quality monitoring stations have reported significant downward trends in SO₂ emissions from October 2015. No limits exist for SO₂ emissions in Namibian environmental legislation. Levels are thus evaluated by DPMT against best practice guidelines of 125 µg/m³ over a 24-hour period (South African and EU standard). Although there has been major improvement in the capturing of SO₂, there are still some exceedances of the 24-hour limits recorded at the monitoring stations in close proximity to the smelter site during upset conditions at the sulphuric acid plant.

It is expected that SO₂ emissions will increase in line with the proposed increased material throughput and production rates. With the sulphuric acid plant being fully operational for 90% of the time when the Ausmelt furnace is active, the air quality study findings showed, however, that for the proposed expanded smelter project the simulated concentrations emitted would comply with the annual and daily monitoring criteria. There could, however, still be some exceedances of the hourly concentration criteria at the three closest modelled receptor locations: the Sewerage Works and Plant Hill monitoring stations and in the closest residential area of Ondundu (see Figure 3). If the acid plant is, however, only efficiently utilised for 75% of the time (which was the average case during 2016) SO₂ emissions could exceed the daily and hourly concentration limits at off-site at sensitive receptors in Tsumeb (see Figure 4).
FIGURE 3: SIMULATED 1-HOUR SO₂ CONCENTRATIONS AT 90% ACID PLANT UTILISATION FOR EXPANDED PROJECT (350 µg/m³ ASSESSMENT CRITERIA INDICATED WITH BLACK LINE)

FIGURE 4: SIMULATED 1-HOUR SO₂ CONCENTRATIONS AT 75% ACID PLANT UTILISATION FOR EXPANDED PROJECT (350 µg/m³ ASSESSMENT CRITERIA INDICATED WITH BLACK LINE)
**Sulphuric Acid**

Although ambient sulphuric acid (H$_2$SO$_4$) levels are expected to increase due to the proposed increased throughput capacity, simulations showed that average off-site concentrations will be well within ambient air quality limits.

**PM$_{10}$ and PM$_{2.5}$**

Based on data from ambient air quality monitoring stations in Tsumeb town itself, the main contribution of airborne particulate matter (PM$_{10}$) sources seem to not be from the smelter site. However, the monitoring station immediately to the west of the smelter (Sewerage Works) reflects activities and sources associated with the smelter operations, likely from the tailings facilities. The proposed increased throughput capacity is expected to increase both long and short term ambient PM$_{10}$ and PM$_{2.5}$ concentrations. Simulated levels associated with the proposed upgrade project do, however, not exceed air quality limits off-site.

**Arsenic**

Arsenic in the PM$_{10}$ fraction is measured at all ambient air quality stations and showed a marked decrease in annual average concentrations observed during 2013 to 2016. 2017 concentrations were slightly higher but still significantly lower than concentrations recorded between 2012 and 2014. These levels exceed the EU ambient air quality reference concentration outside of the smelter footprint. It was found that furnace building fugitives (fumes escaping primary and secondary capture systems), as well as emissions from the Ausmelt and Copper stacks, contribute significantly to these off-site exceedances. The results clearly show higher ambient arsenic levels during dry and windy months. This also indicates fugitive dust rather than stack emissions from the smelter contributes to elevated arsenic concentrations.

Simulations showed that ground level ambient arsenic levels could potentially increase by approximately 54% due to the proposed increased throughput capacity of the smelter. The increase is attributed to the conservative assumption that furnace building fugitive emissions will increase linearly with increased production rates. The contribution of additional arsenic emissions from the proposed RHF to ground level arsenic concentrations is, however, minimal. Efforts should therefore be made to reduce building fugitive emissions through suitable and effective engineering controls.

Simulated arsenic levels at the smelter boundary and at sensitive air quality receptors at Ondundu and Endombo are predicted to be above the EU annual exposure criteria for the expansion scenario. Based on urine arsenic levels tested as part of the community health assessment, the measured arsenic in air levels are, however, low and unlikely to impact urine arsenic levels or to pose a lung cancer risk for Tsumeb residents.

Key mitigation measures for the management of all emissions from smelter operations include efficient capture / prevention of fugitive dust emissions across the smelter site, ensuring the sulphuric acid plant is utilized at least 90% of the time and undertaking continuous monitoring of SO$_2$ emissions through the acid plant stack in order to provide a true reflection of SO$_2$ emissions over time and an accurate dispersion plume.
NOISE

The only noise sensitive receptors where activities from the smelter complex were audible was a farmstead approximately 650 m northwest of the smelter boundary and 600 m east of the M75 road. Noise levels in the town are greatly influenced by community activities and highly dependent on wind speed. Noise simulations indicated that the proposed increased throughput capacity would not result in exceedances of noise level guidelines at noise sensitive receptors in and around Tsumeb. The increases in noise levels above the background levels during the day and night would not be detectable. Key mitigation measures included improvement of the silencer at the No. 2 oxygen plant (already implemented) and establishing a noise monitoring programme at noise sensitive receptors.

SOCIO-ECONOMIC

Construction phase project expenditure (positive impact)

The construction phase of the project would result in spending injections that would lead to increased economic activity. All expenditures will lead to linked direct, indirect and induced impacts on employment and incomes. In the case of employment, impacts would be direct where people are employed directly for the construction of new project components (e.g. jobs for construction workers). Indirect impacts would be where the direct expenditure associated with the project leads to jobs and incomes in other sectors (e.g. purchasing building materials maintains jobs in that sector) and induced impacts where jobs are created due to the expenditure of employees and other consumers that gained from the project. Preliminary estimates indicate that a total of around N$722 million would be spent on all aspects of construction over the roughly one and a half year construction period and that approximately 185 person years of temporary employment would be created. Approximately N$155.8 million would be spent on suppliers in the Tsumeb municipal area. It is recommended that local labour and sub-contractors be used as far as possible in line with local employment targets and that opportunities for the training of unskilled and skilled workers from local communities be maximised.

Operational phase expenditure and increase in corporate social responsibility spending (positive impact)

It is not expected that new direct employment opportunities would be created at the smelter during the operational phase, but rather that existing employees would be redeployed within the facility. Economic benefits during the operational phase largely relate to indirect employment opportunities for service providers (e.g. electricity, transport and handling services, engineering services and local municipal services). It is expected that these benefits would be experiences on a local to national scale.

It is also expected that there may be an increase in DPMT’s corporate social responsibility spending with the increased revenue to be generated by the upgrade project. This would be in addition to the already significant contributions being made by DPMT through the Tsumeb Community Trust.

Macro-economic benefits (positive impact)

In terms of macro-economic benefits, it is expected that foreign exchange earnings resulting from the
The proposed expansion would average around US$66 million per year for copper blister and sulphuric acid exports. These would be in addition to current earnings of approximately US$140 million per year. This increase is likely to have a strong positive impact on the Namibian economy and the macro-economic benefit. In this regard, it is recommended that DPMT favour Namibian suppliers of goods and services, where possible.

**Potential Negative Impact of Construction Workers on Local Communities**

The presence of construction workers from outside the local area could have the potential to impact on local communities by disrupting existing family structures and social networks through their conduct. Risks include an increase in alcohol and drug use and related crime levels. Due to the rapid increase in the population of Tsumeb in the last decade linked to general internal migration from rural to urban areas and the high numbers of truck drivers and other road users passing through the town on a monthly basis, the presence of additional workers from outside the area over a one and a half year construction period is unlikely to have a significant impact on the local community. While these impacts may be considered unlikely at a community level, at an individual and family level they may be more significant, especially in the case of contracting a sexually transmitted disease or having an unplanned pregnancies. Recommended measures include the appointment of local labour as far as possible and the briefing of local communities on the potential risks associated with construction workers.

**Potential Negative Impacts Related to Increased Storage and Transport Between Walvis Bay and Tsumeb**

Concerns raised at the Walvis Bay storage and handling facility relate to wind-blown dust and, to a limited extent, contaminated run-off. Ongoing improvement in management measures in line with the current ISO standards for the facility should limit the impacts of dust and run-off. Options for enclosed storage and potential storage and transport of concentrate in bags will be investigated. By increasing the volumes of concentrate transported via rail, the increased impacts of heavily loaded trucks on the road network and other road users would be limited. DPMT will keep their emergency response plans for road and rail transport up to date and in line with government road and rail safety initiatives.

**Potential Negative Impact of Smelter Decommissioning and Closure**

Given the relatively high number of permanent employees (667) the potential impacts associated with potential future decommissioning and closure of the smelter would be significant. The major social impacts associated with the decommissioning phase are linked to the loss of jobs and associated income. This has implications for the households who are directly affected, the communities within which they live, and the relevant local authorities. Without an effective plan to manage the social and economic impacts associated with smelter closure and decommissioning, the impacts will be significant. However, the potential impacts associated with the decommissioning phase can be effectively managed with the implementation of an effective and well planned retrenchment and downscaling programme. Appropriate retrenchment packages, the implementation of skills training programmes and ensuring that DPMT’s Asset Retirement Obligations are accurate and current in order to fund its Closure Plan objectives will be measures considered within revision of the Closure plan (due to be revised during 2019/2020). The current proposed project would extend the
viability of the smelter and thus delay the ultimate negative impacts related to decommissioning and closure.

COMMUNITY HEALTH

Impacts Related to SO$_2$ and PM$_{10}$ Exposure

Although a marked decrease in SO$_2$ emissions has been experienced after the installation of the sulphuric acid plant and other capital improvements at the smelter, exceedances of the South African and WHO 24-hour limits are still recorded on a monthly basis outside of the smelter boundary in the northern parts of town. These exceedances can cause temporary mild upper respiratory symptoms of cough and throat irritation. Less frequently, more severe lower respiratory symptoms may also be experienced. A survey of residents showed that compared with Oshakati (which is a completely unexposed control area) there is evidence of respiratory symptoms being significantly more prevalent in Tsumeb. While the level of exposure is not likely to cause a substantial symptom burden or irreversible effects, there is definitely a nuisance burden experienced by Tsumeb residents. Long-term monitoring data shows that the SO$_2$ exposures to the community, however, continue to decline. This was confirmed by the results of the respiratory health questionnaire survey in the community health study conducted in 2016.

It was noted in the specialist assessment that capital improvements were not yet fully implemented during 2016 when the study was undertaken and that it can be assumed that when these improvements function optimally, it would result in further reduction in SO$_2$ exposures going forward. Improved ventilation extraction from new converters and new methods of slag cooling may be expected to bring about further future reductions in exposure. With the sulphuric acid plant functioning at its optimal design capacity, the appropriate use of hoods at the RHF and improved ventilation extraction, increasingly more efficient capture of SO$_2$ would be likely, notwithstanding any increase in the production throughput.

The current burden of disease caused by PM$_{10}$ for Tsumeb residents is considered to be small. Simulation results of the air quality assessment showed that it is not expected that increased PM$_{10}$ emissions as a result of the expanded smelter operations would add cumulatively to the current burden of disease experienced from other PM$_{10}$ sources in the area.

Based on the above, the potential community health impacts largely relate to the upper and lower respiratory symptoms attributable to SO$_2$ exposures experienced in all areas of Tsumeb. The impact is assessed as cumulative to the current effects experienced by Tsumeb residents and rated as of low significance after mitigation. In addition to achieving optimum sulphuric acid plant conversion efficiency, the key mitigation measure is the implementation of engineering solutions to better control fugitive emissions at all components of the smelter operations.

Arsenic Exposures

It must be noted that there are currently significant contamination levels on the smelter property and surrounds due to historic mining and smelter operations and legacy waste stockpiles. Although it is acknowledged that the current DPMT smelter operations, since DPMT purchased the facility in 2010, have
contributed to and continue to contribute to the overall contamination loads, the majority of the measured contamination levels and related impacts (i.e. groundwater and community health) are attributable to historic operations prior to DPMT taking control of operations, and various improvement measures have been implemented by DPMT since 2010. DPMT is currently undertaking a Contaminated Land Assessment that will inform community health assessment studies and the Closure Plan (due to be revised 2019/2020).

The community health assessment included analysis of urine arsenic levels in community members from different residential areas in Tsumeb, compared with an unexposed control group in Oshakati. When considering the latest emissions data together with results of the urine arsenic levels, elevated urine arsenic levels were found in Tsumeb when compared to the unexposed control samples in Oshakati. The main findings of the community health investigation, however, showed that there did not seem to be a general systemic overexposure problem based on urine inorganic (attributable to mining/smelter operations) arsenic for Tsumeb residents as a whole. The geometric mean was actually found to be below the most conservative international occupational hygiene standard. The overall impacts on Tsumeb communities were thus estimated to be negligible. Further detailed investigations were recommended for the Town North community (particularly Ondundu), where mean levels were higher, and showed a high proportion (18.9%) of outliers above the Namibian Biological Exposure Index for inorganic arsenic. The results of the investigation showed that airborne arsenic and drinking water are not responsible for the elevated urine arsenic levels in outlier samples from Ondundu. More likely exposure pathways are expected to be to arsenic in dust from roadways and garden soil, arsenic in vegetables and fruit grown locally in Ondundu, and hand to mouth behaviour by both children and adults resulting in arsenic ingestion. Preliminary results of a follow-up soil sampling programme confirmed that there are numerous historic mine dump sites, exposed reefs and ongoing small scale mining sites surrounding Ondundu which showed elevated soil arsenic levels, further indicating soil as an arsenic exposure pathway.

From the available data and with the implementation of further engineering improvements for the capture of fugitive emissions, the risk of lung cancer due to environmental arsenic exposure for both the current baseline and proposed expansion project are considered to be low for Tsumeb as a whole, however, results from the 2018 monitoring programme will be required to confirm the level of risk due to historic and current operations.

No significant increase in airborne arsenic exposures for residents is expected at the proposed increased throughput capacity.

As the results indicated that arsenic in air emissions from smelter operations are not linked to elevated urine arsenic levels recorded in Ondundu (the community closest to the smelter) recommendations were made for further community health investigations in order to confirm the arsenic exposure pathways and identify areas for remediation in partnership with the Tsumeb Municipality. As part of this recommendation, a follow-up community health monitoring programme commenced in the fourth quarter of 2018. The results of this monitoring programme would be further informed by the Contaminated Land Assessment which is currently underway. Should soil and home grown food arsenic levels be high, initial prohibition of growing home crops...
and removal of the topsoil layer should be considered. These additional investigations should inform further actions, which may include an exclusion zone being negotiated around the smelter. In this regard, DPMT recently extended their boundary fence between the hazardous waste disposal site and Ondundu in order to provide a buffer and limit community activities in an area that showed elevated arsenic levels linked to historic mining.

**Arsenic exposure to DPMT employees**
The assessment of occupational health impacts do not as a rule form part of an ESIA process as occupational health is not dealt with in terms of environmental legislation. To address concerns raised by unions and other I&APs during the scoping phase and to align with EBRD’s Performance Requirements, occupational health concerns were also addressed in an appendix to the community health assessment. DPMT has developed a comprehensive Arsenic Exposure Reduction Plan which is currently being implemented. More focus is placed on emission controls versus the focus on personal protective equipment (PPE).

**ENVIRONMENTAL IMPACT STATEMENT AND CONCLUSIONS**
Based on the findings of this ESIA, it is not expected that the proposed expansion project to allow increased throughput capacity of the DPMT smelter would have a significant contribution (i.e. without mitigation measures) to current negative operational impacts. However, with the implementation of the proposed mitigation measures and further optimising of the already implemented engineering solutions for the management of air emissions, it is expected that cumulative negative impacts related to smelter operations would be reduced to a great extent.

A tabulated summary of the potential impacts is presented in Table 1 below. As can be seen, the impacts associated with the project vary from high positive to high negative without mitigation.

It is possible to mitigate the potential negative impacts by committing to apply related mitigation objectives and actions as presented in the ESMP.

The key areas of concern were centred around air quality, community health and groundwater. However, the key findings in this regard are set out below:

**Air Quality:**
- Continuous improvement in ambient air quality has been recorded for all measured parameters since 2012;
- With the implementation of the recommended mitigation measures for utilisation of the sulphuric acid plant and management of fugitive emissions, the proposed expansion project should not lead to any significant increases in emissions experienced within Tsumeb;

**Community Health:**
- Since the installation of the Sulphuric Acid Plant, residential areas in Tsumeb rarely experience exceedances of the World Health Organisation (WHO) daily limits for SO₂. Short-term exceedances of
the hourly limits are, however, still being experienced in the northern parts of the town which can cause temporary mild upper respiratory symptoms of cough and throat irritation.

- For the expansion project, exceedances of the hourly criteria for SO$_2$ might still be experienced in the northernmost parts of Tsumeb during upset plant conditions, leading to temporary respiratory irritation.

- Elevated urine arsenic levels recorded for residents closest to the smelter site were found not to be attributable to arsenic in air from smelter operations, and were more likely as a result of behavioural exposures linked to soil from historic sources, hand-to-mouth and eating wild harvested plants. The draft 2018 results indicate that the legacy waste sites may also be a possible source.

**Groundwater:**

- Groundwater quality on and beyond the site boundary is related to both current and historic impacts processing activities on the site.

- It is not expected that the proposed expansion project would lead to any measurable cumulative contribution to current groundwater quality impacts.

- A conservative update of the current groundwater model indicated that contaminated groundwater may be moving in a north-easterly direction to outside of the smelter boundary, but due to the geological formations present providing a groundwater barrier, it is not expected that contaminated groundwater would reach the irrigation farms to the north of the smelter complex.

With regards to the potential benefits of the proposed expansion project, the positive cumulative impacts related to socio-economic aspects (i.e. direct construction and operational project expenditure, indirect business opportunities, CSR contributions and macro-economic benefits) were all rated as of high significance after mitigation.

As stated above, there are currently significant contamination levels on the smelter property and surrounds due to historic mining and smelter operations and legacy waste stockpiles. Although it is acknowledged that the current DPMT smelter operations, since DPMT purchased the facility in 2010, have contributed to and continue to contribute to the overall contamination load, the majority of the measured contamination levels and related impacts (i.e. groundwater and community health) are attributable to historic operations prior to DPMT taking control of operations, and various improvement measures have been implemented by DPMT since 2010. These are described in Section 5.2.

The ongoing Contaminated Land Assessment and community health monitoring programme will aim to quantify the historic and current contributions. DPMT will continue to support the Tsumeb Municipality in finding ways to address legacy impacts outside of the smelter boundary. It is, however, suggested that MET instruct the owner of the old mine infrastructure and land surrounding Ondundu to become involved in addressing these matters.

The following key aspects with regards to current and future operations are to be addressed as a matter of
priority by DPMT:

- Ensure that the sulphuric acid plant and other recent engineering interventions (e.g. fume extraction hoods) are operating at optimal design levels in order to control SO\textsubscript{2} and other fugitive dust emissions;
- Improve waste management practices through the establishment of a formalised general landfill site within the smelter footprint;
- A final solution for the long term disposal of hazardous (arsenic) waste well in advance of the onsite hazardous waste disposal site reaching its full design capacity. The following alternatives will be further considered and a final decision should be made as soon as possible:
  - Disposal to a potential future national site in Namibia; or
  - Transport of waste to a suitable hazardous waste site in South Africa; or
  - Vitrification of flue dust which would render arsenic wastes non-hazardous; or
  - A combination of the above options;
- Completion of the contaminated land assessment and further detailed investigations into arsenic exposure pathways in order to inform priority actions to be taken with regards to remediation; and
- Completion of studies into the options for groundwater treatment.

### TABLE 1: SUMMARY OF POTENTIAL IMPACTS ASSOCIATED WITH THE PROPOSED UPGRADE AND OPTIMISATION PROJECT

<table>
<thead>
<tr>
<th>Section</th>
<th>Potential impact</th>
<th>Significance of the impact (the ratings are negative unless otherwise specified) (L=low, M= medium, H= high)</th>
<th>Unmitigated</th>
<th>Mitigated</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surface water</strong></td>
<td>Changes in surface water runoff</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>Surface water pollution</td>
<td>M</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td><strong>Groundwater</strong></td>
<td>Groundwater quantity</td>
<td>M</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>Groundwater quality</td>
<td>H</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td><strong>Air quality</strong></td>
<td>Cumulative air pollution impacts</td>
<td>M</td>
<td>L-M</td>
<td>L-M</td>
</tr>
<tr>
<td><strong>Noise</strong></td>
<td>Cumulative noise pollution impacts</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td><strong>Socio-economic impacts</strong></td>
<td>Construction phase project expenditure, including employment and downstream business opportunities</td>
<td>L-M\textsuperscript{+}</td>
<td>L-M\textsuperscript{+}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Employment phase project expenditure, mainly related to indirect employment opportunities</td>
<td>L-M\textsuperscript{+}</td>
<td>M\textsuperscript{+}</td>
<td>H\textsuperscript{+} (cumulative)</td>
</tr>
<tr>
<td></td>
<td>Increased Corporate Social Responsibility expenditure</td>
<td>L-M\textsuperscript{+}</td>
<td>M\textsuperscript{+}</td>
<td>H\textsuperscript{+} (cumulative)</td>
</tr>
<tr>
<td>Section</td>
<td>Potential impact</td>
<td>Significance of the impact (the ratings are negative unless otherwise specified)</td>
<td>Unmitigated</td>
<td>Mitigated</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(L=low, M= medium, H= high)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Macro-economic benefits</strong></td>
<td><strong>M-H⁺</strong></td>
<td><strong>M-H⁺</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>H⁺ (cumulative)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Impact of construction workers on local communities</strong></td>
<td><strong>M</strong></td>
<td><strong>L</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Impacts of increased storage and transport</strong></td>
<td><strong>M</strong></td>
<td><strong>L</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Smelter decommissioning and closure</strong></td>
<td><strong>M</strong></td>
<td><strong>L</strong></td>
</tr>
<tr>
<td>Community health impacts</td>
<td><strong>Community health impacts related to SO₂ and PM₁₀ exposure</strong></td>
<td><strong>M</strong></td>
<td><strong>L</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Community health impacts of arsenic exposures to Tsumeb communities</strong></td>
<td><strong>L-M</strong></td>
<td><strong>M</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Health impacts of arsenic exposures to DPMT employees</strong></td>
<td><strong>H</strong></td>
<td><strong>L</strong></td>
<td></td>
</tr>
</tbody>
</table>
CONTENTS

NON-TECHNICAL SUMMARY .................................................................................................................. VI

1 INTRODUCTION ................................................................................................................................. 1-1

1.1 INTRODUCTION TO THE PROPOSED PROJECT ............................................................................. 1-1

1.2 PROJECT MOTIVATION (NEED AND DESIRABILITY) .................................................................... 1-2

1.2.1 ECONOMIC 1-2

1.2.2 COMPATIBILITY WITH KEY POLICY AND PLANNING GUIDANCE .......................................... 1-3

1.3 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT PROCESS ............................................ 1-6

1.3.1 INTRODUCTION ............................................................................................................................ 1-6

1.3.2 EUROPEAN BANK OF RECONSTRUCTION AND DEVELOPMENT (EBRD) PERFORMANCE REQUIREMENTS ........................................................................................................ 1-6

1.3.3 ESIA AMENDMENT PROCESS SUMMARY ................................................................................. 1-9

1.3.4 ESIA COMPLETED AND APPROVED ......................................................................................... 1-10

1.3.5 ESIA TEAM 1-11

1.3.6 STRUCTURE OF THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT REPORT .......... 1-12

2 ASSESSMENT APPROACH AND PUBLIC CONSULTATION PROCESS ............................................. 2-1

2.1 INFORMATION COLLECTION .......................................................................................................... 2-1

2.2 SPECIALIST STUDIES ...................................................................................................................... 2-2

2.3 IMPACT ASSESSMENT METHODOLOGY ...................................................................................... 2-2

2.4 PUBLIC PARTICIPATION PROCESS ............................................................................................... 2-2

2.4.1 SCOPING PHASE ......................................................................................................................... 2-2

2.4.1.1 STAKEHOLDERS .................................................................................................................... 2-2

2.4.1.2 STEPS IN THE CONSULTATION PROCESS ......................................................................... 2-3

2.4.1.3 SUMMARY OF ISSUES RAISED DURING THE SCOPING PHASE ....................................... 2-5

2.4.2 PUBLIC CONSULTATION AND REVIEW OF THE DRAFT ESIA REPORT (2017) ....................... 2-6

2.4.3 PUBLIC CONSULTATION, STAKEHOLDER ENGAGEMENT AND REVIEW OF THE REVISED ESIA REPORT (2019) ................................................................. 2-7

3 LEGAL FRAMEWORK .......................................................................................................................... 3-1

3.1 SUMMARY OF APPLICABLE ACTS & POLICIES ........................................................................... 3-1

3.2 APPLICABLE MONITORING STANDARDS ..................................................................................... 3-4

4 DESCRIPTION OF THE CURRENT ENVIRONMENT ........................................................................ 4-1

4.1 CLIMATE .......................................................................................................................................... 4-1
4.1.1 TEMPERATURE .................................................................................................................. 4-1
4.1.2 RAINFALL AND EVAPORATION .................................................................................... 4-2
4.1.3 WIND .............................................................................................................................. 4-2

4.2 TOPOGRAPHY .................................................................................................................... 4-3

4.3 GEOLOGY ........................................................................................................................... 4-3

4.4 GROUNDWATER ................................................................................................................. 4-7
  4.4.1 GROUNDWATER LEVELS .............................................................................................. 4-8
  4.4.2 GROUNDWATER FLOW ............................................................................................... 4-9
  4.4.3 GROUNDWATER QUALITY .......................................................................................... 4-10
  4.4.4 GROUNDWATER USE ................................................................................................ 4-14

4.5 SURFACE WATER .............................................................................................................. 4-17
  4.5.1 REGIONAL HYDROLOGY .............................................................................................. 4-17
  4.5.2 LOCAL HYDROLOGY .................................................................................................... 4-17
  4.5.3 SURFACE WATER QUALITY ....................................................................................... 4-17

4.6 SOIL .................................................................................................................................. 4-19

4.7 CONTAMINATED LAND ..................................................................................................... 4-24

4.8 AIR QUALITY ....................................................................................................................... 4-33
  4.8.1 AMBIENT PM_{10} AND PM_{2.5} CONCENTRATIONS ..................................................... 4-34
  4.8.2 AMBIENT ARSENIC CONCENTRATIONS ...................................................................... 4-2
  4.8.3 SULPHUR DIOXIDE ...................................................................................................... 4-3
  4.8.4 COMPARISON OF STACK EMISSIONS TO BEST AVAILABLE TECHNOLOGY LEVELS .... 4-7

4.9 NOISE .................................................................................................................................. 4-8

4.10 VISUAL ............................................................................................................................... 4-9

4.11 ARCHAEOLOGY AND CULTURAL HERITAGE .................................................................. 4-9

4.12 BIODIVERSITY ................................................................................................................... 4-9
  4.12.1 VEGETATION ................................................................................................................ 4-9
  4.12.2 ANIMAL LIFE ............................................................................................................... 4-11

4.13 SOCIO-ECONOMIC ENVIRONMENT .............................................................................. 4-11
  4.13.1 ECONOMIC DESCRIPTION ......................................................................................... 4-11
  4.13.2 SOCIAL ENVIRONMENT ............................................................................................. 4-13

4.14 NEIGHBOURS AND SURROUNDING LAND USE ............................................................... 4-17

4.15 COMMUNITY HEALTH ..................................................................................................... 4-17

4.16 OCCUPATIONAL HEALTH ............................................................................................... 4-25
5 DESCRIPTION OF CURRENT OPERATIONS, IMPROVEMENTS AND THE EXPANSION PROPOSED PROJECTS-27

5.1 BACKGROUND ............................................................................................................. 5-27

5.2 IMPROVEMENTS SINCE 2010 ..................................................................................... 5-27

5.3 DESCRIPTION OF CURRENT OPERATIONS ................................................................ 5-29

5.3.1 WALVIS BAY PORT STORAGE AND TRANSPORT ................................................... 5-2
5.3.2 RECEIVING BAY ........................................................................................................ 5-2
5.3.3 AUSMELT FURNACE ................................................................................................. 5-2
5.3.4 PEIRCE SMITH CONVERTER FURNACE ............................................................... 5-3
5.3.5 REVERTS 5-3
5.3.6 GAS CLEANING ......................................................................................................... 5-3
5.3.7 ARSENIC PLANT AND BAG HOUSE ....................................................................... 5-4
5.3.8 SLAG MILL 5-4
5.3.9 POWER PLANT .......................................................................................................... 5-4
5.3.10 OXYGEN PLANT ...................................................................................................... 5-4
5.3.11 SULPHURIC ACID PLANT .......................................................................................... 5-5
5.3.12 GAS PRE-TREATMENT (GAS CLEANING) .............................................................. 5-5
5.3.13 GAS CONVERSION .................................................................................................. 5-5
5.3.13 SULPHURIC ACID PLANT COMPONENTS ................................................................ 5-5
5.3.14 EFFLUENT TREATMENT PLANT ............................................................................. 5-6
5.3.15 SEWAGE TREATMENT PLANT ............................................................................... 5-6
5.2.16 KIPLIME QUARRY ................................................................................................ 5-7
5.2.17 OTHER INFRASTRUCTURE AND OPERATIONAL COMPONENTS ......................... 5-8
5.2.18 WASTE SITES ......................................................................................................... 5-8
5.2.19 TRANSPORT REQUIREMENTS ............................................................................. 5-10
5.2.20 EMERGENCY PREPAREDNESS AND RESPONSE ................................................. 5-11
5.2.21 CONTRACT HSE MANAGEMENT .......................................................................... 5-12

5.4 WASTE MANAGEMENT REVIEW .............................................................................. 5-12

5.4.1 CURRENT WASTE MANAGEMENT PRACTICES ..................................................... 5-13
5.4.2 LEGACY WASTES ..................................................................................................... 5-18

5.5 PROPOSED UPGRADE AND OPTIMISATION COMPONENTS ..................................... 5-19

5.5.1 AUSMELT FEED SYSTEM AND FURNACE UPGRADES .......................................... 5-20
5.5.2 ROTARY HOLDING FURNACE (RHF) ....................................................................... 5-22
5.5.3 PEIRCE-SMITH CONVERTER .................................................................................. 5-24
5.5.4 SLAG SLOW COOLING ............................................................................................ 5-25
5.5.5 SLAG MILL UPGRADES .......................................................................................... 5-25
5.5.6 UTILITY UPGRADES ............................................................................................... 5-25
5.5.7 STORMWATER MANAGEMENT .............................................................................. 5-26
5.5.8 TRANSPORT ............................................................................................................ 5-27
5.5.9 HAZARDOUS WASTE SITE ...................................................................................... 5-27
5.5.10 CONSTRUCTION PHASE ....................................................................................... 5-30
5.5.10.1 SCHEDULE ......................................................................................................... 5-30
7.7 COMMUNITY HEALTH ........................................................................................................7-24
  7.7.1 ISSUE: COMMUNITY HEALTH IMPACTS RELATED TO SO₂ AND PM₁₀ EXPOSURE ................................................................. 7-24
  7.7.2 ISSUE: HEALTH IMPACTS OF ARSENIC EXPOSURES TO TSUMEAB COMMUNITIES ................................................................. 7-26
  7.7.3 ISSUE: HEALTH IMPACTS OF ARSENIC EXPOSURES TO DPMT EMPLOYEES ................................................................. 7-30
  7.7.4 ISSUE: IMPACTS ASSOCIATED WITH OTHER ENVIRONMENTAL HEALTH AREAS ........................................................................ 7-32

7.8 NO-GO OPTION .............................................................................................................. 7-33

8  KEY ASSUMPTIONS, UNCERTAINTIES AND LIMITATIONS ............................................. 8-34
  8.1 ENVIRONMENTAL ASSESSMENT LIMIT ........................................................................ 8-34
  8.2 PREDICTIVE MODELS IN GENERAL ............................................................................. 8-34

9  ENVIRONMENTAL IMPACT STATEMENT AND CONCLUSIONS .................................. 9-35

10 REFERENCES .................................................................................................................... 10-1
APPENDICES

APPENDIX A: ENVIRONMENTAL CLEARANCE CERTIFICATE
APPENDIX B: CURRICULUM VITAE OF ESIA TEAM
APPENDIX C: PUBLIC PARTICIPATION DOCUMENTATION
APPENDIX D: WASTE MANAGEMENT REPORT
APPENDIX E: GROUNDWATER AND SURFACE WATER ASSESSMENT
APPENDIX F: AIR QUALITY ASSESSMENT
APPENDIX G: NOISE ASSESSMENT
APPENDIX H: SOCIO-ECONOMIC ASSESSMENTS
APPENDIX I: COMMUNITY HEALTH ASSESSMENT
APPENDIX J: DETAILS REGARDING RELEVANT LAWS, POLICIES, STANDARDS
APPENDIX K: CONSOLIDATED ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN
APPENDIX L: STAKEHOLDER ENGAGEMENT PLAN FOR THE REVISED ESIA

LIST OF FIGURES

FIGURE 1-1: REGIONAL SETTING OF THE TSUMEB SMELTER................................................................. 1-4
FIGURE 1-2: LOCAL SETTING OF THE TSUMEB SMELTER........................................................................... 1-5
FIGURE 4-1: PERIOD AVERAGE WIND ROSES FROM THE STADIUM STATION DATA (JANUARY 2013 – DECEMBER 2017) ....................................................................................................................................................... 4-2
FIGURE 4-2: TOPOGRAPHY OF TSUMEB AND SURROUNDS ........................................................................... 4-3
FIGURE 4-3: REGIONAL GEOLOGY OF TSUMEB AND SURROUNDS (ADAPTED FROM THE TCL GEOLOGY MAP OF 1974) ................................................................................................................................. 4-8
FIGURE 4-4: LOCAL GEOLOGY AROUND THE TSUMEB SMELTER, WITH SW-NE CROSS SECTION (GCS, 2013 AND SUBSEQUENTLY MODIFIED BY J. NEL, GCS) ........................................................................................................ 4-9
FIGURE 4-5: HYDRAULIC CONDUCTIVITY OF GEOLOGICAL FORMATIONS AND DISCREET FEATURES (I.E. REGIONAL FAULTS AND FR Actures) IN THE TSUMEB AREA ........................................................................ 4-10
FIGURE 4-6: LOCATION OF GROUNDWATER MONITORING BOREHOL ES WITHIN THE DPMT SITE .............. 4-12
FIGURE 4-7: SIMPLIFIED GROUNDWATER MODEL MAP SHOWING POTENTIAL CONTAMINANT DISPERSION PLUME AFTER 10 YEARS, ASSUMING NO REMEDIATION AND CONTAINMENT ...... 4-13
FIGURE 4-8: SIMPLIFIED GROUNDWATER MODEL MAP SHOWING POTENTIAL CONTAMINANT DISPERSION PLUME AFTER 25 YEARS, ASSUMING NO REMEDIATION AND CONTAINMENT ..... 4-14
FIGURE 9: DPMT WATER BALANCE BLOCK FLOW DIAGRAM (DEVELOPED BY AURECON) ......................... 4-16
FIGURE 4-10: LOCAL HYDROLOGY OF THE DPMT SMELTER SITE ..................................................................... 4-18
FIGURE 4-11: SOIL MAPPING UNITS RECORDED ON THE SMELTER PROPERTY (MC LERO TH, 2015) ......... 4-20
FIGURE 4-12: INDEX OF INDUSTRIAL POLLUTION (CIP) FOR AS, CD, CU, PB AND SB IN ALL SURFACE MATERIALS COMBINED. TAILINGS, WASTES, OVERBURDEN AND STOCKPILES ARE SHOWN FOR THE 0-30 CM DEPTH, AND SURROUNDING (I.E. NO OVERBURDEN) SOILS FOR 0-2 CM DEPTH..........................................................................................................................4-29
FIGURE 4-13: AREAS OF HISTORIC MINING, ONGOING SMALL SCALE MINING AND SLAG-TOPPED ROADS WHERE ELEVATED ARSENIC LEVELS WERE RECORDED OUTSIDE OF THE SMELTER BOUNDARY (YELLOW) ..................................................................................................................4-32
FIGURE 4-14: AIR QUALITY MONITORING SITES AND AIR QUALITY SENSITIVE RECEPTORS ......................4-35
FIGURE 4-15: ANNUAL AVERAGE PM$_{10}$ CONCENTRATIONS RECORDED AT AMBIENT MONITORING STATIONS (JAN-13 TO DEC-17) ........................................................................................................................................4-1
FIGURE 4-16: POLAR PLOTS OF PM$_{10}$ ($\mu$G/M$^3$) CONCENTRATIONS FOR 2017........................................4-2
FIGURE 4-17: ANNUAL AVERAGE ARSENIC CONCENTRATIONS MEASURED BETWEEN 2012 AND 2017 ......4-3
FIGURE 4-18: ANNUAL AVERAGE SO$_2$ CONCENTRATIONS RECORDED AT THE DPMT MONITORING STATIONS BETWEEN 2013 AND 2017 .................................................................4-4
FIGURE 4-19: MEAN MONTHLY SO$_2$ LEVELS RECORDED AT TSUMEB SMELTER MONITORING SITES FROM 2013 TO 2016 (DPMT, 2016) ........................................................................................................4-5
FIGURE 4-20: POLAR PLOTS OF MAXIMUM HOURLY SO$_2$ ($\mu$G/M$^3$) CONCENTRATIONS DURING 2017........4-6
FIGURE 4-21: DIURNAL ATMOSPHERIC STABILITY AS ESTIMATED FROM THE SPORT STADIUM STATION ATMOSPHERIC DATA FROM 2013 TO 2017 ........................................................................................................4-7
FIGURE 4-22: MAP OF HABITAT TYPES IDENTIFIED WITHIN THE SMELTER BOUNDARY (VAN ZYL ET AL., 2016). (YELLOW LINE = STUDY AREA USED IN MANNHEIMER, 2014) ..................4-10
FIGURE 4-23: POPULATION BREAKDOWN FOR TSUMEB (2011 CENSUS) .................................................................4-15
FIGURE 4-24: EXPOSURE ZONES AND RESIDENTIAL SUBURBS IN TSUMEB (MYERS, 2016) .....................4-19
FIGURE 5-1: GENERAL LAYOUT OF THE DPMT SITE AND INFRASTRUCTURE .................................................5-30
FIGURE 5-2: LAYOUT OF GREATER SMELTER AREA, INDICATING TAILINGS STORAGE FACILITIES AND OTHER STOCKPILES AND SUPPORTING INFRASTRUCTURE .......................5-5
FIGURE 5-3: SIMPLIFIED FLOW DIAGRAM OF THE CURRENT SMELTER OPERATIONS ..................................5-1
FIGURE 5-4: FLOW DIAGRAM OF THE CURRENT SMELTER OPERATIONS AS AT MARCH 2019 .......................5-1
FIGURE 5-5: LOCATION OF THE KLIPLIME QUARRY TO THE EAST OF TSUMEB (SYNERGISTICS, 2013) .......5-7
FIGURE 5-6: PROCESS FLOW DIAGRAM FOR THE EXPANDED TSUMEB SMELTER OPERATIONS. [RED AND YELLOW ITEMS INDICATE THE NEW/UPGRADED COMPONENTS LINKED INTO THE EXISTING PROCESS STEPS] (WORLEYPARSONS, 2015) ..........................................................5-22
FIGURE 5-7: SMELTER LAYOUT PLAN SHOWING THE LOCATION OF EXISTING AND PROPOSED NEW MAIN INFRASTRUCTURE COMPONENTS ..........................................................5-23
FIGURE 7-1: SIMULATED 1-YEAR AVERAGE SO$_2$ CONCENTRATIONS AT 75% ACID PLANT UTILISATION ......7-17
FIGURE 7-2: 99TH PERCENTILE OF SIMULATED 24-HOUR AVERAGE SO$_2$ CONCENTRATIONS AT 75% ACID PLANT UTILISATION ...........................................................................................................7-17
FIGURE 7-3: SIMULATED 1-YEAR AVERAGE SO$_2$ CONCENTRATIONS AT 90% ACID PLANT UTILISATION RATE ..................................................................................................................................7-18
LIST OF TABLES

TABLE 1-1: OVERVIEW OF THE EBRD PRS.................................................................1-7
TABLE 1-2: ESIA AMENDMENT PROCESS...............................................................1-9
TABLE 1-3: PREVIOUS DPMT EIA PROCESSES AND APPROVALS........................1-10
TABLE 1-4: THE ENVIRONMENTAL PROJECT TEAM .............................................1-11
TABLE 1-5: ESIA REPORT REQUIREMENTS STIPULATED IN THE 2012 EIA REGULATION UNDER EMA..........................................................1-12
TABLE 2-1: DUNDEE PRECIOUS METALS STAKEHOLDERS................................2-3
TABLE 2-2: CONSULTATION PROCESS WITH IAPS AND AUTHORITIES DURING THE SCOPING PHASE .........................................................2-3
TABLE 2-3: CONSULTATION PROCESS WITH IAPS AND AUTHORITIES DURING THE EIA PHASE .................................................................2-6
TABLE 3-1: RELEVANT LEGISLATION AND POLICIES FOR THE TSUMEB SMELTER UPGRADE AND OPTIMISATION PROJECT ...........................................3-2
TABLE 4-1: MINIMUM, MAXIMUM AND AVERAGE TEMPERATURES RECORDED AT THE PLANT HILL SITE ........................................................................4-1
TABLE 4-2: GEOLOGY AND STRATIGRAPHY OF THE AREA ..................................4-5
TABLE 4-3: SUMMARY OF SOIL FORMS (MCLEROTH, 2015) ................................4-19
TABLE 4-4: ECONOMIC ACTIVITIES IN THE TSUMEB DISTRICT ..........................4-19
TABLE 4-5: ACTIVITY STATUS FOR THE POPULATION 15 YEARS AND ABOVE BY AREA, 2011 ..........................................................4-12
TABLE 4-6: ARSENIC EXPOSURES AS GEOMETRIC MEAN AND 95TH PERCENTILE BY RESIDENTIAL AREA ........................................4-16
TABLE 5-1: DPMT’S CURRENT TRANSPORT REQUIREMENTS (VAN ZYL, 2016) ....5-11
TABLE 5-2: LIKELY SPREAD OF CONSTRUCTION JOBS PER AREA .....................5-31
TABLE 7-1: CRITERIA FOR ASSESSING IMPACTS ....................................................7-3
TABLE 7-2: ASSESSMENT GUIDELINES AND STANDARDS CONSIDERED IN THE ASSESSMENT ..............................................................7-15
TABLE 7-3: CHRONIC AND ACUTE INHALATION SCREENING CRITERIA AND CANCER UNIT RISK FACTORS ............................................................................7-16
TABLE 7-4: IFC NOISE LEVEL GUIDELINES ............................................................7-4
TABLE 7-5: CONSTRUCTION PHASE EXPENDITURE ..............................................7-8
TABLE 7-6: CONSTRUCTION PHASE EXPENDITURE PER GEOGRAPHIC AREA ..........7-8
TABLE 7-7: TOTAL SALARIES AND WAGES ASSOCIATED WITH THE CONSTRUCTION PHASE OF THE PROJECT ........................................................................7-9
TABLE 7-8: INDIRECT FIRST ROUND EMPLOYMENT DURING THE OPERATIONAL PHASE .................................................................7-13
TABLE 7-9: SPENDING ALLOCATIONS WITHIN THE TSUMEB COMMUNITY TRUST, 2010 - 2015 .........................................................7-15

FIGURE 7-4: 99TH PERCENTILE OF SIMULATED 24-HOUR AVERAGE SO2 CONCENTRATIONS AT 90%
ACID PLANT UTILISATION RATE .............................................................................7-18
FIGURE 7-5: SIMULATED 1-YEAR AVERAGE PM10 CONCENTRATIONS ...................7-19
FIGURE 7-6: 99TH PERCENTILE OF SIMULATED 24-HOUR AVERAGE PM10 CONCENTRATIONS ..........7-19
FIGURE 7-7: SIMULATED 1-YEAR AVERAGE ARSENIC CONCENTRATIONS ..............7-20
FIGURE 7-8: SIMULATED 1-YEAR AVERAGE H2SO4 CONCENTRATIONS ..................7-20
TABLE 7-10: THE RELATIONSHIP BETWEEN INPUTS, OUTPUTS AND FOREIGN EXCHANGE EARNINGS ........ 7-17
TABLE 9-1: SUMMARY OF POTENTIAL IMPACTS ASSOCIATED WITH THE PROPOSED UPGRADE AND
OPTIMISATION PROJECT ........................................................................................................ 9-37
### ACRONYMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Acronyms/Abbreviations</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>BA</td>
<td>Basic Assessment</td>
</tr>
<tr>
<td>CEAPSA</td>
<td>Certified Environmental Practitioner of South Africa</td>
</tr>
<tr>
<td>DEA</td>
<td>Department of Environmental Affairs</td>
</tr>
<tr>
<td>DWS</td>
<td>Department of Water and Sanitation</td>
</tr>
<tr>
<td>EAP</td>
<td>Environmental Assessment Practitioner</td>
</tr>
<tr>
<td>EIA</td>
<td>Scoping and Environmental Impact Assessment</td>
</tr>
<tr>
<td>ESMP</td>
<td>Environmental and Social Management Plan</td>
</tr>
<tr>
<td>EN</td>
<td>Endangered</td>
</tr>
<tr>
<td>GN</td>
<td>Government Notice</td>
</tr>
<tr>
<td>HWC</td>
<td>Heritage Western Cape</td>
</tr>
<tr>
<td>I&amp;APs</td>
<td>Interested and Affected Parties</td>
</tr>
<tr>
<td>IDP</td>
<td>Integrated Development Plans</td>
</tr>
<tr>
<td>IUCN</td>
<td>International Union Conservation of Nature</td>
</tr>
<tr>
<td>LC</td>
<td>Least Concern</td>
</tr>
<tr>
<td>MPA</td>
<td>Marine Protected Area</td>
</tr>
<tr>
<td>NID</td>
<td>Notice of Intent to Develop</td>
</tr>
<tr>
<td>NEMAQA</td>
<td>National Environmental Management Air Quality Act, 2004 (No. 57 of 2003)</td>
</tr>
<tr>
<td>NEMBA</td>
<td>National Environmental Management Biodiversity Act, 2004 (No. 10 of 2004)</td>
</tr>
<tr>
<td>NEMPAA</td>
<td>National Environmental Management: Protected Areas Act, 2003 (No. 57 of 2003)</td>
</tr>
<tr>
<td>NHRA</td>
<td>National Heritage Resources Act, 1999 (No. 25 of 1999)</td>
</tr>
<tr>
<td>NT</td>
<td>Near Threatened</td>
</tr>
<tr>
<td>OTR</td>
<td>Overberg Test Range</td>
</tr>
<tr>
<td>PAMP</td>
<td>Protected Area Management Plan</td>
</tr>
<tr>
<td>Pr.Sci.Nat.</td>
<td>Registered Professional Natural Scientists</td>
</tr>
<tr>
<td>SAHRA</td>
<td>South African Heritage Resources Agency</td>
</tr>
<tr>
<td>SDFs</td>
<td>Spatial Development Frameworks</td>
</tr>
<tr>
<td>SLR</td>
<td>SLR Consulting (South Africa) (Pty) Ltd</td>
</tr>
<tr>
<td>VU</td>
<td>Vulnerable</td>
</tr>
</tbody>
</table>
1 INTRODUCTION

1.1 INTRODUCTION TO THE PROPOSED PROJECT

The Tsumeb Smelter is currently owned and operated by Dundee Precious Metals Tsumeb (DPMT); a subsidiary of the Canadian based Dundee Precious Metals (Pty) Ltd. The smelter is located on the outskirts of Tsumeb in the Oshikoto Region of Namibia, approximately 2 km northeast of the Tsumeb town centre. The regional and local settings of the Tsumeb Smelter are shown in Figure 1-1 and Figure 1-2.

With additional custom copper concentrates available worldwide and areas for operational improvements identified, DPMT is now proposing to expand their current operations in order to increase their concentrate processing capacity from approximately 240,000 to 370,000 tons per annum (tpa) and at the same time, implement some operational improvements to the existing facility. The proposed expansion would be contained within the existing facility footprint and would include the following components:

- Upgrading of the existing Ausmelt feed and furnace;
- Installation of a rotary holding furnace (RHF);
- Implementation of slow cooling of the RHF and converter slag;
- Upgrading of the slag mill to improve copper recovery and handle the increased tonnage from slow cooled slags;
- Option to install an additional Peirce-Smith (PS) converter; and
- Additional related infrastructure improvements (power supply, etc.).

New facilities will be designed, constructed, operated and maintained in line with good international practice.

The new project components and associated service infrastructure, together with the existing (approved) infrastructure/facilities, is collectively referred to as the ‘Tsumeb Smelter Upgrade and Optimisation Project’.

DPMT currently holds an Environmental Clearance Certificate (ECC) in terms of the Environmental Management Act (No. 7 or 2007; EMA) for its operations at the Tsumeb Smelter. To allow for the proposed Upgrade and Optimisation Project, an amendment of the original ECC and Environmental Management Plan (EMP) is required. SLR Environmental Consulting (Namibia) (Pty) Ltd (SLR) has been appointed by DPMT to undertake the required application and assessment process. This report focuses on the above mentioned additional components not covered in the current ECC and EMP.

DPMT currently also holds various other ECCs and EMPs for different project components established after the original ECC for the Smelter operations was issued. The objective of this project and Environmental and Social Impact Assessment (ESIA) Amendment process is further to combine all of the commitments in the separate EMPs into one consolidated ESMP for all DPMT’s facilities and operational components. This is beneficial, as
impacts and related management and mitigation measures will be considered cumulatively and it would be
easier to manage the environmental aspects if consolidated into one document linked to DPMT’s overarching
management system. If approval is granted and an Amended ECC issued, it would then serve as a consolidated
ECC for the entire DPMT Smelter complex and would supersede the previous ECCs. Refer to Section 1.3.1 for
further information relating to previously issued ECCs.

1.2 PROJECT MOTIVATION (NEED AND DESIRABILITY)

1.2.1 Economic

The Tsumeb Smelter is unique in that it has the ability to process high sulphur, high arsenic and low copper
grade concentrates. Originally designed and built to process such concentrates from the adjacent mine, it is
capable of processing concentrates with a high arsenic content and thus provides highly specialised services to
global clients.

Between 600 and 700 people are currently employed by DPMT in Tsumeb, with many other services directly
dependent on DPMT operations. As the proposed project would largely relate to the optimisation of existing
components and processes within the facility, it would not create a high number of new employment
opportunities. Some opportunities would be created for contractors during the construction phase. The
proposed upgrade and optimisation of the smelter and related increase in the throughput capacity of the
smelter would promote long term efficiency and economic sustainability of the facility, supporting the goal of
moving the facility to good international practice. By increasing the efficiency and sustainability of the facility,
long term employment security would be ensured, together with downstream economic benefits to the town
of Tsumeb.

An essential aspect of the upgrade is the installation of a RHF, which would make it possible to increase the
throughput of the existing Ausmelt furnace. Much of the smelter upgrades that have been implemented since
2012 have enabled the plant to accommodate a concentrate throughput of at least 370 000 tpa, but the
Ausmelt production rate cannot be increased without the addition of the holding furnace. The current low
utilisation is costly in terms of fixed costs and depreciation of equipment, (such as the acid plant, oxygen plant,
converters, etc.) which incurred high costs over the past three years. This, however, presents a unique
opportunity for the company to leverage previously invested capital and to achieve higher throughput by
alleviating bottlenecks with limited additional expenditure, thereby increasing the profitability and ensuring the
sustainability of the operations. In addition, the RHF would facilitate higher production rates, improved
recoveries and the reduction in metal lock-up due to reverts (e.g. circulating load in furnace), resulting in a
reduction in pollution (reduction of metal in slag and reduction of reverts). By ensuring sustainability and
increasing the profitability of the operations, current jobs at the smelter and additional jobs related to the
expansion would be preserved together with the related economic benefits to Tsumeb.
The current proposed Upgrading and Optimisation Project is one of the later phases of an overall optimisation and expansion which has already required substantial capital investment. Recovering the cost of this investment would be significantly more challenging should the proposed project not go ahead.

1.2.2 Compatibility with Key Policy and Planning Guidance

A critical aspect of economic desirability of the proposed project is the compatibility of the project with key Namibian policy and planning guidance. A comprehensive review of compatibility with socio-economic policy and planning was undertaken as part of this ESIA (see Appendix H). The review includes a consideration of the following documents:

- Vision 2030;
- The Fifth National Development Plan (NDPS);
- Namibia’s Industrial Policy; and
- The Logistics Master Plan for Namibia.

The conclusion of the review is that the proposed DPMT expansion would be largely compatible with key economic policies and plans, provided environmental and other impacts can be adequately mitigated.

The proposed expansion would increase the amount of foreign revenue generated by DPMT through value addition and provide benefits in a region with relatively high socio-economic needs. It should thus achieve in-principle compatibility with the Strategy.
FIGURE 1-1: REGIONAL SETTING OF THE TSUMEB SMELTER
FIGURE 1-2: LOCAL SETTING OF THE TSUMEB SMELTER
1.3 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT PROCESS

1.3.1 Introduction

Environmental Impact Assessment (EIA) in Namibia is regulated by the Ministry of Environment and Tourism (MET) in terms of the Environmental Management Act, 7 of 2007. This Act was gazetted on 27 December 2007 (Government Gazette No. 3966) and the EIA Regulations were promulgated on 6 February 2012.

These regulations promulgated in terms of the Environmental Management Act, identify certain activities which could have a substantially detrimental effect on the environment. These listed activities require environmental clearance from MET (Department of Environmental Affairs; DEA) prior to commencing. DPMT already holds an ECC for the activities related to the Smelter operations (see Appendix A) as well as various other relevant ECCs (refer to Section 1.3.1). No new listed activities would be triggered by the proposed new project components (i.e. amendments).

The proposed Upgrade and Optimisation Project requires the amendment of some of the project components previously approved. Section 19 of the EIA Regulations allows for an amendment of an ECC under section 39 of the Environmental Management Act, 2007.

Due to the significant potential environmental impacts associated with the general operations of a smelter of this nature and the ongoing public interest in the facility, MET: DEA (pers. comm. Mr Damian Nchindo) requested that a full ESIA process (including a scoping phase and an assessment of impacts phase) be undertaken to assess the new project components, even though no new listed activities would be triggered. Impacts from the proposed upgrade and new project components would be assessed as cumulative to the impacts experienced from the current Tsumeb Smelter operations.

1.3.2 European Bank of Reconstruction and Development (EBRD) Performance Requirements

In 2016, the EBRD made a strategic equity investment in DPM. EBRD-financed investments are expected to operate in compliance with good international practices relating to sustainable development. To assist the EBRD’s clients and their projects in achieving this, the EBRD has defined ten Performance Requirements (PRs) covering the key areas of environmental and social issues and impacts. The current ESIA amendment process and specialist assessments have taken the EBRD PRs into consideration as has the public participation process. An overview of the EBRD PRs and their relevance to the proposed project is provided in Table 1-1 below.

As part of the investment, DPMT’s operations are also to be reviewed periodically by EBRD. The ESIA Amendment process thus also included the compilation of a consolidated project ESMP based on Namibian regulatory requirements, EBRD PRs and international good practice (refer to Appendix K).
### TABLE 1-1: OVERVIEW OF THE EBRD PRS

<table>
<thead>
<tr>
<th>EBRD Performance Requirements (PR)</th>
<th>Key points relevant to the proposed project</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PR 1: Assessment and Management of Environmental and Social Impacts and issues</strong></td>
<td>This PR establishes the importance of integrated assessment in order to identify the environmental and social impacts and issues associated with projects and the client’s management of environmental and social performance through the lifecycle of the project.</td>
</tr>
<tr>
<td><strong>PR 2: Labour and Working Conditions</strong></td>
<td>This PR relates to the fair treatment of workers and providing them with safe and healthy working conditions. The project is required to comply, at a minimum, with Namibian labour, social security and occupational health and safety laws as well as the fundamental principles and standards of the International Labour Organisation (ILO) conventions (i.e. related to forced labour, freedom of association, right to collective bargaining, discrimination, minimum age, child labour, etc.). Labour and working conditions for contractors are specified in the “Service/Supply Contract” for each contractor. These contracts addresses aspects related to competency, control of personnel, discipline, alcohol and illegal substances, medical services, access to site, compliance with laws, etc.</td>
</tr>
</tbody>
</table>
| **PR 3: Resource Efficiency and Pollution Prevention and Control** | This PR recognises the importance of using best available techniques and good international practice in order to ensure resource efficiency and pollution prevention and control for a project that is environmentally and socially sustainable. The objectives of the PR are to:  
  - Identify project-related opportunities for energy, water and resource efficiency improvements and waste minimization;  
  - Adopt impact avoidance and/or mitigation measures in order to address adverse impacts on human health and environment from resource use and pollution released from the project operations; and  
  - Promote the reduction of project-related greenhouse gas emissions.  
  The PR notes that an ESIA process must determine the appropriate pollution prevention and control methods to be applied to the project, taking into consideration the project’s existing facilities and operations, its geographical location and local ambient environmental conditions. Through this process, technically and financially feasible and cost-effective pollution prevention and control techniques, best suited to avoid or minimise adverse impacts on human health and the local environment, would be identified. The project would need to meet either the European Union (EU) environmental standards, or other appropriate environmental standards as agreed with the EBRD, over a reasonable period of time based on ongoing performance assessments against the applicable standards. |
| **PR 4: Health and Safety** | This PR recognises the importance of avoiding or mitigating adverse health and safety impacts and issues associated with project activities on workers, surrounding communities and consumers. DPMT is responsible for providing safe and healthy working conditions. It is also responsible for promoting health and safety of the surrounding communities by identifying, avoiding, minimising or mitigating the risks and adverse impacts to these communities arising from its operations. DPMT also has a Vendor/Contractor HSE Agreement (Ref 8-01-MS-PR-03) which sets out the health, safety and environmental standards that contractors need to adhere to. DPMT also |
adopted ten Safety Golden Rules which every employee and Vendor/Contractor must comply with. These Golden Rules cover the following:

- Contact with Electricity;
- Confined Spaces;
- Working at heights;
- Suspended loads;
- Molten metals;
- Isolation;
- Heavy Mobile Equipment;
- Fit for work;
- Permit to work; and
- Driving.

**PR 5: Land Acquisition, Involuntary Resettlement and Economic Displacement**

In this PR, involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and economic displacement that could affect income sources or means of livelihood. This could take place as a result of project-related land acquisition and/or restrictions on land use. No resettlement of communities is envisaged as part of the proposed project. Some restrictions on economic activity in close proximity to the smelter facilities are, however, currently being implemented due to historic mining and smelter activities prior to DPMT’s purchase of the facility.

**PR 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources**

This PR provides for the sustainable management and use of living natural resources. Although the proposed project will be contained within the existing smelter footprint where no direct impacts on any living natural resources are expected, measures are to be put in place to ensure containment of any pollutants to within the smelter boundary in order to prevent impacts to natural resources in the surrounding area and along any transport routes linked to operations.

**PR 8: Cultural Heritage**

This PR recognises the importance of protecting cultural heritage and avoiding or mitigating adverse impacts on cultural heritage in the course of business operations. Although the project will be contained with the existing smelter footprint with no direct impacts on any items or places of cultural heritage importance, measures are to be put in place to ensure that operations do not impact on any culturally significant aspects in the surrounding area and along transport routes linked to operations.

**PR 10: Information Disclosure and Stakeholder Engagement**

This PR recognises the importance of an open and transparent engagement between DPMT, its workers, local communities that may be directly affected by its operations and other interested stakeholders as an essential element of good international practice. Stakeholder engagement forms an integral part of the ESIA process and all documentation produced is made available in the public domain (refer to Section 2.4). DPMT has a Stakeholder Engagement Framework in place which aims to promote and stimulate stakeholder awareness and understanding of DPMT operations. DPMT also has an Internal (Employee) Grievance Policy and Procedure (2017) in place for workers and contractors, as well as a “Receiving Suggestions, Opinions and Grievances Procedure” that outlines the process of receiving opinions, suggestions and grievances from the community. The DPMT Information Centre is available for the general public to submit grievances, and DPMT has a “Speak Up” process which is available to internal and external parties. This process provides a direct connection to the Chair of the HSE and Audit Committee.
1.3.3 ESIA Amendment Process Summary

The ESIA amendment process and corresponding activities undertaken for this project are outlined in Table 1-2 below. The process followed is in accordance with the requirements outlined in the EIA Regulations.

TABLE 1-2: ESIA AMENDMENT PROCESS

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Corresponding activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project initiation and Screening phase (February – March 2016)</strong></td>
<td></td>
</tr>
<tr>
<td>• Understanding of the environmental and social baseline relating to the</td>
<td>• Initiate baseline studies&lt;br&gt;• Early identification of environmental aspects and potential impacts associated with the proposed project.</td>
</tr>
<tr>
<td>proposed smelter upgrade and optimisation project</td>
<td></td>
</tr>
<tr>
<td>• Initiate the screening process</td>
<td></td>
</tr>
<tr>
<td>• Initiate the environmental impact assessment process.</td>
<td></td>
</tr>
<tr>
<td><strong>Scoping phase (March – June 2016)</strong></td>
<td></td>
</tr>
<tr>
<td>• Notify the decision making authority of the proposed project</td>
<td>• Application submitted to MET.</td>
</tr>
<tr>
<td>• Identify interested and/or affected parties (IAPs) and involve them in</td>
<td>• Notify government authorities and IAPs of the project and EIA process (telephone calls, e-mails, newspaper and radio advertisements and site notices).</td>
</tr>
<tr>
<td>the scoping process through information sharing.</td>
<td>• Scoping meetings with local authorities and IAPs.</td>
</tr>
<tr>
<td>• Identify potential environmental issues associated with the proposed</td>
<td>• Compilation of draft scoping report.</td>
</tr>
<tr>
<td>amendment.</td>
<td>• Distribute scoping report to relevant authorities and IAPs for review (May 2016).</td>
</tr>
<tr>
<td>• Consider alternatives.</td>
<td>• Finalisation of scoping report</td>
</tr>
<tr>
<td>• Identify any fatal flaws.</td>
<td>• Forward final scoping report and IAPs comments to MET for review in June 2016.</td>
</tr>
<tr>
<td>• Determine the terms of reference for additional assessment work.</td>
<td>• MET accepted the final scoping report on 4 August 2016.</td>
</tr>
<tr>
<td><strong>Draft ESIA/ESMP phase (June 2016 – April 2017)</strong></td>
<td></td>
</tr>
<tr>
<td>• Provide a detailed description of the potentially affected environment.</td>
<td>• Investigations by technical project team and appointed specialists.</td>
</tr>
<tr>
<td>• Assessment of potential environmental impacts.</td>
<td>• Compilation of draft ESIA and ESMP report.</td>
</tr>
<tr>
<td>• Design requirements and management and mitigation measures.</td>
<td>• Distribute draft ESIA and ESMP report to authorities and IAPs for review.</td>
</tr>
<tr>
<td>• Feedback meetings/open days with local authorities and IAPs.</td>
<td>• Feedback meetings/open days with local authorities and IAPs.</td>
</tr>
<tr>
<td><strong>Final ESIA/ESMP phase (May 2017 – February 2019)</strong></td>
<td></td>
</tr>
<tr>
<td>• Updating of some specialist studies based on comments received on the</td>
<td>• Make final ESIA and ESMP publically available</td>
</tr>
<tr>
<td>draft ESIA and ESMP</td>
<td>• Collate and respond to IAP comments.</td>
</tr>
<tr>
<td>• Updating of ESIA</td>
<td>• Update draft ESIA report to final version, taking comments received into account.</td>
</tr>
<tr>
<td>• Review of ESIA by MET</td>
<td>• Submit final ESIA and ESMP, including IAP comments to MET for review and decision-making.</td>
</tr>
<tr>
<td><strong>Revised ESIA/ESMP phase (February 2019 – July 2019)</strong></td>
<td></td>
</tr>
<tr>
<td>• Alignment with EBRD Performance Requirements</td>
<td>• Revise ESIA and appendices to align with EBRD Performance Requirements</td>
</tr>
<tr>
<td>• Submission to DEA for decision making</td>
<td>• Make ESIA available to IAPs for commenting</td>
</tr>
</tbody>
</table>
Objectives | Corresponding activities
--- | ---
• Collate and respond to IAP comments.
• Update draft ESIA report to final version, taking comments received into account.
• Submit final ESIA and ESMP, including IAP comments to DEA for review and decision-making.

Within this framework, the required components of the ESIA report are discussed in more detail as part of the assessment approach in Section 2.

1.3.4 EIAs Completed and Approved

A number of EIAs have been undertaken for DPMT’s current operations. These are set out in Table 1-3 below:

**TABLE 1-3: PREVIOUS DPMT EIA PROCESSES AND APPROVALS**

<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>After purchasing the Namibia Custom Smelters in 2010, DPMT commissioned an EIA in order to determine the effect that the operation of the Tsumeb Smelter has on the biophysical and social environment (Synergistics, 2011). The EIA was undertaken in terms of best practice and pre-empted the need for an ECC in terms of the Namibian legislation. This process was undertaken prior to the February 2012 publishing of the Environmental Management Act Regulations. The ECC was issued on 26 October 2012.</td>
</tr>
<tr>
<td>2012</td>
<td>An EIA process was undertaken for the construction of the hazardous waste site within an old quarry site to the south of the Tsumeb Smelter (Synergistics, 2012). The ECC was issued in 2012.</td>
</tr>
<tr>
<td>2013</td>
<td>An EIA process was undertaken for the establishment of a general waste landfill site at the smelter in 2013 (Synergistics 2013). The ECC was issued in August 2013.</td>
</tr>
<tr>
<td>2013</td>
<td>An EIA process was undertaken for a new sulphuric acid plant in 2013 (Golder, 2013). The project was viewed as an environmental improvement project to reduce SO(_2) air emissions from the smelter and improve ambient air quality. The ECC was issued in 2014.</td>
</tr>
<tr>
<td>2014</td>
<td>An EIA process for the upgrading of the sewerage system at the smelter was undertaken by SLR in 2014 (SLR, 2014a). The ECC was issued in June 2014.</td>
</tr>
<tr>
<td>2014</td>
<td>An EIA process for a new 11kV power line was undertaken by SLR in 2014 (SLR, 2014b). The ECC was issued in June 2014.</td>
</tr>
<tr>
<td>2015</td>
<td>An EIA and EMP amendment process for hazardous waste site was undertaken by SLR in 2015 (SLR, 2015). The amendment would allow for additional hazardous waste streams to be disposed of at the smelter’s hazardous waste site. The application was, however, withdrawn during August 2015 following the decision to only dispose of arsenic wastes at the site.</td>
</tr>
<tr>
<td>2016</td>
<td>An application for the renewal of the ECC for the smelter operations was lodged with MET during February 2016 (SLR, 2016). The renewal was issued in September 2016.</td>
</tr>
<tr>
<td>2017</td>
<td>A combined Scoping and EIA process for the upgrading of the surface water infrastructure, including the construction of pollution control dams was undertaken during the fourth quarter of 2017 (Tortoise, 2017). The ECC was issued in March 2018.</td>
</tr>
</tbody>
</table>

The aim of the current ESIA Amendment process is to consolidate all the separate ECCs listed in the above table under a single ECC to cover the upgrading and optimisation project and further operations of the Tsumeb...
Smelter. In addition, the ESIA includes a consolidated ESMP for all DPMT operations (see Appendix K). The ESMP consolidates the approved EMP documents for all the smelter components.

### 1.3.5 ESIA Team

SLR is the independent firm of consultants that has been appointed by DPMT to undertake the environmental impact assessment and related processes. The relevant curriculum vitae documentation of the project team is attached in Appendix A.

The environmental project team is outlined in Table 1-4.

**TABLE 1-4: THE ENVIRONMENTAL PROJECT TEAM**

<table>
<thead>
<tr>
<th>Team</th>
<th>Name</th>
<th>Designation</th>
<th>Tasks and roles</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPMT TEAM</td>
<td>Benedicta Uris</td>
<td>Director: Health, Safety and Environment</td>
<td>Responsible for ensuring implementation of the EIA outcomes and interface between DPMT and environmental team (2017-2018)</td>
<td>DPMT</td>
</tr>
<tr>
<td>Environmental Project Team</td>
<td>Eloise Costandius</td>
<td>Project Manager</td>
<td>Management of the process, team members and other stakeholders. Report compilation.</td>
<td>SLR Consulting</td>
</tr>
<tr>
<td></td>
<td>Werner Petrick</td>
<td>Project Reviewer</td>
<td>Report and process review</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Andrew Bradbury</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Conroy van der Riet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Immanuel Katali</td>
<td>Project Assistant</td>
<td>Assistance with compilation of documents</td>
<td></td>
</tr>
<tr>
<td>Specialists investigations</td>
<td>Gwendal Madec</td>
<td>Groundwater specialists</td>
<td>Groundwater and surface water assessment and groundwater model update</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Arnold Bittner</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Winnie Kambinda</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jonathan Church</td>
<td>Surface water specialist</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gordon Kernick</td>
<td>Waste specialist</td>
<td>Waste management study</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hanlie Liebenberg-Enslin</td>
<td>Air quality specialist</td>
<td>Air quality and noise specialist assessments</td>
<td>Airshed Planning Professionals</td>
</tr>
<tr>
<td></td>
<td>Nicolette von Reiche</td>
<td>Noise specialist</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tony Barbour</td>
<td>Social specialist</td>
<td>Socio-economic assessment</td>
<td>Independent social specialist</td>
</tr>
<tr>
<td></td>
<td>Hugo van Zyl</td>
<td>Economics specialist</td>
<td></td>
<td>Independent economic specialist</td>
</tr>
<tr>
<td></td>
<td>Jonny Myers</td>
<td>Community health specialist</td>
<td>Community and occupational health assessment</td>
<td>University of Cape Town</td>
</tr>
<tr>
<td></td>
<td>Greg Kew</td>
<td></td>
<td></td>
<td>EOH Health</td>
</tr>
</tbody>
</table>
1.3.6 Structure of the Environmental and Social Impact Assessment Report

The purpose of this ESIA report is to assess potential environmental and social impacts associated with the proposed upgrading and optimisation of the Tsumeb Smelter cumulatively (taking the current activities and facilities into consideration) and to provide meaningful additional/amended management and mitigation measures to avoid or reduce the negative impacts and enhance positive impacts.

The content of this ESIA report is informed by Section 15 of the above mentioned EIA Regulations. The required components of this report are included in Table 1-5 below. The process alignment with the EBRD PRs is also indicated.

### TABLE 1-5: ESIA REPORT REQUIREMENTS STIPULATED IN THE 2012 EIA REGULATION UNDER EMA

<table>
<thead>
<tr>
<th>EIA Regulation Requirement</th>
<th>Reference in the ESIA Report</th>
<th>Alignment with EBRD PRs</th>
</tr>
</thead>
<tbody>
<tr>
<td>The curriculum vitae of the EAP who compiled the report</td>
<td>Appendix B</td>
<td></td>
</tr>
<tr>
<td>A detailed description of the proposed listed activity</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>A description of the environment that may be affected by the activity and the manner in which the physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed activity</td>
<td>Section 4</td>
<td>PR1, PR6 and PR8</td>
</tr>
<tr>
<td>A description of the need and desirability of the proposed listed activity and identified potential alternatives to the proposed listed activity, including advantages and disadvantages that the proposed activity or alternatives may have on the environment and the community that may be affected by the activity</td>
<td>Sections 1.2 and 5</td>
<td>PR1, PR3, PR6 and PR8</td>
</tr>
<tr>
<td>An indication of the methodology used in determining the significance of potential effects</td>
<td>Section 7</td>
<td>PR1</td>
</tr>
<tr>
<td>A description and comparative assessment of all alternatives identified during the assessment process</td>
<td>Sections 6 and 7</td>
<td>PR1</td>
</tr>
<tr>
<td>A description of all environmental issues that were identified during the assessment process, an assessment of the significance of each issue and an indication of the extent to which the issue could be addressed by the adoption of mitigation measures</td>
<td>Section 7, Appendices D to I (specialist assessments), and Appendix K (ESMP).</td>
<td>PR1, PR3, PR6 and PR8</td>
</tr>
<tr>
<td>An assessment of each identified potentially significant effect, including -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- cumulative effects;</td>
<td>Section 7 and Appendices D to I</td>
<td>PR1, PR3, PR4, PR5, PR6 and PR8</td>
</tr>
<tr>
<td>- the nature of the effects;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- the extent and duration of the effects;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- the probability of the effects occurring;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- the degree to which the effects can be reversed;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- the degree to which the effects may cause irreplaceable loss of resources; and</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The ESMP included in Appendix K includes the following as per the requirements of Section 8 (j) of the EMA regulations:

(j) a management plan, which includes –

(aa) information on any proposed management, mitigation, protection or remedial measures to be undertaken to address the effects on the environment that have been identified including objectives in respect of the rehabilitation of the environment and closure;

(bb) as far as is reasonably practicable, measures to rehabilitate the environment affected by the undertaking of the activity or specified activity to its natural or predetermined state or to a land use which conforms to the generally accepted principle of sustainable development; and

(cc) a description of the manner in which the applicant intends to modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation remedy the cause of pollution or degradation and migration of pollutants.

EBRD PRs and other international good practices have also been considered in the compilation of the consolidated ESMP.
2 ASSESSMENT APPROACH AND PUBLIC CONSULTATION PROCESS

The scoping phase of the assessment for the project was completed and described in the Scoping Report. The Final Scoping Report was submitted to MET in June 2016. MET accepted the Final Scoping Report on 4 August 2016.

The ESIA Report presents the ESIA and ESMP for the upgrading and optimisation of the Tsumeb Smelter. This section sets out the steps followed in the ESIA process.

2.1 INFORMATION COLLECTION

SLR used various sources to identify both the environmental and social issues associated with the proposed amendments and the terms of reference for the required investigations. The main sources of information for the preparation of both the scoping and ESIA reports include:

- Project information provided by DPMT:
  - Tsumeb Smelter Expansion Pre-feasibility Study report (Worley Parsons, 2015);
  - Air and water quality monitoring results;
  - Closure Plan (Golder, 2016)

- Site visits by SLR;

- Consultation with the DPMT project team (additional technical information provided by DPMT and their project team and engineers);

- Previous EIA Reports and other specialist reports compiled for the DPMT smelter facility:
  - Tsumeb Smelter EIA (Synergistics, 2011);
  - General Waste Landfill Site (Synergistics, 2013);
  - Sulphuric Acid Plant EIA (Golder, 2013);
  - Kliplime Quarry EMP (Synergistics, 2013);
  - Sewage Treatment Plant EIA (SLR, 2014a);
  - 11kV Power line EIA (SLR, 2014b);
  - Scoping Report (including assessment) for the DPMT hazardous waste site amendment (SLR, 2015);
  - Baseline soil, land capability and land use assessment (Red Earth, 2016);
  - Environmental Management Progress Report – Contaminated Land Assessment (Weiersbye, 2016);
  - Biodiversity Assessment Report (Enviro Dynamics, 2016); and
  - Amended EMP for the Tsumeb Smelter (SLR, 2016)

- Consultation with IAPs and with relevant authorities; and

- Atlas of Namibia (Mendelsohn et al., 2009)
2.2 SPECIALIST STUDIES

The proposed terms of reference for further specialist investigations were developed as part of the scoping phase and were presented in the Scoping Report.

Based on the terms of reference and findings of the Scoping phase, specialists were required to inform the various impacts that the proposed amendments may have on the physical and socio-economic environments for inclusion in the ESIA Report.

The following specialist studies were conducted:

- Air Quality Impact Assessment Report (Airshed, 2017 and 2018 update);
- Groundwater and Surface Water Report (SLR, 2016a);
- Updated Groundwater Model (SLR, 2018);
- Waste Management Report (SLR, 2016b);
- Noise Impact Assessment (Airshed, 2017);
- Community Health Assessment (Myers, 2016 and 2019 update) and
- Socio-Economic Impact Assessment (Barbour & Van Zyl, 2017 with update edits by SLR in 2019).

The specialist studies are attached to this report in Appendices D to I.

2.3 IMPACT ASSESSMENT METHODOLOGY

The criteria used to assess the impacts and the method of determining the significance of the impacts is outlined in Section 7. This method complies with the EIA Regulations: EMA, 2007 (Government Gazette No. 4878) and was used by the relevant specialists to conduct their impact assessments. Specialists were also referred to the EBRD PRs.

2.4 PUBLIC PARTICIPATION PROCESS

The aim of the public participation process (PPP) for this ESIA was to ensure that all persons or organisations that are interested in or affected by the project were informed of the issues and can register their views and concerns. A description of the PPP is provided below. A detailed PPP report is provided in Appendix C.

2.4.1 Scoping Phase

2.4.1.1 Stakeholders

Key stakeholders were identified as those people who are interested or potentially affected by the proposed project. Table 2-1 below provides a broad list of stakeholders that were engaged with during the Scoping and ESIA process.
TABLE 2-1: DUNDEE PRECIOUS METALS STAKEHOLDERS

<table>
<thead>
<tr>
<th>Stakeholder Grouping</th>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local government – councillors and key officers</td>
<td>Tsumeb Town Council</td>
</tr>
</tbody>
</table>
| Government Ministries | • Ministry of Environment and Tourism (MET)  
|                       |   o Directorate of Environmental Affairs  
|                       | • Ministry of Health and Social Services  
|                       | • Ministry of Labour, Industrial Relations and Employment Creation  
|                       | • Ministry of Agriculture, Water and Forestry  
|                       | • Ministry of Industrialisation, Trade and SME Development  
|                       | • Ministry of Finance  
|                       | • Ministry of Public Enterprises  
|                       | • Ministry of Poverty Eradication |
| Non-Governmental Organisations (NGOs) | • Earth Life Namibia  
|                       | • Wildlife Society of Namibia  
|                       | • Birdlife Africa  
|                       | • WWF in Namibia  
|                       | • Earth Organisation, Namibia  
|                       | • Bankwatch  
|                       | • Tsumeb Health and Environmental Action Network |
| Industries in the Tsumeb region | Various industries |
| Unions | Mineworkers Union, Namibia National Labour Union, National Union of Namibian Workers |
| Media | Newspapers: The Namibian, Republikein, The Villager/Prime Focus, Confidente, Namibian Sun, NAMPA, New Era Newspaper, Informante, Algemeine Zetung |
| Other interested and affected parties | Any other people with an interest in, or who may be affected by, the proposed project. |

2.4.1.2 Steps in the Consultation Process

TABLE 2-2: CONSULTATION PROCESS WITH IAPS AND AUTHORITIES DURING THE SCOPING PHASE

<table>
<thead>
<tr>
<th>TASK</th>
<th>DESCRIPTION</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notification - regulatory authorities and IAPS</td>
<td>SLR discussed the project proposal with MET telephonically and confirmed the required Scoping and ESIA amendment process</td>
<td>February 2016</td>
</tr>
<tr>
<td>Consultation with MET</td>
<td>SLR discussed the project proposal with MET telephonically and confirmed the required Scoping and ESIA amendment process</td>
<td>February 2016</td>
</tr>
</tbody>
</table>
| IAP identification          | The existing DPMT stakeholder database was used. This database is updated throughout the process.  
<p>|                             | A copy of the IAP database is attached in Appendix C.                        | March 2016 and throughout the process |</p>
<table>
<thead>
<tr>
<th>TASK</th>
<th>DESCRIPTION</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background Information Document (BID)</td>
<td>BIDs with covering letters were distributed electronically (where possible) to relevant authorities and IAPs on DPMT’s stakeholder database and copies were made available on request to SLR. Hard copies of the BID were also made available during the public scoping meetings in Tsumeb. The purpose of the BID was to inform IAPs and authorities about the proposed optimisation and upgrade project, the assessment process being followed, possible environmental impacts and ways in which IAPs could provide input to SLR. Attached to the BID was a registration and response form, which provided IAPs with an opportunity to submit their names, contact details and comments on the project. A copy of the BID is attached in Appendix C.</td>
<td>April 2016</td>
</tr>
<tr>
<td>Site notices and pamphlet distribution</td>
<td>A site notice was placed at the entrance to the smelter facility. A4 posters advertising the project and public meetings were put up at the municipality. Notification letters with meeting invitations were hand delivered to over 50 businesses in Tsumeb on 19 April 2016. A photo of the site notice is attached in Error! Reference source not found.</td>
<td>April 2016</td>
</tr>
</tbody>
</table>
| Newspaper Advertisements                         | Block advertisements were placed as follows:  
  - The Namibian (8 and 15 April 2016)  
  - Republikein (8 and 15 April 2016)  
  The newspaper advertisements provided information of the proposed project, the availability of the BID and the time and venues of the planned public scoping meetings.                                                                 | April 2016 |
| Radio advertisements                              | Radio advertisements announcing the project and advertising the public scoping meetings were broadcast on the evenings of 18 and 19 April 2016. These advertisements were broadcast on NBC radio stations in Afrikaans, English and Oshiwambo.                                                                 | April 2016 |
| Public and focus group meetings and submission of BID comments | The following public meetings and focus group meetings were held as part of the Scoping phase of the ESIA:  
  - A public meeting was held at the Makalani Hotel in Tsumeb on 20 April at 11:00.  
  - A focus group meeting was held with the Ondundu Village residents at the Ondundu School Hall on 20 April at 18:00.  
  - A focus group meeting was held with the Tsumeb Town Council members, including the executive mayor, at the Tsumeb Municipality council chambers on 21 April at 15:00.  
  - A focus group meeting was held at the community hall in Nomtsoub on 21 April at 18:00.  
  The same project and ESIA information was shared at all of the above mentioned meetings. Project information was presented in English and Afrikaans, with translators available should information be requested in Oshiwambo or Damara. A copy of the presentation is attached in Appendix C.                                                                 | April 2016 |
### TASK

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comments and Responses</td>
<td></td>
</tr>
<tr>
<td>Minutes of the meetings and a comments and responses report on initial comments received on the BID were appended to the draft Scoping Report.</td>
<td></td>
</tr>
<tr>
<td>Review of draft Scoping Report</td>
<td></td>
</tr>
<tr>
<td>IAPs and authorities (excluding MET) review of scoping report</td>
<td>June 2016</td>
</tr>
<tr>
<td>Notifications regarding the availability of the draft Scoping Report were sent via email and text message to all parties registered on the project database and/or parties that showed an interest in this ESIA process. An electronic copy of the report was made available online and CDs on written request. Hard copies of the report were made available at the Tsumeb public library and the DPMT Information Centre. Registered IAPs were given two weeks to review the report and submit comments in writing to SLR. The Scoping Report comment period closed on 29 June 2016. Only one written comment was received during the formal comment period.</td>
<td></td>
</tr>
<tr>
<td>MET review and acceptance of Scoping Report</td>
<td>July - August 2016</td>
</tr>
<tr>
<td>A copy of the final Scoping Report, including IAP review comments was submitted to MET on 8 July 2016. Acceptance of the Scoping Report was issued by MET on 4 August 2016.</td>
<td></td>
</tr>
</tbody>
</table>

#### 2.4.1.3 Summary of Issues Raised During the Scoping Phase

The issues raised by IAPs during the Scoping Phase pertain to the following:

- Air quality and health impacts;
- DPMT’s reputation;
- Socio-economic issues;
- Project design;
- ESIA process and specialist studies;
- Public participation process;
- Groundwater impacts;
- Noise impacts; and
- Waste disposal.

All comments were provided to the independent specialist team for consideration in their assessments. An Issues and Responses Report was compiled and appended to the draft ESIA Report. It summarised all the comments received during the Scoping Phase with responses and reference to the ESIA Report, ESMP and specialist studies, where relevant.
2.4.2 Public Consultation and Review of the Draft ESIA Report (2017)

**TABLE 2-3: CONSULTATION PROCESS WITH IAPS AND AUTHORITIES DURING THE EIA PHASE**

<table>
<thead>
<tr>
<th>TASK</th>
<th>DESCRIPTION</th>
<th>DATE</th>
</tr>
</thead>
</table>
| Focus group meetings to provide feedback on specialist findings     | Public and authority meetings were held in Tsumeb on 8 and 9 March 2017 in order to provide feedback on the key findings of the specialist studies and ESIA process prior to distribution of the Draft ESIA report. Meeting invitations were sent to all parties on the project database via E-mail and text message. The meetings were held as follows:  
  - 8 March 2017, 10:00 – Focus group meeting with the Tsumeb Town Council members at the Tsumeb Municipality council chambers;  
  - 8 March 2017, 18:00 - Focus group meeting with the Ondundu Village residents at the Ondundu School Hall;  
  - 9 March 2017, 10:00 - Focus group meeting at the Makalani Hotel in Tsumeb; and  
  - 9 March 2017, 18:00 - Focus group meeting the community hall in Nomtsoub.  
  The same project and ESIA information was shared at all of the above mentioned meetings. Project information was presented in English and Afrikaans, with translators available should information be requested in Oshiwambo or Damara. A copy of the presentation is attached in Appendix C. | March 2017 |
| Comments and Responses                                               | Minutes of the meetings are included in Appendix C.                                                                                                                                                         |        |
| Employee information-sharing meeting                                 | Information-sharing meetings were held with DPMT employees on 24 April 2017 in order to present the proposed project and outcomes of the specialist investigations with a special focus on employee occupational health aspects. Employees were invited to attend the presentations in between shift changes. Posters summarising the outcomes of specialist investigations were also put up at the meeting venue. | April 2017 |
| Review of draft ESIA Report                                           | Notifications regarding the availability of the draft ESIA Report were sent via email and text message to all parties registered on the project database and/or parties that showed an interest in this ESIA process. E-mail notifications included a copy of the Executive Summary of the report. An electronic copy of the report was made available online and CDs on written request. Hard copies of the report were made available at the Tsumeb public library and the DPMT Information Centre. Registered IAPs were given 40 days to review the report and submit comments in writing to SLR. The ESIA Report comment period closed on 29 May 2017. Four written comments were received during the formal comment period. | May 2017  |
The Issues and Responses Report referred to in Section 2.4.1.3 above was subsequently updated to include comments received on the draft ESIA Report and is included in Appendix C.

Issues during the comment period on the draft ESIA Report largely related to:

- Air quality and health;
- Social;
- Hazardous and general waste disposal; and
- Groundwater.

Based on comments received on the draft ESIA Report and the availability of data related to further improvements made at the smelter during 2017, the decision was made to update the air quality and community health assessments and to also appoint a specialist consultant to update the groundwater model, as recommended in the draft ESIA Report. Further preliminary results from the ongoing Contaminated Land Assessment also became available during the second quarter of 2018 for inclusion in the updated ESIA Report. The final ESIA Report has been made available to the public to view responses to their comments and updates made. The report has been submitted to MET for their review and decision-making.

2.4.3 Public Consultation, Stakeholder Engagement and Review of the Revised ESIA Report (2019)

Further public consultation and stakeholder engagement will be done according to the Stakeholder Engagement Plan (SEP) for the Revised ESIA (as provided in Appendix L). The Revised ESIA will be made available to all the stakeholders, and comments will be reflected in the updated Issues and Responses Report prior to submission to the DEA.
3 LEGAL FRAMEWORK

The Republic of Namibia has five tiers of law and a number of policies relevant to environmental assessment and protection, which includes:

- The Constitution
- Statutory law
- Common law
- Customary law
- International law

Relevant policies currently in force include:

- The National Climate Change Policy of Namibia (September 2010).

As the main source of legislation, the Constitution of the Republic of Namibia (1990) makes provision for the creation and enforcement of applicable legislation. In this context and in accordance with its constitution, Namibia has passed numerous laws intended to protect the natural environment and mitigate against adverse environmental impacts.

The environmental management legislation is enforced by the Department of Environmental Affairs (DEA) within the Ministry of Environment and Tourism (MET).

Section 3.1 below summarises the various applicable laws and policies, while the local and international standards used in monitoring smelter operations are set out in Section 3.2.

3.1 SUMMARY OF APPLICABLE ACTS & POLICIES

In the context of the Tsumeb Smelter Upgrade and Optimisation Project, there are several laws and policies currently applicable. They are reflected in Table 3-1.

A list of permits and approvals currently held by DPMT as well as a list of additional pending permit applications are provided in Section 3 of the Consolidation ESMP in Appendix K.
### TABLE 3-1: RELEVANT LEGISLATION AND POLICIES FOR THE TSUMEB SMELTER UPGRADE AND OPTIMISATION PROJECT

<table>
<thead>
<tr>
<th>YEAR</th>
<th>NAME</th>
<th>Natural Resource Use</th>
<th>Emissions to air</th>
<th>Emissions to land</th>
<th>Noise (remote only)</th>
<th>Visual</th>
<th>Vibrations</th>
<th>Impact on Land use</th>
<th>Impact on biodiversity</th>
<th>Impact on Archaeology</th>
<th>Emergency situations</th>
<th>Socio-economic</th>
<th>Safety &amp; Health</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969</td>
<td>Soil Conservation Act (No. 76 of 1969)</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>Namibian Water Corporation Act, 12 of 1997</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>Water Resources Management Act 11 of 2013</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>Environmental Management, Act 7 of 2007</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>Regulations promulgated in terms of the Environmental Management, Act 7 of 2007</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1975</td>
<td>Nature Conservation Ordinance 14 of 1975</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1976</td>
<td>Atmospheric Pollution Prevention Ordinance 11 of 1976</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td>Namibia’s Environmental Assessment Policy for Sustainable Development and Environmental Conservation</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>Pollution Control and Waste Management Bill (3rd Draft September 2003)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1974</td>
<td>Hazardous Substance Ordinance, No. 14 of 1974</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>YEAR</td>
<td>NAME</td>
<td>Natural Resource Use (energy &amp; water)</td>
<td>Emissions to air (fumes, dust &amp; odours)</td>
<td>Emissions to water (non-hazardous &amp; hazardous)</td>
<td>Emissions to water (industrial &amp; domestic)</td>
<td>Noise (remote only)</td>
<td>Vibrations</td>
<td>Impact on Land use</td>
<td>Impact on biodiversity</td>
<td>Impact on Archaeology</td>
<td>Emergency situations</td>
<td>Socio-economic</td>
<td>Safety &amp; Health</td>
<td>Other</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------------------</td>
<td>---------------------------------------</td>
<td>------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------------------------</td>
<td>-------------------</td>
<td>------------</td>
<td>------------------</td>
<td>------------------------</td>
<td>----------------------</td>
<td>---------------------</td>
<td>---------------</td>
<td>----------------</td>
<td>-------</td>
</tr>
<tr>
<td>2015</td>
<td>Public and Environmental Health Act, No. 86 of 2015</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
The following International Conventions, which in terms of article 144 of the Constitution, automatically form part of Namibian law may also apply:

- The Convention on Biodiversity, 1992
- The United Nations Framework Convention on Climate Change (UNFCCC)
- Vienna Convention for the Protection of the Ozone Layer, 1985
- Montreal Protocol on Substances that Deplete the Ozone Layer, 1987

Further details regarding relevant legislation as it applies to the different specialist fields are provided in the specialist studies in Appendices D to I as well as in Appendix J.

3.2 APPLICABLE MONITORING STANDARDS

Since commencement of its operations, DPMT has aimed to continuously improve its environmental and occupational health standards by aiming to meet at least the accepted Namibian and South African standards. With progressive modernisation of the smelter operations since 2011, DPMT has aimed to reach improved levels related to all its emissions to the environment and where it relates to worker health. DPMT is aiming to reach the higher EU standards over time as further engineering improvements are completed. The monitoring standards applicable to this project, and DPMTs general operations, include:

- Namibia Environmental Management Act, 2007;
- Water Resources Management Act, 2013;
- Namibia Regulations relating to the Health and Safety of Employees at the Workplace, 1997;
- South African National Ambient Air Quality Standards for PM$_{10}$ and SO$_2$;
- EU Directive 2010/75/EU Establishing Best Available Techniques (BAT) for the non-ferrous metals industries (2016);
- EU Directive 2017/164/EU Indicative OEL values (for certain Workplace Exposure Limits);
- European Commission 2008/50/EC Directive on Ambient air quality air quality (standards for particulate matter PM$_{10}$);
- European Commission 2008/50/EC Directive on Ambient air quality air quality (standard for particulate matter PM$_{2.5}$);
- European Commission /50/EC Directive on Ambient air quality air quality (standard for heavy metals);
- World Health Organisation (WHO) guideline for SO$_2$ and PM$_{2.5}$;
- South African National Dust Control Regulations (Government Gazette No. 36794, 1 November 2013);
- Canadian Soil Quality Guidelines for the protection of Environmental and Human Health (2007);
- Canadian Environmental Guidelines (Ontario Ambient Air Quality Criteria);
- Namibia guideline for the evaluation of drinking water for human consumption;
- California Environmental Protection Agency Screening Criteria and Inhalation unit risk factors (URFs) for Arsenic and H$_2$SO$_4$;
- New York State Department of Health (NYSDOH) rankings for cancer risk estimates;
- IFC Guidelines on Environmental Noise;
- National Norms and Standards for the Storage of Waste (GN R 926 of November 2013);
- Namibia Radiation Protection and Waste Disposal Regulations, 2005;
- Constituents listed in Section 3.3.7 of the Groundwater and Surface Water Study (Appendix E of the ESIA); and
- Constituents listed in Section 6 of the ESMP (Appendix K of the ESIA).
4 DESCRIPTION OF THE CURRENT ENVIRONMENT

This section was compiled using the following sources of information:

- Digital Atlas of Namibia which was compiled by the University of Cologne (Universität zu Köln) based on data sourced from the Directorate of Environmental Affairs, Ministry of Environment and Tourism (http://www.uni-koeln.de/sfb389/e/e1/download/atlas_namibia/index_e.htm);
- Namibian Weather Services website (www.namibiaweather.info);
- Visual observations during site visits by SLR;
- Google Earth; and
- Specialist assessments.

4.1 CLIMATE

4.1.1 Temperature

Monthly mean and hourly maximum and minimum temperatures are given in Table 4-1. Temperatures range between 6 °C and 44 °C. The highest temperature was recorded in September and October and the lowest in June. During the day, temperatures increase to reach a maximum at around 15:00 in the afternoon. Ambient air temperature decreases to reach a minimum at around 07:00 i.e. just before sunrise.

**TABLE 4-1: MINIMUM, MAXIMUM AND AVERAGE TEMPERATURES RECORDED AT THE PLANT HILL SITE**

<table>
<thead>
<tr>
<th>Month</th>
<th>Maximum Hourly Temperature (°C)</th>
<th>Minimum Hourly Temperature (°C)</th>
<th>Average Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>38</td>
<td>14</td>
<td>27.7</td>
</tr>
<tr>
<td>Feb</td>
<td>39</td>
<td>12</td>
<td>26.6</td>
</tr>
<tr>
<td>Mar</td>
<td>38</td>
<td>11</td>
<td>26.1</td>
</tr>
<tr>
<td>Apr</td>
<td>33</td>
<td>8</td>
<td>20.9</td>
</tr>
<tr>
<td>May</td>
<td>33</td>
<td>8</td>
<td>21.3</td>
</tr>
<tr>
<td>Jun</td>
<td>31</td>
<td>6</td>
<td>19.9</td>
</tr>
<tr>
<td>Jul</td>
<td>30</td>
<td>11</td>
<td>20.1</td>
</tr>
<tr>
<td>Aug</td>
<td>40</td>
<td>8</td>
<td>24.4</td>
</tr>
<tr>
<td>Sep</td>
<td>44</td>
<td>12</td>
<td>29.4</td>
</tr>
<tr>
<td>Oct</td>
<td>44</td>
<td>12</td>
<td>30.8</td>
</tr>
<tr>
<td>Nov</td>
<td>43</td>
<td>12</td>
<td>28.1</td>
</tr>
<tr>
<td>Dec</td>
<td>42</td>
<td>19</td>
<td>29.1</td>
</tr>
</tbody>
</table>
4.1.2 Rainfall and Evaporation

Tsumeb has an annual average rainfall of 520 mm with most of the rainfall occurring in the summer months (October to April). Approximately two thirds of the rainfall occurs in the months of January, February and March, with the highest number of productive rainfall days (i.e. days with rainfall of 10 mm and more) registered in January and February.

4.1.3 Wind

Wind data are recorded at the Tsumeb weather station and at DPMT’s five sampling stations (see Figure 4-9 for locations). Average, day and night time wind roses for the period January 2013 to December 2017 as measured at the Stadium station, are shown in Figure 4-1. This station had a much higher data availability compared to the Plant Hill station located closer to the smelter site. The wind data at this monitoring station were, however, found to provide an accurate indication of conditions across Tsumeb and in the general area of the smelter. The wind field is uniform with frequent south-easterly winds. There are also occasionally winds from the north. Calm conditions prevailed 9.7% during the recording period with a period average wind speed of 2.3 m/s. During day-time the wind field is mostly characterised by wind from the east-southeast and east with an average wind speed of 2.6 m/s and 4.8% calm conditions. The average wind speed decreased to 1.9 m/s during night-time hours and blew mostly from the southeast with 12.4% calm conditions.

![Wind roses](image)

**FIGURE 4-1: PERIOD AVERAGE WIND ROSES FROM THE STADIUM STATION DATA (JANUARY 2013 – DECEMBER 2017)**
4.2 TOPOGRAPHY

The town of Tsumeb is located in the northern section of the central Namibian Plateau on the northern edge of the Otavi Mountainland which is characterised by a typical karst landscape. The town is relatively flat (1 300 meters above mean sea level [mamsl]) and flanked to the south and east by the Otavi Mountains. An east-west ridge separates the town from the smelter complex (1 257 mamsl) which is located at the base of a valley to the north of the town. The terrain of the area is characterised by gentle undulating relief around the smelter complex. The Waterberg plateau is located approximately 12 km to the south-west of the smelter complex. The regional topography is shown in Figure 4-2.

![Figure 4-2: Topography of Tsumeb and Surrounds](image)

4.3 GEOLOGY

The period 900-950Ma was marked by extensive continental fragmentation with geosynclinals deposition in a major Late Proterozoic – Early Paleozoic tectono-thermal event referred as Pan-African event (Master, 1991). Downward flexing of the craton margins produced extensive intra-cratonic foreland basins (Thomas & al, 1993). The late Proterozoic to Early Palaeozoic Damara belt forms part of the Pan-African mobile system belt, which surrounds and bisects the African continent (Martin 1983, Miller 1983a).
The NE-trending Pan-African Damara Belt is 400 km wide and is located between the Congo and the Kalahari Cratons in the South West region of Southern Africa.

The Damara Supergroup consists of a north east trending intracontinental arm and a north south trending coastal arm with a present outcrop width in Namibia of 150 km. The triple junction between the two arms is located off the coast near Swakopmund (Miller, 1983c). Evolution of the belt involves a complex history which includes rifting, spreading, convergence and collision of Kalahari and Congo Cratons. In addition to this, deformation, metamorphism and magmatism accompanied the collision. Subsequently the belt underwent episodes of continental rifting, ocean floor spreading, glaciation, subduction, collision and metamorphism over a time span of about 250 million years.

With regards to stratigraphy, rocks of the Damara Supergroup were deposited on an Archean granite-gneiss Basement exposed in the northern and southern zones, and in the inlier in the centre of the belt (Jacob & Kroner, 1977). The Basement complex crops out in several major inliers along the northern and southern margins of the Damara province, as well as numerous small inliers in the central parts. A stratigraphic column for the Otavi Mountainland (OML) is shown in detail in Table 4-2, with the regional geology depicted in Figure 4-3.

The Nosib Group unconformably overlies the Basement Complex. It consists of the Nabis, Chuos, Berg Aukas and Gauss formations. The environment of deposition progressively developed from predominantly fluvial to marine when finer grained shales were deposited (Kamona & Gunzel, 2006).

The Otavi Group consists of Abenab and the Tsumeb subgroups which are unconformably overlying the Nosib Group and the Basement Complex (Hedberg, 1979). The latest, the Tsumeb Subgroup, is subdivided into 8 litho-zones (T1 to T8) from the clastic Ghaub Formation to the carbonate dominant Maieberg, Elandshoek as well as the Hüttenberg Formations.

The Ghaub Formation, referred to as T1, is a glacio-marine tillite with lenses of dolomite and schist.

The Maieberg Formation is a platform slope, deep water deposit and overlies the Ghaub Formation. The lower Maieberg Formation (T2) consists of slump brecciated and laminated carbonate and argillaceous sediments. The upper Maieberg Formation (T3) comprises bedded and finely laminated carbonates.

The Elandshoek Formation conformably overlies the Maieberg Formation. It covers most of the northern limb
of the Otavi Valley north of Kombat Mine. The lower Elandshoek Formation (T4) comprises of massive dolomite and is responsible for the rugged geomorphologic terrain of the northern limb of the Otavi Valley. The brecciation is generally intensive and therefore T4 is regarded as an important aquifer (Van der Merwe, 1986). The upper Elandshoek Formation (T5) is fairly thin and not easily distinguishable from T4.

The Hüttenberg Formation marks the change from the deep sea environment observed in the Elandshoek Formation to shallow lagoon shelves. It consists of a grey bedded basal dolomite, stromatolite rich (T6), overlain by two upper units, a massive dark and bedded dolomite with chert and with phyllite (T7) and T8 is marked by pisolite and oolite.

**TABLE 4-2: GEOLOGY AND STRATIGRAPHY OF THE AREA**

(Stratigraphic Column for the Otavi Mountainland, revised after Hoffmann and Prave (2008))

<table>
<thead>
<tr>
<th>SUPER GROUP</th>
<th>GROUP</th>
<th>SUB GROUP</th>
<th>Age, Ma</th>
<th>FORMATION</th>
<th>LITHOLOGY</th>
<th>ZONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposits</td>
<td>MULDEN</td>
<td>550</td>
<td>Tschudi</td>
<td>Arkose, feldspathic sandstone, grit conglomerate</td>
<td>T3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>570</td>
<td>Kombat</td>
<td>Phyllite, interbedded with lenticular dolostone</td>
<td>T4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kombat</td>
<td></td>
<td>760?</td>
<td>Hüttenberg</td>
<td>Thin Bedded Light dolostone with algal markers and chert beds, prominent pisolite-oolite chert beds at the top</td>
<td>T7</td>
<td></td>
</tr>
<tr>
<td>(Cu - Pb - Ag)</td>
<td>Ko</td>
<td></td>
<td></td>
<td>Thin Bedded Dark Dolomites with Phyllite, black oolitic chert, anhydrite horizons silicified reef (Tschudi area)</td>
<td>T6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>760?</td>
<td></td>
<td>Hüttenberg</td>
<td>Thin Bedded Limestone and Shale</td>
<td>T5</td>
<td></td>
</tr>
<tr>
<td>Tsumeb</td>
<td></td>
<td>760?</td>
<td>Tsumeb</td>
<td>Bedded light Dolomite and Chert (Algal stromatolites</td>
<td>T4</td>
<td></td>
</tr>
<tr>
<td>(Cu - Pb - Zn - Ag)</td>
<td></td>
<td></td>
<td></td>
<td>Massive and Bedded Light Dolomite</td>
<td>T3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Massive Light Dolomite, with bedded dolostone</td>
<td>T2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Thin Bedded Dolomite</td>
<td>T1</td>
<td></td>
</tr>
<tr>
<td>Formation</td>
<td>Abenab</td>
<td>Ghaub</td>
<td>Berg Aukas</td>
<td>Auros</td>
<td>Keilberg</td>
<td>Otavi</td>
</tr>
<tr>
<td>-----------</td>
<td>--------</td>
<td>-------</td>
<td>------------</td>
<td>-------</td>
<td>----------</td>
<td>-------</td>
</tr>
<tr>
<td>Abenab</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Pb - Zn - V)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAMARA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abenab</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Pb - Zn - V)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTAVI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abenab</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Pb - Zn - V)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Thin Bedded Limestone, Quartzite | Bedded Dolomite, Thin-bedded Limestone, greenish-grey shale | Thin bedded Limestone and Shale | Localised Tillite and Limestone | Fine grained laminated to massive pale pink dolostone | Massive carbonate class dominated diamictite | T2
| T1       | Medium to thin bedded diamictite with dropstones | Bedded Dolomite (Quartz Clusters) | Massive Dolomite (Algal – Columnar) | Bedded Limestone and Shale | Massive Dolomite (Algal – Columnar) | Bedded Dolomite (Algal – Cryptozoon) | Bedded Limestone and Shale | Bedded Dolomite (Algal – Columnar) | Bedded Limestone and Shale | Massive Dolomite (Jasperoid) | Bedded Limestone and Shale |
| Gruis    | Pink and light pinkish grey fine grained, micritic dolostone and chert, oolite and stromatolite at top, interbedded with shale locally | Very Light grey, pinkish grey and buff enterolithic dolomictite dessication structures and microbial, stromatolite, micrite | Very light to medium grey and buff massive dolostone with colloform texture local stromatolite and oolite | Gauss | 830 |
The **Mulden Group** is characterised by the **Kombat Formation** in the southern part of the OML, which consists of a siliciclastic molasses (poorly graded phyllite, arkose, argillite and siltstone) deposited syn-tectonically during the early stage of the Damara Orogeny, and the **Tschudi Formation** (Arkose and feldspathic sandstone) in the northern part of the OML, and is separated from the Tsumeb Subgroup by an angular disconformity.

The town of Tsumeb lies on the northern edge of the OML and the dolomites of the Otavi Group characterise the area. The sandstones of the Mulden Group have been preserved in the Tschudi Syncline which extends in an east-west direction and is the representative geology of most of the area covered by the town (see FIGURE 4-4).

The dolomites to the north of the town house the Tsumeb deposit located in a pipe structure extending to a depth of 1 800 m and formed by the karstification process (Grünert, 2000). The deposit contains an extraordinary diversity of ores including lead, copper, zinc, silver, arsenic, antimony, cadmium, cobalt, germanium, gallium, iron, mercury molybdenum, nickel and tin as well as vanadium. The Tsumeb Smelter was established to allow for the processing of this polymetallic deposit.

### 4.4 GROUNDWATER

The town of Tsumeb falls within the Etosha Basin Hydrogeological Region. Groundwater occurs in the Tsumeb Dolomitic Aquifer with the Mulden Sandstones acting as an aquiclude. The Smelter site is located on the Elandshoek and Hüttenberg Formation lithozones in an ESE-WNW sloping valley formed as part of an anticlinal structure. The groundwater is expected to move in fold axes, pressure relief joints, faults or on lithological contact zones (see Figure 4-4).
4.4.1 Groundwater Levels

The average natural groundwater levels in Tsumeb are at approximately 1 210 mamsl (60 m below the land surface in the town area) with little seasonal fluctuation in the levels.

The Tsumeb Mine was operational from 1907 to 1996, temporarily closed until 2000 then re-commissioned for a short period. (GCS, July 2013). Dewatering occurred at Shaft No.1 at the old Tsumeb Mine, south-west of the smelter. During 2000, water was pumped from the shaft for mining of mineral specimens from the upper levels of the mine (approximately 250 m below ground surface) at a rate of 350 m$^3$/hr (WSP Walmsley, 2004).

It is understood that during actual mining operations the water was pumped from a much greater depth. The shaft is approximately 1 600 m deep.

FIGURE 4-3: REGIONAL GEOLOGY OF TSUMEB AND SURROUNDS (ADAPTED FROM THE TCL GEOLOGY MAP OF 1974)
4.4.2 Groundwater Flow

The natural groundwater flow from Tsumeb is in a northerly direction and flow is largely restricted to the dolomites of the Tsumeb Subgroup and in to a minor degree to the other fractured but less permeable hard rocks. The dolomite of the Hüttenberg Formation has high transmissivity and it is estimated that water migrates at a rate of approximately 1.08m/day or 360 m per annum (GCS, 2013), although secondary fracture flow in the area may result in localised acceleration of the groundwater flow rates. The hills are considered a recharge zone for the groundwater.

As recommended in the Draft ESIA Report in 2017, the Groundwater Flow Model for the area was updated by SLR in 2018 (see Addendum to Appendix E). The model was updated and refined in order to account in more detail for the complex geology of the area, including the Mannheim Dome with Maieberg Formation to the north of the smelter complex as a possible hydraulic barrier (i.e. a geological formation with low hydraulic conductivity). The model also built on the existing regional numerical groundwater flow model as part of the

![Image of local geology around the Tsumeb smelter with SW-NE cross section](image_url)
2003 Tsumeb Ground Water Study (GKW Consult / Bicon, 2003).

Hydraulic conductivity (k-values) of the different geological formations in the Tsumeb area is indicated in Figure 4-5. An area of low hydraulic conductivity is visible approximately 5 km north of the smelter site. Due to its low hydraulic conductivity, it is expected that this area would act as a barrier or retarder to groundwater flow.

![Hydraulic Conductivity Map](image)

**FIGURE 4-5:** HYDRAULIC CONDUCTIVITY OF GEOLOGICAL FORMATIONS AND DISCREET FEATURES (I.E. REGIONAL FAULTS AND FRACTURES) IN THE TSUMEB AREA

### 4.4.3 Groundwater Quality

Based on a hydrocensus undertaken in November 2012, GCS (May 2013) summarises the background groundwater quality as follows:
- High calcium, magnesium, bicarbonate water is encountered as expected from dolomitic water.
- pH values between 6.9 and 7.4 were measured in the hydrocensus boreholes. pH across boreholes is stable.
- Elevated concentrations, above Namibian drinking water standards, of sulphate (SO\textsubscript{4}), arsenic (As) and molybdenum (Mo) were measured at the boreholes situated on the smelter site.
- Elevated iron (Fe) is also observed in all boreholes and is probably a result of the mineralogical composition of the rock.

It is important to view the groundwater quality monitoring results against some background values for the larger karst region, specifically when looking at arsenic pollution. Data from wider area studies do indicate elevated arsenic concentrations in areas not previously affected by mining which may be reflective of naturally high background arsenic levels in the geology.

Results of DPMT's July 2015 groundwater sampling round showed that only the Calcine- and Return Boreholes (see Figure 4-6) had arsenic concentrations exceeding the Namibian Guideline values for drinking water. All other boreholes had concentrations falling within the Group B or better quality drinking water according to the Guideline.

Groundwater monitoring boreholes within the DPMT site were increased from 12 to 20 during October 2015 and sampling from the new monitoring network commenced from February 2016. DPMT is currently busy with a process to further expand the groundwater monitoring borehole network and commenced with the drilling of additional monitoring boreholes in 2018. Groundwater monitoring results from the first quarter of 2018 showed arsenic levels of higher than 0.1 mg/l at seven of the monitoring boreholes on the smelter site. The 0.1 mg/l Namibian standard for drinking water is still classified as excellent quality water (Group A). This standard is, however, 10 times higher than the WHO drinking water limit of 0.01 mg/l. Any levels above the 0.1 mg/l standard are thus already exceeding the WHO drinking water limit by a factor of 10. No extraction of water for drinking purposes, however, takes place within the smelter boundary. The highest levels were recorded at the new monitoring boreholes situated between the old Return and Calcine boreholes (see Figure 4-6). There are, however, no indications that arsenic from these boreholes has moved beyond the smelter site. Elevated arsenic levels were not recorded at boreholes in the vicinity of the Hazardous Waste Disposal Site, indicating that the design of the site is sufficient to contain arsenic within the lined areas.

A recent groundwater audit undertaken by Water Associates Namibia (2017) at water monitoring points in Tsumeb and at surrounding farms, indicated that arsenic levels in groundwater and drinking water points were well within the Namibian and WHO drinking water limits. Arsenic levels at groundwater monitoring boreholes within a 2 km radius of the smelter boundary and on farms up to 6 km north of the smelter boundary were found to be at zero or well below the 0.01 mg/l WHO drinking water standard.
This is in line with the 2018 groundwater flow model update referred to in Section 4.4.2 and its predicted arsenic dispersion plume to the north of the smelter site. The updated model showed that an arsenic pollution plume may be migrating north, but that the arsenic concentrations decrease rapidly as it moves north. Three of the transport scenarios modelled (10, 25 and 100 years) are summarised below. These models are very conservative and considered a worst case scenario situation where no action is taken to contain and remediate current groundwater pollution. It also indicates arsenic dispersion from the hazardous waste disposal site which there is currently no evidence of due to the impermeability of the liner and high standard of operation of the site (confirmed by the latest external audit). Detailed simulation maps are provided in the Addendum to Appendix E.

**Transport Scenario 1: situation after 10 years**

After 10 years, the plume is predicted to spread mainly towards the general northerly flow direction with contaminant concentrations decreasing rapidly (see Figure 4-8). At a maximum distance of approximately 150 m from the contaminant source, concentrations have already dropped to below 5 % of the initial
concentration. The predicted plume extends to outside of the DPMT property boundary at levels less than 5-10% of the original concentration.

![Diagram showing contaminant dispersion plume](image)

**FIGURE 4-7:** SIMPLIFIED GROUNDWATER MODEL MAP SHOWING POTENTIAL CONTAMINANT DISPERSION PLUME AFTER 10 YEARS, ASSUMING NO REMEDIATION AND CONTAINMENT

**Transport Scenario 2: Situation after 25 years**

After 25 years, the contaminant plume is predicted to continue spreading towards the general northerly flow direction (see Figure 4-8). Contaminant concentrations are predicted to reach general background concentrations at a distance of 800 m from the potential contaminant sources.

**Transport Scenario 3: Situation after 100 years (and beyond)**

After 100 years, contaminant concentrations drop to below 5% of initial concentration at approximately 3.2 km from potential contaminant sources. The plume may still spread further in a north-easterly direction, but seems to reach a state of equilibrium, since no significant change is predicted after 100 years. The Maieberg geological formation located between the smelter and the irrigation farms to the north forms a hydraulic barrier and is expected to slow down groundwater flow towards the irrigation areas.
In summary, based on the latest groundwater model update, it is not expected that groundwater with elevated arsenic levels would reach the closest irrigation farms to the north of the smelter site within the next 100 to 200 years, with the dispersion model predicted to reach an equilibrium where no further transport to the north is expected. A groundwater divide is also present to the west of the smelter boundary and predicted dispersion plume which implies that contaminated groundwater would not be transported to the west towards the municipal sewage works and municipal water supply boreholes. Note again that this model assumes that no remedial action would be taken. A specialist study is currently underway in order to identify key groundwater pollution points and remediation actions. With the implementation of remedial actions, ongoing monitoring of on-site boreholes and the drilling of additional offsite boreholes, the groundwater model could be refined even further in order to confirm its accuracy. With the implementation of remedial action, it might be possible to prevent dispersion of contaminated groundwater and to ensure containment within the smelter boundary.

4.4.4 Groundwater Use

Tsumeb is highly dependent on groundwater resources (WSP Walmsley, 2004). Groundwater use in the area is
as follows:

- The Tsumeb Municipality has a network of 39 boreholes which are used for domestic and industrial water supply.
- Several of the industries located to the north of the town have their own boreholes for water supply.
- Extensive agricultural activities occur immediately north of Tsumeb carrying out irrigation using groundwater resources.
- Agriculture to the south east of Tsumeb is also dependent on groundwater resources.

In 2002, the agricultural, industrial and domestic demand for groundwater from the Tsumeb Aquifer was estimated at 12 million m$^3$ per annum (Mm$^3$/a)(GKW Consult/Bicon, 2002). It is estimated that a surplus of 31 Mm$^3$ flows to the north.

Currently the main groundwater abstraction in the Tsumeb area includes: 1.83 Mm$^3$/a to the DPMT Smelter, 1.67 Mm$^3$/a for municipal public water supply, 2.03 Mm$^3$/a for use by irrigation farms and 0.15 Mm$^3$/a for use by other farms.

DPMT currently abstract groundwater from the old No. 1 Shaft at an installed pumping capacity of about 300 m$^3$/h for use at the smelter site (Worley Parsons, 2015). The Ministry of Agriculture, Water and Forestry in August 2017 issued a new abstraction permit to DPMT for water abstraction from the No. 1 Shaft. The permit allows for the abstraction of 450 000 m$^3$ of water per year for industrial use.

According to the Surface Water Management: Site Water Balance Report (May 2019, Revision 3), 88% of the total water introduced to the smelter system is sourced from the mine shaft via the Raw Mill Dam #2 with the remainder (12%) sourced from the municipal potable water supply. The overall water balance revealed that the majority of water introduced to the smelter (from the mine shaft and from municipal potable supply) is exported for use at the golf course (40%), or lost to evaporation in cooling towers and open dams (28%), or infiltrates the aquifer from unlined ponds and dams (21%), or is discharged as sewage to the WWTW (11%). The water balance block flow diagram is presented in Figure 9.

There are significant losses to evaporation, and to infiltration (predominantly poor quality reclaimed water at the tailings dam and No 10 Dam). It was therefore recommended in this study to:

- Isolate and protect good reclaim water from contamination with pollution;
- Upgrade good reclaim water to reduce salinity so that it could substitute raw water with good reclaim water wherever possible;
- Contain and treat poor reclaim water (at source) to remove pollution from the system; and
- Reduce evaporative and infiltration losses.
FIGURE 9: DPMT WATER BALANCE BLOCK FLOW DIAGRAM (DEVELOPED BY AURECON)
4.5 SURFACE WATER

4.5.1 Regional Hydrology

Tsumeb is located on the eastern side of the Etosha Basin catchment, which is an inland drainage system where runoff flows into the Etosha Pan from where it then evaporates. The area around Tsumeb is predominantly karstic, which means that it is formed from the dissolution of soluble base rock (mainly dolomite and limestone in this area) which is characterised by underground drainage systems with sink holes and caves. Due to the geology of the area, there is no well-defined drainage pattern in the Tsumeb-Grootfontein area, but rather many small individual drainage systems, dependant on the local geology.

4.5.2 Local Hydrology

The local catchment can be divided up into an upper section (which included the old eastern Tailings Storage Facility (TSF) dam) covering an area of approximately 2.85 km² and the lower catchment below the TSF dam, which includes the main smelter and current western TSF areas, covering an area of 6.88 km², giving a total catchment area at the outlet on the border of the DPMT site boundary of 9.73 km².

To the west of the site is a drainage line (locally known as the Jordan River), which has its catchment area in the townlands of Tsumeb, flowing in a northerly direction along the western boundary of the site and then continuing off to the north where it reportedly disappears into the ground. The Jordan River is not a natural water course, relying on runoff from the central business area and the north eastern part of Tsumeb, but typically has only a low flow or is temporarily dry if there is no rainfall. There is some indication that a portion of the water pumped from Shaft 1 reaches the Jordan River, but this is not confirmed.

Within the lower catchment area are two small dams (Dam 10 [also called No. 10 Gate Dam] which contains decant water from the tailings dam plus return process water and Railway Dam which contains overflow from Dam 10). The local hydrology is indicated in Figure 4-10.

4.5.3 Surface Water Quality

As there are no natural surface water sources on the site, open water sources on the site consist of manmade dams and concrete reservoirs fed by abstracted groundwater, and stormwater runoff during rain events. No historical surface water sample programme has been undertaken at site, but a monitoring programme is currently being set up which should start to provide baseline data for the site.

Surface water samples from storage dams and the Jordan River were collected in October 2015 by Groundwater Consulting Services at four locations within the site and one just outside the site at the Jordan River road crossing. Samples within the site were collected at the Railway Dam and Dam 10 (both open water surfaces) as well as from Large Reservoir and Small Reservoir (concrete elevated reservoirs) located on the southern watershed. The water which supplies the Large Reservoir is municipal water pumped from municipal
boreholes to the south of Tsumeb, while the water supply to the Small Reservoir is raw water pumped from Shaft 1. Technically the samples from the Large and Small Reservoirs are classified as groundwater, having been pumped from boreholes. The results showed that the arsenic levels in all the surface water samples, except for the municipal borehole water, are above acceptable guideline levels for human consumption. The water quality from the municipal boreholes was found to be at Group C level which indicates a low health risk (see Appendix E for a more detailed analysis of the results from this sampling). A further investigation by Water Associates Namibia in 2017 also found that all surface water samples from reservoirs and dams on the site showed greatly elevated arsenic levels, ranging between 0.187 mg/l at the onsite reservoir to 10 393 mg/l at the hazardous waste disposal site’s leachate dam.

FIGURE 4-10: LOCAL HYDROLOGY OF THE DPMT SMELTER SITE

Apart from the arsenic contamination sources, an additional smaller surface water impact was generated until recently from the wastewater effluent and sewerage temporarily discharged to the reed beds on the site. This has since ceased and all sewerage is treated at the fully operational sewerage treatment plant on site. Treated effluent is discharged to the reed beds in line with a discharge permit from the Ministry of Agriculture, Water and Forestry.

With regards to stormwater drainage across the site, the system currently comprises two main drainage pipelines through the plant area which end in sumps, from where the runoff is pumped to various points inside the plant. Problems have been experienced with silting of the storm water system and some of the
infrastructure is inadequate for the generated runoff, resulting in ponding of runoff at a number of identified sites around the plant after storm events. An updated stormwater management plan was, however, compiled by Aurecon (2013) which included recommendations for improvement of the system. The improved system includes the rehabilitation of the old eastern tailings storage facility and historical slag area and establishment of pollution control dams and diversion channels. This system is currently being implemented in phases by DPMT. As part of this system, concrete lining of a portion of the main open stormwater channel through the site was completed in the first quarter of 2018. Construction of a pollution control dam and related stormwater management infrastructure also took place in 2018.

There are no identified downstream users of surface water between the smelter site and the Jordan River, which has limited flow for a short distance downstream.

4.6 SOIL

A soil survey and mapping exercise of the DPMT property was undertaken by Red Earth cc (McLeroth, 2015) in 2015 with further follow-up soil sampling undertaken during 2018 as part of the ongoing contaminated land assessment process. The different soil types identified were grouped together into soil-mapping units on the basis of soil form, effective soil depth for rehabilitation (stripping depth) and cropping (effective rooting depth), surface features, parent material, perched water-table depth, location of precipitated salts associated with pollution plumes and overburden/underburden waste or non-waste type/depth where present (McLeroth, 2015). The different soils are indicated in Figure 4-10 and in Table 4-3. A short summary of the soil forms identified within the smelter boundary are provided below.

TABLE 4-3: SUMMARY OF SOIL FORMS (MCLEROTH, 2015)
FIGURE 4-11: SOIL MAPPING UNITS RECORDED ON THE SMELTER PROPERTY (MCLEROOTH, 2015)
The soils encountered in the study area can be divided into the following eight groups as described in McCleroth, 2015:

i) **Red apedal soils** (Hutton and Bainsvlei forms) [15.35% of the study area]
These well drained deep to intermediate (vast majority >1.8 - 0.5m), or occasionally shallow (0.4 - 0.2m) soils occur in the ‘flats’ (very gently to gently sloping areas between the hills), the parent material underlying these areas being dolomite (vast majority), dolerite (narrow band trending west-north-west through the ‘flats’, and alluvium (narrow band east/upslope of the Jordan River).

In dolomite and alluvium derived areas textures are sandy-loam (clay percentage 14 - 16 %, or occasionally 12 % or 20 %) in the topsoil; and sandy-loam (clay percentage 14 - 20 %) in the subsoil. In dolerite derived areas textures are sandy-clay-loam (clay percentage 30 %) in the topsoil and sandy-clay-loam to clay (clay percentage 25 - 50 %) in the subsoil, all of the aforementioned being field estimates. The analytical data showed 9 - 11 % for the topsoils, and 12 - 13 % for the subsoils (two topsoils and two subsoils).

Soil structure is apedal in both horizons in the dolomite and alluvium derived areas; and weak blocky (occasionally apedal) in the dolerite derived areas. Sand grades are all fine.

These soils are poorly leached. The high quality orthic A- and red apedal B-horizons are highly suitable materials for annual cropping (good rooting medium) and use as topsoil (for rehabilitation purposes), having favourable texture (sandy-loam in dolomite derived areas, to sandy-clay-loam to clay in dolerite derived areas), structure (apedal in dolomite derived areas, to weak blocky in dolerite derived areas) and consistency (friable to slightly firm).

ii) **Red structured soils** (Shortlands form) [0.45% of the study area]
These dolerite derived soils occur in one small patch only, and are surrounded by red apedal soils, to which they are similar. However, their properties vary in a number of ways. Textures are clay (clay percentage 40 - 50 % in dolerite derived areas) or sandy-clay-loam (clay percentage 20 - 25 % due to soil creep from surrounding red apedal areas) in the topsoil; and clay (clay percentage 50 - 60 % all dolerite derived) in the subsoil.

Structure is weak blocky or apedal in the topsoil; and moderate blocky in the subsoil. These soils are poorly leached (eutrophic). The high quality orthic A- and red structured B-horizons are highly suitable materials for annual cropping (good rooting medium) and use as topsoil having a favourable texture (sandy-clay-loam to clay).

iii) **Neocutanic soils** (Oakleaf form) [0.61% of the study area]
These relatively well drained, deep (>1.8 - 1.0m) soils predominantly occur in one band on the flood plain (eastern side) of the Jordan River. This area has been divided into two patches by the western boundary of the study area. This area is derived from alluvium parent material, with one connected patch being derived from
dolomite colluvium. Textures are sandy-loam (clay percentage 14 - 20 %) or loamy-sand (clay percentage 8 - 12 %) in the topsoil; and sandy-loam (clay percentage 12 - 20 %) or sandy-clay-loam (clay percentage 20 - 30 %) in the subsoil.

These soils are essentially red apedal soils, the only difference being that they are non-uniform in colour due to the presence of cutans and channel infillings. One other small patch of neocutanic soils derived from dolomite colluvium occurs at the base of the hill to the east of the plant.

Structure is apedal or weak blocky in both horizons, while sand grades are medium (occasionally fine or coarse). A number of the topsoils are now slightly calcareous (transformed by man) due to the incorporation of washed tailings into the topsoil. The high quality orthic A- and neocutanic B-horizons of these soils are suitable materials for annual cropping and for use as topsoil, having favourable texture (loamy-sand to sandy-clay-loam), structure (apedal to weak blocky) and consistency (friable). However, these areas must not be disturbed since they are in riparian areas.

iv) **Carbonate soils** (Brandvlei, Gamoep, Augrabies, Plooysburg, Prieska, and Montagu forms) [2.08 % of the study area]

Carbonate soils (in McLeroth, 2015) include those soil profiles which display one or more of the following soil horizons: hardpan carbonate (dominant), soft carbonate (sub-dominant), or neocarbonate (rare). The effective rooting depth is dependent on the depth of the underlying hardpan carbonate horizon, soft carbonate horizon, hard rock, or unspecified material with signs of wetness.

These well-drained moderate to deep (0.4 - 1.5m) soils predominantly occur in the vicinity (east) of the Jordan River, the majority of these areas being derived from alluvium, which in turn overlies calcrete. These soils are generally non-calcareous except in the A-horizon. Soil textures are sandy-loam (clay percentage 12 - 20 %) for both horizons, and occasionally sandy-clay-loam (clay percentage 25 - 35 %) in the subsoils. Soil structure is generally apedal for both horizons. Sand grade is medium or fine in the vicinity of the Jordan River and fine in the Brandvlei soil form areas. Two further patches of carbonate soils of the Brandvlei form occur in the hilly areas, these soils being shallow (0 - 0.1m) and overlying a soft carbonate horizon. These areas are derived from a dark coloured schist parent material, with occasional to frequent small quartz stones being present on the surface. These topsoils are highly calcareous. The generally high quality orthic A-, neocutanic B-, and neocarbonate B-horizons are suitable materials for use as ‘topsoil’, having favourable texture (sandy-loam to sandy-clay-loam), structure (apedal), and consistency (very friable to friable). However, the carbonate soils in the vicinity of the Jordan River should not be disturbed when they are derived from alluvium parent material, since these are in riparian areas.

v) **Structured (i.e. pedocutanic) soils** (Sepane and Bonheim forms) [1.40 % of the study area]

These poorly drained intermediate depth (0.5 - 0.8m) pedocutanic soils occur in two patches on base rich
parent material (probably dolerite, although not observed in augered depth).

Textures are clay (clay percentage 50 - 60 %) in the topsoil, and clay (clay percentage 60 %) in the subsoil, the sand grades all being fine. Structure varies from weak to moderate blocky in the topsoil and from moderate to strong angular blocky in the subsoil, while subsoil consistence (dry) is hard to very hard. The subsoils are eutrophic (poorly leached). The area at the northern corner of the study area is highly calcareous, while the southern area is only slightly calcareous. The pedocutanic subsoils are non-uniform in colour due to the presence of cutans (clay skins) on most ped surfaces, and both the presence of 2:1 clays and the high clay contents have given rise to the pedality (structure) of the soils.

The usable soil depth is dependent on the depth of the underlying unconsolidated material with signs of wetness, these areas (majority) being temporary wetlands. The poor quality orthic A-, melanic A- and pedocutanic B-horizons are unsuitable materials for rehabilitation topsoiling purposes, given their unfavourable properties.

The structured soil group material is useful (most suitable of all of the broad soil groups in the study area) for sealing purposes (underlying tailings/slimes dams, evaporation ponds, pollution control/return water dams, the dirty water gullies/drains/canals, and the slag/arsenic dumps; or overlying [as a compacted- ‘remoulded’ layer below the ‘topsoil’] rehabilitated tailings/slimes dams, pollution control/return water dams or slag/arsenic dumps) since it naturally displays a slow-moderate permeability when dry, and a slow permeability once moist or compacted. Unfortunately, this material is in very short supply in the study area.

vi) Shallow soils (Mispah and Glenrosa forms) [51.75 % of the study area]
These shallow (0.02 - 0.1m majority, 0.2 - 0.3m minority) rocky (40 - 80 % surface rock in the form of rocks 5 - 50 cm diameter, boulders >50 cm diameter, outcrops = flat surface rock, and stones 2 - 5cm diameter) soils occur extensively in the hilly areas on a range of parent material types including cherty-dolomite, dolomite, chert, stromatolite inter-beds, limestone, schist, quartz (rare), and shale (very rare). The ‘usable’ soil depth is dependent on the depth of the underlying hard (vast majority Mispah form) or weathering (very rarely Glenrosa form) rock.

Textures are all sandy-loam (dominant clay percentage 14 - 16 %, occasionally 18 - 20 %, rarely 12 %), sand grades are fine (all), and soil structure is apedal (all). These soils are poorly leached (eutrophic), and approximately 45 % of the topsoils are calcareous (slightly, moderately, or highly) [extremely poorly leached, to not leached at all].

These areas are comprised of natural bush and must be preserved as repositories of biodiversity. Such areas are normally suited to game ranching, although this is not the case in the study area due to wind-blown pollution. These areas must not be disturbed in any way.
vii) **Hydromorphic soils** (Westleigh form) [0.52 % of the study area]. Also buried (by wastes and the ‘western’ tailings storage facility) Katspruit form (total buried area unknown)

The entirety of the hydromorphic soil area is buried beneath the southern two-thirds of the plant (Katspruit area), beneath an intermediate (0.5m) to thick (>1.8m) layer of overburden/underburden wastes (Witbank soil form overlying Katspruit soil form); and by the ‘western’ tailings storage facility. This originally concave valley-bottom slope position trends from the east to the west, but is now a level industrialized area, unrecognizable as a wetland area from the surface. These areas are buried permanent (majority of buried area - buried Katspruit soil form) and seasonal (minority of buried area - buried Westleigh soil form) wetlands. The discussion which follows relates to the buried soils (not the overlying waste layers).

These poorly drained (frequently waterlogged in summer) hydromorphic soils display a clay texture (clay percentage 40 - 50 %) in the topsoil, and a clay texture (clay percentage 50 - 60 %) in the subsoil, these soils being derived from colluvium (probably of dolerite origin) and calcrite. These soils are highly calcareous, and particularly so in the subsoil. Soil structure varies from weak to moderate blocky in the topsoil, and from massive (G-horizon) to weak blocky (soft plinthic B-horizon) in the subsoil. Such soils have formed due to either a permanent/semi-permanent water-table (G-horizon - year round reduction), or a seasonal water-table (soft plinthic B - alternating cycles of oxidation and reduction accompanied by an accumulation of iron and manganese oxides). The poor quality (bleached and mottled, or dark) orthic A-horizons of this broad soil group may not be cropped, since these are wetland (permanent and seasonal) areas. These topsoils are not suitable for rehabilitation purposes. The majority of the buried hydromorphic soils were wet or moist at the time of the soil survey, thus displaying a perched water-table.

viii) **Man-made soils** (Witbank form) [4.72 % of the study area]

Man-made (i.e. anthropogenic) ‘soils’ occur in the developed (plant, associated auxiliary infrastructure, and lay-down areas) areas, as well as in six patches (fragmented into numerous patches by man-made features) to the north and west of the ‘western’ tailings storage facility. These areas either comprise *in-situ* soils (red apedal, hydromorphic, carbonate, and structured broad soil groups) that are buried by thick waste layers (most of the plant area, and the areas to the north and east of the ‘western’ tailings storage facility), or alternatively thick levelled waste layers that are buried by levelled topsoil of the red apedal (mostly) and/or hydromorphic broad soil groups (most of the lay-down area). These areas frequently display a number of alternating layers of soil, and occasionally wastes.

### 4.7 CONTAMINATED LAND

There are currently significant contamination levels on the smelter property and surrounds mainly due to historic mining and smelter operations and legacy waste stockpiles. Although it is acknowledged that the current DPMT smelter operations, since DPMT purchased the facility in 2010, have contributed to and continue to contribute to the overall contamination loads, the majority of the measured contamination levels and
related impacts (i.e. groundwater and community health) are attributable to historic operations prior to DPMT taking control of operations.

A study has been commissioned by DPMT to investigate the level of land contamination within and surrounding the Tsumeb smelter property. The outcome of this Contaminated Land Assessment will be used to inform the Community Health Impact Assessment and Closure Plan (due to be revised 2019/2020), and once completed the recommendations/mitigation measures of the contaminated land study will be incorporated into the ESMP which will be updated.

The Contaminated Land Assessment is designed to inform the required Closure Plan activities where it relates to land historically contaminated by chemicals of concern and where DPMT would be responsible for remediation. The study is an ongoing long term study which is still underway, but some preliminary results of soil sampling and related contamination levels have been made available for inclusion in this ESIA. The below summary of preliminary results has been provided by the Contaminated Land Assessment specialist from the University of the Witwatersrand (Weiersbye, 2016 and pers. comm.). Once completed, the full report will be made available to key stakeholders, including the MET, and incorporated into the next update of the Closure Plan, which is due to be revised during 2019/2020.

The investigation is based on an intensive soil and waste survey on the greater Tsumeb mine area and smelter property and surrounding lands undertaken between 2014 and 2016 with additional samples taken during 2018. Soil sampling results were then compared to similar soil sampling studies undertaken prior to 2007. The contaminated land assessment is being undertaken in phases. Phase 1 has been completed and entailed mapping the spatial extent and depth of metal contamination on the smelter property. Phase 2, Part A entailed an investigation into the soil leaching profiles of metals on the smelter property. Phase 2, Part B entailed the mapping of metal contamination off site in Tsumeb and along the Jordan River riparian zones and in the rooting zone of common edible plants and is still underway. Phase 3 is currently underway and includes a quantitative environmental risk assessment of the consumption of soil and edible plants. Preliminary results of the three phases are provided below.

**Phase 1 – identification and spatial mapping of Contaminants of Concern on and off the DPMT site and depth profiling of contamination**

In summary, soils comprise 721.41ha (75.02%), while man-made features comprise 240.23ha (24.98%), of the DPMT property survey area of 961.64ha (100%); the soils, and overburden/underburden wastes having been mapped through the smelter plant areas. An equivalent additional area was mapped to the south of the DPMT property over the municipality of Tsumeb and surrounding lands, and northwards along the Jordan canal and creek system.

The findings independently verify the results of previous pilot and research studies on arsenic, lead, copper,
cadmium and other metal concentrations in topsoils in the Tsumeb general region around the smelter property, and provide more confidence in spatial distribution and depth profiling of contaminants for quantitative risk assessment and remediation measures. A comparison with the prior findings can assist in quantifying the additional contamination load since 2007. The previous pilot studies supported by the current findings, as far as soil metal concentrations and contaminant sources are concerned, were conducted between 2004 and 2007 (Kribeck et al., 2004; Geological Survey of the Mines and Energy, 2005; 2011; Mapani et al., undated unpublished report (circa 2007); Hasheela et al., 2014; Ellmies et al., 2015; Kribeck et al., 2010; 2016).

The findings of the soil investigation indicate that there is moderate to severe contamination by hazardous metals on the DPMT property, off-site in the northern section of Tsumeb Municipality, and along the Jordan Creek riparian zone and projected smelter deposition zone towards Witvlei Farm. In some cases contamination is exceeding all international soil guideline values (SGVs) or trigger soil screening values (SSVs) or critical toxicity threshold levels. Lesser contamination (still exceeding some SGVs) is evident throughout most of the town of Tsumeb. Even when severe, contamination throughout the DPMT and off-site regions (including town of Tsumeb) tends to be shallow – largely limited to the upper 10 cm, or even 0-2 cm, of undisturbed soils, by 30 cm to 60 cm depth contamination has significantly declined or is non-evident. Exceptions are where soils are disturbed (dug, excavated, cultivated, relocated) or in seepage zones, and adjacent to canals, in which case contamination can reach 100 cm to 180 cm depths.

The investigation showed that the contamination emanates from four major sources:

- the historical smelter complex, in the form of deposition and run-off of contaminated soils to lower areas,
- the tailings storage facilities (TSFs) or “mine dumps”, in the form of wind-blown tailings dust, spillage or run-off, and sub-surface seepage from the toe and unlined canals,
- the calcine dam and arsenic plant, in the form of wind-blown dust, spillage or run-off, and sub-surface seepage from the toe and unlined canals, and
- the modern smelter, in the form of deposition and run-off of contaminated soils.

In addition to wind and rainfall run-off, significant contaminant loads are relocated by:

- burial or relocation of contaminated material on and around site,
- pollutant saturated wetland soils.
- subsurface seepage and surface run-off of tailings and particulates into creek sediments,
- unlined canals draining the plant area, and sediment transport

Some secondary sources of contamination include:

- run-off of trapped smelter particulates from higher-lying areas (i.e. the surrounding hill-crests) to lower on the soil slopes;
• contaminated sediments of the Jordan River draining Tsumeb and the smelter property in areas where no pollution control barriers exist;
• wetland sediments on-site and off-site;
• relocation of contaminated soil for levelling purposes in the laydown areas;
• road dust transported on vehicle tyres into Tsumeb and other areas; and
• fugitive dust trapped on buildings, and wash-off.

The Contaminants of Concern (CoC) identified on and off site, with surface concentrations of orders of magnitude greater than local geochemical backgrounds (i.e. primarily from mined ores and smelting) include: sulphur (S), arsenic (As), copper (Cu), chromium (Cr), cadmium (Cd), lead (Pb), antimony (Sb), vanadium (V) and zinc (Zn). Additional contaminants, of lesser or low concern, are cobalt (Co), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), selenium (Se) and tin (Sn). Mercury (Hg) contamination was expected, but was not detectable above 1 ppm. Further sensitive analysis of Hg levels is still to be undertaken.

The median values for the main contaminants of concern in the 0-2 cm soil layers of the DPMT property as a whole (almost 1000 ha surveyed on-site) were 266 mg/kg As, 829 mg/kg Cu, 28 mg/kg Cd, 1 139 mg/kg Pb and 21 mg/kg Sb, with maxima of 6 315 mg/kg As, 28 950 mg/kg Cu, 2 105 mg/kg Cd, 31 140 mg/kg Pb and 3 760 mg/kg Sb in some deposition zones and localised contaminated areas.

The median values for the surveyed off-site area (the entire town of Tsumeb and surrounds) were 44 mg/kg As, 161 mg/kg Cu, 3 mg/kg Cd, 229 mg/kg Pb and 9 mg/kg Sb in the 0-2 cm soil layers, with maxima of 1 829 mg/kg As, 10 810 mg/kg Cu, 139 mg/kg Cd, 8 146 mg/kg Pb and 179 mg/kg Sb. All the higher soil metal values were localised in the northern section of Tsumeb Municipality, abutting the historical smelter site, the derelict mining infrastructure and the DPMT property boundary with the modern smelter infrastructure and tailings dams. Elevated metal concentrations were also evident off-site along the riparian soils of the Jordan creek system.

Low soil pH levels were recorded around the arsenic calcine dam area and in some buried wastes and tailings spillages or seepage. Low pH could have an impact on mobility of some CoCs and could increase leaching with the related risk of shallow groundwater pollution. All areas around waste and tailings dams with a pH of below 7.0 are considered of priority for remediation.

Due to the natural topography, the distribution of CoCs to the north, east and south over the town of Tsumeb is however limited. Significant contamination of Tsumeb is localised to the northern section and appears to have emanated from the historical smelter and mining operations, overlain by the modern smelter impact. The main dispersion area of significant contamination from the DPMT property is off-site to the west, northwest and southwest, and appears to extend off-site at medium to severe levels (depending upon CoC) for at least
20 km to the northwest and 20 km to the west.

The measured CoCs were spatially mapped to show distribution and depth of contamination. One of the maps showing the combined distribution of arsenic, cadmium, copper, lead and antimony in all surface materials on the smelter property, Tsumeb town and surrounding lands is provided in Figure 4-12.

In summary, despite the sometimes exceptionally high concentrations of CoCs recorded, the depth of contamination of soil and sediments was found to be superficial over most of the DPMT site and the Municipality of Tsumeb, with contamination levels declining rapidly with soil sampling depth. Where soils are undisturbed the leaching of contaminants to deeper profiles were found to be extremely limited. Exceptions are areas of seepage, and deeper soil disturbance (e.g. construction, man-made soil platforms, ploughing, rubbish tips, tarpits, etc.), and zones of soil acidification where soil pH is below pH 6.4.
**FIGURE 4-12:** INDEX OF INDUSTRIAL POLLUTION (CIP) FOR AS, CD, CU, PB AND SB IN ALL SURFACE MATERIALS COMBINED. TAILINGS, WASTES, OVERBURDEN AND STOCKPILES ARE SHOWN FOR THE 0-30 CM DEPTH, AND SURROUNDING (I.E. NO OVERBURDEN) SOILS FOR 0-2 CM DEPTH.
Phase 2 – preliminary results of contaminant depth profiling and seasonal mobility

a) In situ rain-water leaching profiles:
A comparison of the dry season and wet season soil samples and profiles clearly shows which soils types facilitate the re-mobilisation of CoCs during wet and dry periods. During the rainy season, some CoCs move down the soil profile with the wetting front, and during the dry season they move up the soil profile due to the evaporation gradient. If properly timed, this seasonal drying and concentration of minerals in shallow soil depths at high concentrations facilitates sweeping or mechanical skimming-off of a significant amount of contaminated material without the need for deeper soil excavation.

Based on wet season soil pit profiles, Cd, As and Zn exhibited some vertical leaching in more acidic profiles. In contrast, clayey soil types and areas with higher levels of soil organic matter (SOM), such as the riparian zones of the Jordan stream canal and wetland areas on-site exhibit little to no vertical migration of CoCs, although the canal itself acts as a major conduit of contamination off-site from the smelter property.

b) Additional sampling of hazardous waste on the DPMT site:
Additional sampling continued to verify anthropogenic activities on-site (primarily smelting, waste disposal and uncovered tailings) as the source of local and regional contamination (historical and modern smelting activities). No additional contamination over-and-above the local levels (already elevated) from the hazardous waste disposal site were recorded. Up to the end of sampling in mid-2016 the hazardous waste disposal site thus appears well contained on the land surface. This was also independently verified through a 2017 audit of the hazardous waste site operations (SRK, 2017).

c) Evidence of contamination outside of smelter boundary
There is evidence for diffuse contamination, exceeding some international soil guideline values (SGVs) for agricultural, residential and commercial land, across the entire Tsumeb area assessed, even allowing for the natural elevation of base metals and arsenic in the soils of this locality. Severe contamination across the town of Tsumeb is however largely limited to the northernmost area, and is clearly of smelter and tailings dust/mining origin.

Contamination over Tsumeb is significantly linearly correlated with distance from the historic smelter and mine area.

d) Contamination of drainage lines and water-courses.
All drainage lines on the DPMT and surrounding properties act as centres and conduits for CoCs to leave the property and enter the Jordan River. Unlined drainage canals are further contributing to significant contamination of deeper soils. The Jordan River is a seasonal drainage system, which was canalled at some point in history for part or all of its length and has an unnaturally linear course until it disperses in a wetland.
The Jordan receives Tsumeb town run-off, DPMT site run-off, historical tailings spills, current tailings run-off and dust, sewage farm overflow and seasonal flood waters. The Jordan does not enter any other watercourses, but courses through Merdestroom Farm (Witvlei) and discharges diffusely into agricultural lands and a vlei area on Witvlei and the neighbouring farm. Due to the degraded nature of this area, the waters will drain into the groundwater system. Of concern is the presence of agricultural crops (including pivots) in the Jordan discharge zone. This will be further investigated as part of the ongoing contaminated land assessment.

Phase 3 – preliminary results of further soil sampling

Follow-up soil sampling was undertaken across large parts of Tsumeb town and surrounding farm lands during 2018. The sampling campaign included sampling at a finer grid in the northernmost parts of Tsumeb, specifically surrounding the community of Ondundu. Preliminary results have identified a number of areas with elevated arsenic levels. These related to historic mine dump sites, reef outcrops, ruins of old mine hostels, slag-topped haul roads and small scale mining sites. Areas related to old mining sites and ongoing small scale mining identified in the area surrounding Ondundu are indicated in Figure 4-13. Some of these areas showed extremely elevated levels of arsenic and can be considered as sources of arsenic exposure to the community. Further analysis of these findings and the sourcing of information on how community members utilise these areas is still underway. DPMT has recently purchased a piece of land to serve as a buffer between Ondundu and the hazardous waste disposal site. A new fence has been erected on the property boundary which will also limit further activities in one of the areas where elevated arsenic levels were recorded. The new fence line has been indicated in Figure 4-13.
In conclusion, there are significant contamination levels on the smelter property and surrounds due to historic mining and smelter operations and legacy waste stockpiles. Although it is acknowledged that the current DPMT smelter operations, since DPMT purchased the facility in 2010, have contributed to and continue to contribute to the overall contamination load, the majority of the measured contamination levels are attributable to historic operations. This was again confirmed by the preliminary results of the finer grid follow-up soil sampling campaign of 2018. The ongoing analysis will aim to quantify the historic and current contributions.

Based on the preliminary results, some recommendations have been made for remediation measures for inclusion in the overall smelter Closure Plan (due to be revised in 2019/2020). Some of the recommendations for remediation have also been included in the Consolidated ESMP (see Appendix K). These largely relate to the process of phytoremediation, a process whereby vegetation is established on contaminated areas in order to extract contaminants from the soil and to assist in limiting seepage of pollutants into the deeper soil layers. Results show that the pollution footprint is already shrinking in the vicinity of the plant/waste sites due to the revamp (new construction/clean-up) which commenced when DPM purchased the smelter operation. The pollution plume is likely to further shrink after the establishment of indigenous trees as proposed in the contaminated land assessment. Phytoremediation ‘woodlands’ will serve (due to evapotranspiration) to both
limit the seepage of pollutants downwards to the perched- and ground-water-tables, as well as to limit seepage/run-off to the Jordan River. An on-site nursery was established in 2017, with propagation of suitable plant species for phytoremediation trials commencing in 2018.

Other preliminary recommendations include the removal of the top 5 cm of surface crust of contaminated soils in the dry season, excavation of contaminated overburden waste layers and disposal to the tailings storage facilities and capping of the tailings facilities in preparation for the establishment of vegetation.

The study also supports the recommendations of previous studies for the cessation of agricultural production in the northern part of Tsumeb town (Ondundu) towards the smelter and to also restrict further development in this area, with development rather directed towards the southern and southwestern areas of the town where the least contamination was recorded. In addition to the above measures, the study also recommended that phytoremediation of soils in the residential areas be undertaken in collaboration with local schools and residents and that awareness programmes be established to educate poorer and more vulnerable population sectors in measures such as avoiding ingestion of soils, washing hands and food before eating, peeling fruit and vegetables, etc. Although outside of DPMT’s boundary, it will continue to support the Tsumeb municipality in finding solutions for remediation of historic contamination.

### 4.8 AIR QUALITY

The DPMT smelter is the main industrial source of air pollution in the Tsumeb area. Since DPMT took over operations of the smelter in 2010, emissions have been reduced through the modernisation of the plant and, most notably, the commissioning of the sulphuric acid plant. An environmental monitoring network is in operation around the smelter complex. PM$_{10}$, PM$_{2.5}$ trace metals (i.e. arsenic, lead and cadmium) and SO$_2$ ground level concentrations are measured on a daily basis (every ten minutes) and reported on monthly and quarterly. Dust fall and the associated trace metal fallout are also sampled, forming part of the quarterly environmental report.

Figure 4-14 shows the location of the current monitoring locations and Air Quality Sensitive Receptors (AQRSRs). The Plant Hill station is situated next to the Hazardous Waste Disposal Site along the southern boundary. Data from this station can be used to determine emissions from the waste site (as well as other sources) and to determine whether dust controls are adequate at the waste site. The Sewerage Works station is situated on the western boundary of the site and downwind of the dominant wind direction. Data from this station can be used to determine emissions from the Smelter site at large and to determine whether dust controls are adequate at the various fugitive and point emission sources on the site. Fugitive emissions refer to all air emission sources not released from stacks, e.g. from unpaved roads, crushing activities, furnaces, etc.

The Namibian Atmospheric Pollution Prevention Ordinance (No. 11 of 1976) does not include any ambient air standards. South African National Ambient Air Quality Standards (SA NAAQS) and EU standards are used in the
below baseline air quality information.

### 4.8.1 Ambient PM$_{10}$ and PM$_{2.5}$ Concentrations

Recorded annual average PM$_{10}$ concentrations have shown a steady decrease from 2013 to 2016, with concentrations slightly higher in 2017 (see Figure 4-15). These higher levels in 2017 were attributed to spikes during dry windy conditions experienced in December. During 2017, exceedances of the annual average assessment criteria of 40 µg/m$^3$ were recorded at the Sewerage Works, Sport Stadium and Info Centre monitoring stations. DPMT is likely the source of elevated PM$_{10}$ concentrations recorded at the Sewerage Works station, while vehicle traffic on unpaved roads, domestic fuel burning and community activities to the south-east and south-west of the Sport Stadium station are the likely sources in that residential area (see Figure 4-14). The Plant Hill Station has consistently recorded the lowest PM$_{10}$ concentrations.
FIGURE 4-14: AIR QUALITY MONITORING SITES AND AIR QUALITY SENSITIVE RECEPTORS
FIGURE 4-15: ANNUAL AVERAGE PM$_{10}$ CONCENTRATIONS RECORDED AT AMBIENT MONITORING STATIONS (JAN-13 TO DEC-17)

The polar plots in Figure 4-16 illustrate hourly PM$_{10}$ concentrations in relation to wind speed and direction in order to provide an indication of the location of sources of dust emissions. Peaks in PM$_{10}$ levels recorded at the Sewerage Works station can be attributed to a source lying south-east of the station and under strong wind conditions. The active tailings dam area is a likely source.

The high PM$_{10}$ concentrations recorded at the Sport Stadium station likely result from the open area in the centre of town and an old open-cast pit to the south-west. There are also unpaved roads, undeveloped erven and the natural environment in the vicinity of the stadium.

High PM$_{10}$ concentrations were recorded from all wind directions, especially under incidences of high wind speeds. The stations located in Tsumeb – Information Centre, Plant Hill and Sport Stadium – all indicate the main contributing PM$_{10}$ sources not to be from DPMT whereas the Sewerage Works station, located downwind from the smelter, reflects activities and sources associated with the DPMT operations.

Monitoring of ambient PM$_{2.5}$ concentrations commenced during 2017 at the Stadium and Info Centre stations. Similar to PM$_{10}$, a variety of sources in the vicinity of the stations contribute to elevated PM$_{2.5}$ concentrations with the highest concentrations recorded in the evening between 18:00 and 21:00 during which the main sources are likely to be from vehicle traffic on unpaved roads, domestic fuel burning for cooking and other community activities.
4.8.2 Ambient Arsenic Concentrations

Arsenic in the PM\textsubscript{10} fraction is reported at all five ambient air quality stations. Recorded ambient concentrations have shown a steady decrease from 2013 to 2016, with a very slight increase in concentrations recorded in 2017 at the Plant Hill, Sewerage Works and Namfo stations relative to 2016 levels. Long term trends are illustrated in Figure 4-17.

The results clearly show higher ambient arsenic levels during dry and windy months. This would indicate fugitive dust from current activities and historic wastes rather than stack emissions from the smelter as the cause of elevated arsenic concentrations.

**FIGURE 4-16: POLAR PLOTS OF PM\textsubscript{10} (µg/m\textsuperscript{3}) CONCENTRATIONS FOR 2017**
4.8.3 Sulphur Dioxide

Air quality monitoring stations commissioned in 2012 showed that maximum daily concentrations of SO$_2$ emissions from the DPMT smelter exceeded the WHO daily guideline and South African standard for every month of the monitoring period (Golder, 2013). This led to the decision by DPMT to construct and commission a 1,540 t/d sulphuric acid plant in 2015 in order to reduce SO$_2$ emissions and improve local and regional ambient air quality. The acid plant was commissioned during June 2015. Air quality stations have reported downward trends of SO$_2$ emissions from October 2015 to December 2017 with the sulphuric acid plant being a major contributing factor. 122 000 tonnes of sulphuric acid was produced from January 2016 to September 2016, resulting in approximately 78 000 tonnes of SO$_2$ captured. Monitored SO$_2$ levels are evaluated by DPMT against the EU standard of 125 µg/m$^3$ over a 24-hour period and the 50 µg/m$^3$ annual average standard. The average annual SO$_2$ levels measured at the air quality monitoring stations are indicated in Figure 4-18. A notable decrease is observed in 2016 and 2017 levels with the only exceedance recorded at the Sewerage Works station.

During 2016 (after commissioning of the sulphuric acid plant), annual average SO$_2$ levels varied between 9.41 µg/m$^3$ and 60.2 µg/m$^3$ across the monitoring stations (50 µg/m$^3$ limit). Similar results were recorded during 2017. When considering the shorter term averages, notable decreases in 24-hour and 1-hour
concentrations are evident. Short term assessment criteria were, however, still exceeded at the Plant Hill and Sewerage Works stations and in the north-eastern part of Tsumeb. \( \text{SO}_2 \) monthly means recorded at the monitoring stations between 2013 and 2016 are indicated Figure 4-19.

![1-year average SO2 concentrations graph](image)

**FIGURE 4-18:** ANNUAL AVERAGE \( \text{SO}_2 \) CONCENTRATIONS RECORDED AT THE DPMT MONITORING STATIONS BETWEEN 2013 AND 2017
FIGURE 4-19: MEAN MONTHLY SO₂ LEVELS RECORDED AT TSUMEB SMELTER MONITORING SITES FROM 2013 TO 2016 (DPMT, 2016)

Polar plots of data from the Plant Hill station indicate a large SO₂ source (smelter) to the north-east of the station (see Figure 4-20). Similarly, Sewerage Works data indicate a large SO₂ source in an easterly direction from the station. Info Centre data show a source from the north, in line with the smelter location.
FIGURE 4-20: POLAR PLOTS OF MAXIMUM HOURLY SO$_2$ (µg/m$^3$) CONCENTRATIONS DURING 2017

The data indicate that maximums occur just after midday when the atmosphere is likely to be unstable (see Figure 4-21). It is known that the highest ground-level impact of elevated releases from tall stacks occurs during unstable atmospheric conditions. For Tsumeb, the most unstable conditions were recorded during 11am and 4pm.
4.8.4 Comparison of Stack Emissions to Best Available Technology Levels

The results of the Isokinetic Testing report (dated May 2019) were compared to the emission levels associated with the best available technologies (BAT-AELs) for copper production as provided in the BAT conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the non-ferrous metals industries (2016). Monitoring results were provided for mercury, dust, dioxins (PCDD/F) and sulphur dioxide (SO$_2$). The results for the following sampling points were compared:

- After hygiene baghouse;
- Acid plant stack; and
- Pierce Smith Gas to Stack.

As indicated in the table below mercury results were all below the BAT-AELs for all three points. Dust results were not provided for the Acid plant stack; however, the dust results for the other two points were above the BAT-AELs. Results for dioxins were also below the BAT-AELs for all three points. SO$_2$ results were below the BAT-AELs at the “After hygiene baghouse” and the “Acid plant stack” points; however, the results for SO$_2$ at the
“Pierce Smith Gas to Stack” point was significantly above the BAT-AELs.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Stack Sampling Points</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>After Hygiene Baghouse</td>
</tr>
<tr>
<td>Mercury (mg/dNm³)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Dust (mg/dNm³)</td>
<td>15 ± 2</td>
</tr>
<tr>
<td>Total VOC (mg/Nm³)</td>
<td>No results</td>
</tr>
<tr>
<td>Dioxins (PCDD/F) (ng I-TEQ/dNm³)</td>
<td>0.002 ± 0.001</td>
</tr>
<tr>
<td>SO₂ (mg/dNm³)</td>
<td>85 ± 3</td>
</tr>
<tr>
<td>BaP (as PAH) (mg/dNm³)</td>
<td>No results</td>
</tr>
<tr>
<td>HF (Fluoride) (mg/dNm³)</td>
<td>No results</td>
</tr>
</tbody>
</table>

*The SO₂ results of the previous year showed much lower values. The monitoring report suggests that there was a process issue.

4.9 NOISE

The noise levels around the project area are influenced by traffic as well as the various construction and operational activities (e.g. blowers, trains, etc.) at the DPMT smelter. To monitor and manage noise control for employees within the smelter facility, DPMT undertakes monthly personal noise exposure measurements. Results of measurements show that within noise zones, most exposures exceed the statutory 85 dBA limit, including most production areas and the power plant. Suitable hearing protective devices are provided to employees and engineering controls to lower noise exposures have been identified. Installation of noise screens at the power plant commenced in the third quarter of 2016, resulting in a marked improvement in exposures.

The closest noise sensitive receivers outside of the smelter footprint include Tsumeb town and farmsteads. The atmospheric conditions in the area are found to be more conducive to noise attenuation during the day, with noise impacts from smelter activities expected to be most notable to the north-west and south of the smelter. The natural hill between the smelter and the town provides some acoustic shielding to residents of Tsumeb and its suburbs. A baseline assessment of noise levels in the area found that current operational activities at the smelter complex are only faintly audible at the closest farmsteads to the northwest of the smelter. Community activities, traffic, domestic animals, birds and insects were found to be the main contributors to the acoustic climate of Tsumeb and its suburbs. Current ambient noise levels at the closest noise sensitive receivers were measured at 44.8 dBA during the day and 39.4 dBA during the night. These levels do not currently exceed the IFC noise level guidelines for residential, institutional and educational receptors (55 dBA during the day and 45
At the time of the 2016 noise assessment, the No. 2 oxygen plant at the smelter generated high noise levels during its start-up cycle and the silencer was not working as per specification. This matter has since been addressed.

4.10 VISUAL

The town of Tsumeb developed as a result of the mining and smelting operations and as such the Tsumeb Mine and Smelter are an integral part of the town’s character. Despite the closure of the mine the De Wet Shaft head gear, located on the western edge of the CBD, has been retained as a constant reminder of the history of the town.

The Tsumeb Smelter and the closed mine and associated plant and infrastructure form a complex of heavily developed and industrialised areas. There are numerous large buildings and structures, rock and waste dumps and excavations that contribute to the mining atmosphere. While much of the smelter is concealed from the town of Tsumeb by the low ridge to the north of the town, the stacks are visible from most areas within the town and form an important component of the Tsumeb horizon. The hazardous waste site is visible from the Tsintsabis Road.

All the proposed new project components would be constructed within the existing facility footprint with no additional natural areas to be cleared or new visual intrusions to be created.

4.11 ARCHAEOLOGY AND CULTURAL HERITAGE

A few sites of archaeological and cultural heritage importance are located within the Tsumeb Smelter boundary fence. These include two stone kraal ruin sites (i.e. informal settlement) located in the hilly areas. The structures are older than 100 years. One possible stone-age stone core has also been recorded in the higher lying area (Red Earth, 2016). Two contemporary house ruin sites and twenty mining related ruin sites also occur within the Smelter property (Red Earth, 2016). None of the sites of heritage significance would be affected by the proposed upgrade and optimisation project.

4.12 BIODIVERSITY

4.12.1 Vegetation

Tsumeb falls within the arid Savanna Biome (Harrison et al., 1997) and the vegetation in the Tsumeb area can broadly be classified as Dolomite Karstveld (Burke et al, in press). Due to the comparatively high rainfall and unique dolomite lithology of the area, it is recognised as a centre of plant species diversity in Namibia (Maggs et al, 1998).

A biodiversity assessment completed in December 2016 (Van Zyl, et al., 2016) identified four habitat types
within the smelter boundary (see Figure 4-22). These include dolomite hills, sandy plains, alien infested plain and drainage line and the active smelter plant facilities and existing tailings area. Of these, only the dolomite hills and sandy plains are still considered as natural, albeit already altered to some extent.


The dolomite ridges comprise the largest unmodified/natural habitat on the site and are highly diverse. It forms part of the Otavi mountain land, which is known to contain endemic and protected species. The sandy plain is more modified than the dolomite ridges due to its accessibility. A considerable degree of bush encroachment has taken place in the sandy plain areas. The alien-infested plain and drainage line habitat is located to the west of the plant facilities and originally probably also consisted of a sandy valley. Currently it has a highly modified species composition due to human influences, including high numbers of invasive alien plant species. The active plant area and tailings facilities comprise the remainder of the smelter site and these
areas are highly modified with low environmental integrity.

Thirteen protected species, including 11 trees, have been recorded within the smelter boundary. Of these, the tamboti (Spirostachys africana) has been heavily impacted by past mining operations. In addition, six endemic species and six near-endemic species were listed. No highly threatened Red Data species were recorded, with one having a Red Data status of Vulnerable (Cyphostemma juttae).

As all new project components would be limited to within the existing facility footprint, no areas of remaining natural vegetation would be cleared. A study is currently underway to determine the long term effects of the smelter operations on existing vegetation surrounding the smelter site. Recommendations from this study will be incorporated into the revised Closure Plan for the smelter in order to ensure appropriate rehabilitation of the site and surrounding environment. For this purpose, a nursery is currently being established for the smelter in order for appropriate plant species to be available for later phytoremediation.

4.12.2 Animal Life

The area of Tsumeb is disturbed as a result of urban development, but it can be expected that the surrounding areas which support natural vegetation will support species of conservation concern including damara dik-dik, eland, Namibian dwarf python, leopard tortoise and possibly endemic birds such as Carp’s black tit and Ruppel’s parrot. Wildlife surrounding the smelter is not abundant. Kudu, steenbok, squirrels, flamingos and other birds have, however, occasionally been spotted near or on the two main slimes dams.

Natural aquatic communities are largely absent from the region as a result of the absence of surface water flow due to the high infiltration rates. Stygobiotic (living in groundwater) amphipods are characteristic of karst landscapes and are known from the areas to the north east of Tsumeb. The effects of prolonged mining operations on such species are not known.

4.13 SOCIO-ECONOMIC ENVIRONMENT

4.13.1 Economic Description

The DPMT smelter falls within the Tsumeb Magisterial District in the Tsumeb Constituency of the Oshikoto Region. Tsumeb is the major urban centre within the region and the economy is largely associated with the operation of the Tsumeb Mining Operations and Tsumeb Smelter Complex. DPMT currently sustains 667 direct jobs, of which 457 are employees and 210 are contractors. These jobs are associated with annual salary payments of around N$168 million. Many other services are directly dependent on DPMT operations.

The key sectors in terms of employment in the Oshikoto region are agriculture (49%), followed by administrative and support service activities (7% of jobs), education and activities of private households (6% of jobs each). The manufacturing sector only contributes 3% to total direct employment in Oshikoto. This serves to emphasise the importance of plants such as DPMT, in providing diversification. The major contributors to
the local economy of Tsumeb are given in Table 4-4.

**TABLE 4-4: ECONOMIC ACTIVITIES IN THE TSUMEB DISTRICT**

<table>
<thead>
<tr>
<th>Economic Sectors</th>
<th>Major Contributors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mining</strong></td>
<td>Ongopolo Mining &amp; Processing Limited</td>
</tr>
<tr>
<td></td>
<td>Henning Crushers</td>
</tr>
<tr>
<td></td>
<td>Punyu Crushers</td>
</tr>
<tr>
<td></td>
<td>Weatherly International Plc.</td>
</tr>
<tr>
<td></td>
<td>Tschudi Copper Mine</td>
</tr>
<tr>
<td><strong>Agriculture</strong></td>
<td>Mannheim Agricultural Area</td>
</tr>
<tr>
<td><strong>Manufacturing</strong></td>
<td>Power 4 Africa</td>
</tr>
<tr>
<td><strong>/Packing</strong></td>
<td>Tsumeb Charcoal</td>
</tr>
<tr>
<td></td>
<td>Family Choice</td>
</tr>
<tr>
<td><strong>Construction</strong></td>
<td>Powerline 2000</td>
</tr>
<tr>
<td></td>
<td>Brandberg Construction</td>
</tr>
<tr>
<td></td>
<td>Travels 2000</td>
</tr>
<tr>
<td><strong>Wholesale &amp; Retail</strong></td>
<td>Three shopping centres</td>
</tr>
<tr>
<td></td>
<td>Electrical Equipment</td>
</tr>
<tr>
<td></td>
<td>Motor Vehicle Spares and Accessories</td>
</tr>
<tr>
<td></td>
<td>Fresh Produce</td>
</tr>
<tr>
<td></td>
<td>Butcheries</td>
</tr>
<tr>
<td></td>
<td>Brick-making and building materials</td>
</tr>
<tr>
<td></td>
<td>Car Dealers</td>
</tr>
<tr>
<td><strong>Services</strong></td>
<td>Vehicle Repair</td>
</tr>
<tr>
<td></td>
<td>Legal Practitioners</td>
</tr>
<tr>
<td></td>
<td>Financial Institutions</td>
</tr>
<tr>
<td></td>
<td>Medical Practitioners</td>
</tr>
<tr>
<td></td>
<td>Three hospitals, three health care centres and 16 primary health care clinics</td>
</tr>
<tr>
<td><strong>Tourism</strong></td>
<td>Tsumeb Museum</td>
</tr>
<tr>
<td></td>
<td>Minen Hotel</td>
</tr>
<tr>
<td></td>
<td>Makalani Hotel</td>
</tr>
<tr>
<td></td>
<td>Tsumeb Airport</td>
</tr>
<tr>
<td></td>
<td>Lake Oshikoto and Guinas Lake (35-45 km north)</td>
</tr>
<tr>
<td></td>
<td>Etosha Pan (100 km north)</td>
</tr>
</tbody>
</table>

The Tsumeb Town Council are actively promoting future development in the town which is recognised as the gateway to the north and a prime locality for attracting industrial and commercial enterprise. It is envisaged that the development of the new railway line linking Namibia, Angola and Zambia will impact directly on the economy of Tsumeb, which is best positioned to support the construction activities. Another notable project is a new largescale development, called SmartCity, in the south-eastern part of Tsumeb for which a ground-breaking ceremony took place in December 2018. The project to be developed by MKP South Africa would
entail the construction of a medical university providing an international standard education to 25,000 students, including accommodation for all staff and students. SmartCity will also have six hotels, office space and entertainment and recreational facilities. An international airport will also be part of the development. The project is projected to provide 10,000 job opportunities. It is currently expected that residents of Tsumeb would be given a 10% equity share in the MKP South Africa and Tsumeb Medical University development. This would amount to an estimated N$2 billion from an estimated N$20 billion total investment in the project (www.northstar.com.na). This is an extremely ambitious project that, if it succeeds, would have the potential to significantly change the economic landscape of Tsumeb.

DPMT operations also provide numerous possibilities that could contribute to a significant broadening of industrial activities and value-added processing. These include:

- Refining of copper;
- Extracting base and precious metals from mine tailings;
- Reclaiming zinc and gallium from slag; and
- Producing arsenic related products such as pesticides.

The Tsumeb area with its vast source of underground waters (refer to Section 4.4) is well suited for the cultivation of fruits and vegetables and is capable of producing large quantities for marketing and canning purposes. The Mannheim area located approximately 10 km north of Tsumeb is particularly suited for this purpose. The Tsumeb Agricultural Development Project was launched in 2003 for further development of agricultural lands immediately south east of Tsumeb.

### 4.13.2 Social Environment

#### Regional Context

Tsumeb is located in the Oshikoto Region in the north-central part of Namibia. The region is subdivided into ten political constituencies, namely: Eengodie, Guinas, Okankolo, Olukonda, Omuntele, Omuthiya, Onayena, Oniipa, Onyaanya and Tsumeb. Omuthiya is the administrative centre of the region, while Tsumeb is the economic centre.

Tsumeb has a well-developed and maintained road network and aerodrome system. Windhoek is located 380 km away by air and 435 km by tarred road. Tsumeb is linked to the Trans Namib railway network and there is a railway siding located in the industrial sector in the northern section of the town. A main tarred trunk road, the B1, runs through the region in a north-south direction, serving as the main route to Angola.

#### Demographics

**Population size**

Tsumeb had a population of 19,840 in 2011, up from 14,907 in 2001, implying that the town had grown by 33%
in this ten-year period. This was more than twice both the national (15%) and regional (13%) growth rates over the same period (NSA, 2012a; NSA 2012b). Growth since 2011 has also been robust according to municipal officials and other sources. Though not based on official statistics, the Tsumeb community needs assessment conducted for DPMT in 2015 found it likely that Tsumeb’s population has grown by at least 25% since 2011 to over 25 000 inhabitants, driven primarily by the growth of informal settlements (Yarmoshuk, 2015). During March 2017 it was, however, noted by the Tsumeb Municipality that the total inhabitants might be closer to 35 000. While DPMT’s acquisition of the smelter might’ve attracted some job-seekers to the town, according to the municipality the establishment of the informal settlement of Kuvukiland in 2009 and other mining operations in the area are also linked to the influx of people. The migration of people from rural to urban areas is also a general trend being experienced across the country. In this regard, a 2015 Country Profile report by the International Organisation for Migration (IOM) indicated that the urban population of Namibia grew by a staggering 49.7% between 2001 and 2011, with this trend continuing. Urbanisation is noted as an important phenomenon in Namibia with major implications in terms of access to land and health and development challenges. The age demographic of migrants in Namibia supports the view that employment and occupation are key drivers of internal migration. In Namibia little is, however, known of whether influx to urban areas is helping to boost economic growth or contributing to poverty (IOM, 2016).

According to the 2011 census, 52% of the total population of the Oshikoto region are female and 48% male. In Tsumeb the gender profile is 50.2% female, 49.8% male.

The average household size in Tsumeb is 3.9, which is close to the national average of 4, but below the average size for the Oshikoto region at 4.8.

Age

According to the 2011 Census, 62% of the Tsumeb population was between the ages of 15 and 59, which is higher than the figure for Oshikoto (59%) and Namibia (57%). When considering the breakdown by age groups as illustrated in Figure 4-23, Tsumeb has a relatively young structure with the highest number of people falling in the 0-4 age group. This is a trait typical of a population with simultaneously high levels of fertility and mortality.
Education and literacy
According to the 2011 Census data, the Namibian literacy rate rose by 8% from 81% to 89% between 2001 and 2011. During the same period, Oshikoto’s literacy rate rose from 70% to 81%, while Tsumeb’s rate remained at 89%. In 2011, approximately 12% of Tsumeb’s population over the age of six years had never attended school. This is similar to the average for Oshikoto and slightly better than the national average of 13%.

Employment
In 2012, unemployment within the Oshikoto Region was estimated at 26.4% and in Tsumeb at 36%. Tsumeb has a relatively high proportion (72%) of economically active people. Table 4-5 sets out the activity status of residents by area.

Farming accounts for a large source of primary income both nationally (16%) and in Oshikoto (33%). In the urban area of Tsumeb, 69% of households, however, report that wages and salaries provide the main source of income. In 2011, around 18.5% of Tsumeb’s population could be classified as poor. This is significantly lower than the average of 42.6% for Oshikoto.
TABLE 4-5:  ACTIVITY STATUS FOR THE POPULATION 15 YEARS AND ABOVE BY AREA, 2011

Municipal and health services

There is an efficient sewage treatment system which currently runs below capacity, largely due to the fact that it does not receive industrial effluent. There are 7 primary schools and two secondary schools within Tsumeb. There is also an adult education centre enabling adults to further their education. In 2011, households in Tsumeb showed relatively high service levels compared to the rest of Oshikoto and Namibia as a whole. Tsumeb’s households had higher access levels to safe drinking water and electricity with fewer households using wood/charcoal for cooking. More households also had access to a toilet facility.

There is one private and one state hospital in Tsumeb with a further three health care centres and 22 primary health care clinics in the Oshikoto region. In Namibia there is a high impact of HIV/AIDS on the labour force. HIV prevalence is estimated through measuring HIV-prevalence among pregnant women attending ante-natal clinics. The results of the 2016 National HIV Sentinel Survey indicated that the HIV prevalence rate in Namibia was 17.2 % with Tsumeb’s prevalence rate at 14.5 %.

A Community Based Organisation, Tov, provides physical, emotional and educational support to school age children who are orphaned or vulnerable as a direct result of HIV/AIDS. The Tov Centre is based in Nomtsoub. This organisation was established in response to the growing number of children becoming orphaned or vulnerable due to losing family to HIV/AIDS.

Zone of Influence

In determining the Zone of Influence of the DPMT smelter operations and proposed expansion from a social...
perspective, the following is included:

- Oshikoto as the administrative region in which the smelter is situated for broader planning frameworks;
- The Municipality of Tsumeb as the directly affected governance structure responsible for delivery of basic services (including health and basic education) and where smelter activities occur;
- Fence-line communities of Ondundu and northern town areas in particular which, according to the Community Health Impact Assessment (see Section 4.15) and Air Quality Impact Assessment (see Section 4.8) are more vulnerable when considering the potential increased emissions from the increased throughput capacity and where expectations of socio-economic benefits are likely to be highest; and
- Walvis Bay as the port of entry for the concentrate and from where material is transported to the Smelter.

**Further Understanding of Social Baseline Environment**

DPMT is committed to gather further primary social baseline data in the near future in order to understand the social environment better (including the community health impacts associated with the DPMT operations as whole). The current data as presented in the Social Impact Assessment (Appendix H2) is deemed to be suitable for assessing the impacts associated with this Expansion Project.

**4.14 NEIGHBOURS AND SURROUNDING LAND USE**

The Tsumeb smelter complex is located to the north of a prominent ridge which separates it from the Tsumeb Mining Area and the town of Tsumeb to the south. Two water reservoirs and a cell phone mast are located on this ridge.

The Tsumeb CBD including shops, restaurants, banks and offices, is located approximately 2.5 km south of the smelter. Ondundu Village, including a primary and nursery school is located approximately 1.2 km south east of the site. The Tsumeb Private Hospital and private boarding school, Tsumeb Gymnasium, are located in the residential area behind the ridge, approximately 1.6 km south of the smelter. The Nomtsoub residential area is located approximately 2.6 km southwest of the smelter. Other land uses located within relatively close proximity of the smelter include the western industrial area and the golf course, which are located 2 km west and 2.2 km south of the smelter, respectively. Refer to Figure 4-24 for the location of sensitive receptors in relation to the Smelter complex.

**4.15 COMMUNITY HEALTH**

The Community Health Assessment undertaken by Myers (2016) as part of this ESIA process investigated the current impact of the smelter operations on Tsumeb residents. This assessment thus provides an indication of the baseline community health conditions prior to the proposed Smelter Upgrading and Optimisation Project. As SO$_2$ and arsenic are considered the main hazards of concern linked to smelter operations, the assessment mainly focused on these two aspects. Reference is also made to other notable environmental health
indicators. A summary of the results of the baseline investigation are provided below. Further details are available in Appendix I.

In order to mitigate against arsenic exposure on communities DPMT have implemented measures to prevent contaminated PPE from being taken offsite, and have developed a Arsenic Exposure Reduction Plan where key actions have been identified between 2018 and 2022. These actions are linked to the following priority areas:

- Ausmelt Baghouse; Ausmelt furnace and roof;
- Feed prep plant;
- Receiving Bay;
- Crushing plant;
- Ditch cooling;
- Ausmelt tapping floor;
- PS Convertor secondary off-gas system;
- Pug mill; and
- Laboratory.

In addition, DMPT also plans to construct a wash bay for trucks leaving the site, provide warning signs at legacy waste sites, conduct follow up community health surveillance and measure airborne arsenic levels more widely in the community.

4.15.1 Community Health Hazards Linked to the Smelter
Arsenic and SO₂ in air are the two principal hazards arising from fugitive and stack emissions from the processing of complex copper concentrates at the Tsumeb Smelter that may affect the surrounding community. SO₂ gas presents risks to health, notably respiratory health disorders including asthma, respiratory infections and cardiorespiratory insult, while arsenic is a known cause of lung cancer.

4.15.2 Sensitive Community Receptors
Based on prevailing wind directions, air emissions from the smelter are mainly driven northwest with occasional winds from the north, potentially affecting the western industrial area and the northern part of town. Based on soil samples taken in different parts of Tsumeb and air quality monitoring along the boundaries of the smelter site, different exposure zones were determined (see Figure 4-24) in order to indicate a possible zone of influence related to smelter operations. The western industrial area and the northern town industrial area are nominally the most highly exposed areas in Tsumeb, but are not residential areas. Together they are considered to be part of the high exposure zone (red) which overlaps with the smelter precinct itself.
The medium exposure zone (orange) comprises the Endombo residential area at the northern edge of Nomtsoub and the Ondundu residential area to the east. There are two schools located in Ondundu. The residential areas to the south of the medium exposure zone include Nomtsoub and the eastern suburbs of Tsumeb which are considered the low exposure zone (green). Kuvukiland, southwest of Tsumeb and further from the smelter is considered an even lower exposed area and is also indicated as yellow in Figure 4-24. The Namfo farms northwest of the smelter are also located in the path of wind dispersion of pollutants, but further away from the smelter.

4.15.3 **Arsenic Exposure**

In terms of arsenic exposure to community residents, the baseline community health investigation found elevated urine arsenic levels for some Tsumeb residents when compared to a non-exposed control sample group from Oshakati. Four possible arsenic exposure pathways were identified, namely: drinking water, air, food and a combination of soil and dust, together with hand to mouth behaviour.

*FIGURE 4-24: EXPOSURE ZONES AND RESIDENTIAL SUBURBS IN TSUMEB (MYERS, 2016)*
Based on urine inorganic arsenic for Tsumeb residents as a whole, the main findings of the investigation showed that there does not seem to be a general systemic overexposure problem. The overall geometric mean was actually found to be well below the most conservative international occupational hygiene standard (ACGIH BEI). However, there are a small number of high exposure outliers driven by location (Ondundu in Town North) and likely behaviours (hand to mouth with ingestion of soil and dust). Results of urine arsenic levels in the more central parts of town showed that arsenic contamination does not affect the entire town, but only a small area comprising Ondundu and its resident population. At the time of the baseline study it was recommended that specifically more sampling was required to characterise the arsenic levels in soil and locally consumed vegetables and fruit in Ondundu. As part of an ongoing contaminated land assessment and community health monitoring programme, follow-up investigations in this regard were undertaken through the course of 2018. As set out in Section 4.7 and Figure 4-12, soils with elevated arsenic levels were recorded in a number of areas surrounding Ondundu linked to exposed reefs, historic mine dumps and ongoing small scale mining activities.

For purposes of the investigation, normal inorganic arsenic levels in urine were defined as those falling below the highest 5% (95th percentile) of the Oshakati population’s values. The expectation is that for other areas being compared with Oshakati, a number exceeding the highest 5% of the Oshakati population’s values would constitute area overexposure to arsenic. The arsenic exposure results for the different residential areas are presented in Table 4-6.

**TABLE 4-6: ARSENIC EXPOSURES AS GEOMETRIC MEAN AND 95TH PERCENTILE BY RESIDENTIAL AREA**

<table>
<thead>
<tr>
<th></th>
<th>Oshakati</th>
<th>All Tsumeb &amp; surrounds</th>
<th>Town North</th>
<th>Town Central</th>
<th>Town South</th>
<th>NAMFO near farms</th>
<th>Remote farms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>41</td>
<td>171</td>
<td>37</td>
<td>86</td>
<td>16</td>
<td>27</td>
<td>5</td>
</tr>
<tr>
<td>Geometric mean μg/g</td>
<td>10.2</td>
<td>15.18</td>
<td>21.5</td>
<td>12.9</td>
<td>22.2</td>
<td>12.4</td>
<td>19.1</td>
</tr>
<tr>
<td>95th percentile</td>
<td>50.4</td>
<td>52.2</td>
<td>90.6</td>
<td>35.6</td>
<td>*</td>
<td>41</td>
<td>*</td>
</tr>
<tr>
<td>n &gt; 50 μg/g</td>
<td>2</td>
<td>10</td>
<td>7</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>% &gt; 50 μg/g</td>
<td>4.8</td>
<td>6.4</td>
<td>18.9</td>
<td>0</td>
<td>12.5</td>
<td>3.7</td>
<td>0</td>
</tr>
<tr>
<td>Maximum μg/g</td>
<td>64.9</td>
<td>176.9</td>
<td>176.9</td>
<td>49.1</td>
<td>60.4</td>
<td>55.4</td>
<td>29.6</td>
</tr>
</tbody>
</table>

*Too few observations

An important finding of the investigation was that prior local studies reporting arsenic in urine levels were unreliable and misleading as the samples were not adjusted for non-toxic organic arsenic of dietary origin in the urine (e.g. organic arsenic from eating fish). Consequently, before the study by Myers in 2016, it has not been possible to estimate the absorption of toxicologically relevant arsenic from the smelter operations by Tsumeb residents. Other determinants of inorganic urinary arsenic in Tsumeb residents included direct or
indirect contact with the smelter, via visits or having household members who work at the smelter. This means
that some arsenic is being brought home on clothes, shoes, bags, vehicles and other objects, and probably via
the hand-to-mouth route being ingested by household members. This applies to all areas of Tsumeb. For
Ondundu, growing and consuming local vegetables and fruit, and picking wild fruit and edibles, also
contributed to the urine arsenic burden among residents.

Based on updated drinking water samples and regular air quality and soil monitoring data, the main findings of
the baseline community health investigation for arsenic exposure pathways can be summarised as follows:

**Water Pathway**

All measured values in drinking water samples were found to be very low in arsenic and well within the
internationally accepted Word Health Organisation (WHO) and European Union (EU) limit of 10 µg/l. Drinking
water is thus not responsible for elevated urine arsenic levels.

**Air Pathway**

Based on average air quality data from the Stadium and Information Centre monitoring stations (see
Figure 4-14 for locations), arsenic in PM$_{10}$ exposures are not responsible for raising the average urine arsenic by
more than 0.33 µg/l, a vanishingly small amount. Even if arsenic in air exposures were an order of magnitude
higher than this, as they are at the Sewerage Works or Plant Hill monitoring stations, this could only raise the
average urine arsenic by 3.3 µg/l – a small amount, not sufficient to explain the difference between the mean
urine inorganic arsenic levels in Town North and Town Central. It is conceivable that the population of
Ondundu are exposed to arsenic in air midway between 0.06 and 0.5 µg/m$^3$, which is even less able to explain
the elevation in urine arsenic in residents there. Arsenic in air is thus not deemed to be responsible for
elevated urine arsenic levels.

**Soil Pathway**

It is highly likely that the soil is a source of arsenic exposure, both from legacy emissions and from current
emissions, especially for Ondundu which is located close to the smelter site. A 2016 study by Kribek et al.
investigated arsenic concentration in the soils and grass surrounding the smelter complex and found high
correlations between arsenic levels in topsoil and the rhizosphere and the arsenic content of grass in the same
areas. They found that only the northern part of Tsumeb town was affected, principally the area around
Ondundu. Their conclusions were, however, based on very few measurements. Similar results were found
during the 2018 follow-up soil sampling programme which was undertaken at a much finer grid in the northern
parts of Tsumeb. The preliminary results confirmed that there are elevated arsenic levels in soils linked to
historic mining activities, exposed reefs and ongoing small scale mining activities in the areas surrounding
Ondundu.
**Food Pathway**

There are few local data available which can be correlated with urine arsenic levels for vegetables and fruit grown at residents’ homes, or for wild fruit and vegetables picked near the smelter. Such data would be of particular importance in Ondundu. Myers (2016) found that those who grow their own vegetables at home in Ondundu showed significantly higher urinary arsenic levels (55.7 vs 17.3 μg/g). Picking wild food is also highly significant in Town North, but sample numbers are small in these areas, and further sampling of arsenic in wild and grown produce and urine is needed. Follow-up sampling was undertaken in 2018, with analysis of results still underway.

**Conclusion**

In conclusion, mean inorganic arsenic levels for Tsumeb as a whole and its suburbs were all below the most conservative limit (ACGIH) for inorganic arsenic, i.e. below 35 μg/l or 35 μg/g (the two units are similar in number at this level). For inorganic arsenic, the 95th percentile for Tsumeb as a whole is close to the 95th percentile for the unexposed Oshakati controls and is also below the Namibian Biological Exposure Index (BEI) of 50 μg/g. With mean exposures at this level, there is no additional risk of lung cancer. The risk of lung cancer due to environmental arsenic exposure is thus low for Tsumeb as a whole. There is no risk above baseline occurrence of cancer for Tsumeb suburbs, with the exception of Ondundu in Town North where the risk remains low, mainly due to the small population size there.

4.15.4 **SO₂ Exposure**

Ambient air quality monitoring shows that since the installation of the Sulphuric Acid Plant, residential areas in Tsumeb rarely experience exceedances of the World Health Organisation (WHO) daily limits for SO₂. Short-term exceedances of the hourly limits are, however, still being experienced in the northern parts of the town which can cause temporary mild upper respiratory symptoms of cough and throat irritation. Less frequently, more severe lower respiratory symptoms may be experienced. The 2016 baseline survey of residents showed that compared with Oshakati (which is a completely unexposed control area) there is evidence of respiratory symptoms being significantly more prevalent in Tsumeb. This is consistent with a 2012 Namibian Government Survey which found an excess of respiratory symptoms in Tsumeb in comparison with a control sample in Grootfontein. Long-term monitoring data shows that the SO₂ exposures to the community, however, continue to decline. This was confirmed by the results of the respiratory health questionnaire survey in the community health study conducted in 2016 and indicated in the air quality monitoring results in Section 4.8.3.

SO₂ has an irritant effect on the respiratory system, causing a symptom burden for the receptor population, especially for those with asthma-related symptoms. Half of all those surveyed in Tsumeb had some asthma-related symptomatology and half of these again experienced some degree of severity of these symptoms constituting an appreciable burden of asthma-related morbidity spread across all the areas of Tsumeb and the
farms to the North. There was no visible trend in these symptoms across areas within Tsumeb, which would make sense for asthma-related symptoms which are not dose-related but can be triggered by low levels of exposure. There definitely is some asthma-related impact from exposure to SO₂ from the smelter, but this is mostly mild to moderate in severity. Other upper respiratory symptoms reported through the community questionnaire were nasal discomfort and sneezing. Itchy throat discomfort was very common, particularly in Endombo at the northern end of Nomtsoob and in the northern part of town in the commercial district. All these findings are compatible with the measured SO₂ levels from the air monitoring stations at Stadium and Information Centre. While not severe, these symptoms do, however, impose some burden of discomfort on the residents in all areas of Tsumeb.

Responses to the respiratory questionnaire also confirmed many statements about improvements with regards to SO₂ exposures in the residential areas made by community members at the various public participation meetings prior to the health survey. The overwhelming majority (82%) of participants indicated that the incidents of discernible SO₂ exposure were less frequent during 2016 than 2015, while only 16% felt they were more frequent.

4.15.5 OTHER ENVIRONMENTAL HEALTH INDICATORS

As part of the HIA a total of 12 Environmental Health Areas were considered. These include the following:

- Housing and Respiratory issues – acute respiratory infections (bacterial and viral), pneumonias, tuberculosis; respiratory effects from housing, overcrowding, housing inflation;
- Vector-related disease – malaria, dengue, Chikungunya, schistosomiasis and ectoparasites, etc.;
- Sexually transmitted infections – HIV/AIDS, syphilis, gonorrhoea, Chlamydia, hepatitis B;
- Soil, Water, Sanitation and Waste related diseases – e.g., giardia, hook and pin worms, etc.;
- Food and nutrition related issues – Changes in subsistence practices; stunting, wasting, anaemia, micronutrient diseases (including folate, Vitamin A, iron, and iodine), gastroenteritis (bacterial and viral); food inflation, etc.
- Accidents/injuries – road and marine traffic related spills and releases, construction;
- Exposure to potentially hazardous materials – road dusts, air pollution (indoor and outdoor related to industrial activity, vehicles, cooking, heating or other forms of combustion/incineration), landfill refuse or incineration ash, any other project related solvents, paints, oils or cleaning agents, by-products;
- Social Determinants of Health (SDH) – psychosocial, resettlement/relocation, violence, and security concerns, substance misuse (drug, alcohol, smoking), depression and changes to social cohesion;
- Cultural health practices – role of traditional medical providers, indigenous medicines and unique cultural health practices;
• Health services infrastructure and capacity – physical infrastructure, staffing levels and competencies, technical capabilities of health care facilities and Program management delivery systems – coordination and alignment of the project to existing national and regional level health programmes, (e.g., TB, HIV/AIDS, Non-communicable Diseases such as diabetes and hypertension), and future development plans;

• Non-Communicable Diseases – hypertension, diabetes, stroke, and cardiovascular disorders; and

• Zoonotic Diseases – animal to human disease transmission; potential disease distributions secondary to changes in animal migration patterns due to project-related activities or infrastructure.

Based on available data for Namibia and the Oshikoto region the following Environmental Health Areas were identified as of high risk to be considered by DPMT:

- Housing and respiratory issues (e.g. Tuberculosis);
- Sexually transmitted infections such as HIV/AIDS;
- Soil, water, sanitation and waste related diseases;
- Food and nutrition related issues; and
- Non-communicable diseases.

These high risk ratings are not surprising or alarming when compared with baseline conditions in other parts of sub-Saharan Africa. A well designed internal health management plan aligned with existing Ministry of Health and local municipal strategies and priorities would significantly mitigate any negative effects and accentuate benefits, e.g. contributions to local health care services which DPMT is already contributing to as part of its Corporate Social Responsibility.

The Overall Risk Matrix Ratings for each of the Environmental Health Areas are presented in the table below:

<table>
<thead>
<tr>
<th>Environmental Health Area</th>
<th>Overall Risk Matrix Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>EHA#1 Housing and Respiratory Issues</td>
<td>High</td>
</tr>
<tr>
<td>EHA#2 Vector-Related Diseases</td>
<td>Minor</td>
</tr>
<tr>
<td>EHA #3 Sexually Transmitted Infections</td>
<td>High</td>
</tr>
<tr>
<td>EHA #4 Soil, Water, Sanitation and Waste Related Diseases</td>
<td>High</td>
</tr>
<tr>
<td>EHA #5 Food and Nutrition Related Issues</td>
<td>High</td>
</tr>
<tr>
<td>EHA #6 Injury burden (intentional and unintentional)</td>
<td>Moderate</td>
</tr>
<tr>
<td>EHA #7 Exposure to Potentially Hazardous Materials</td>
<td>Moderate</td>
</tr>
<tr>
<td>EHA #8 Social Determinants of Health</td>
<td>Moderate</td>
</tr>
<tr>
<td>EHA #9 Cultural Health Practices</td>
<td>Minor</td>
</tr>
<tr>
<td>EHA #10 Health Services Infrastructure/Capacity - Programme Management Delivery System</td>
<td>Low</td>
</tr>
<tr>
<td>EHA #11 Non-Communicable Diseases</td>
<td>High</td>
</tr>
<tr>
<td>EHA #12 Zoonotic Diseases</td>
<td>Minor</td>
</tr>
</tbody>
</table>
4.16 OCCUPATIONAL HEALTH

While not normally forming part of a community health assessment or ESIA, the study conducted as part of this ESIA process included an occupational health component describing the current baseline conditions for employees (see Appendix I). Main hazards to employees from smelter operations were identified as exposure to harmful chemicals, noise, heat and ergonomics. These parameters are regularly monitored by DPMT as part of their industrial hygiene programme and include monitoring of worker urine arsenic levels.

In summary, the substantial biomonitoring programme at DPMT shows that arsenic in urine has declined significantly overall and for all business units. There are, however, still some outliers that exceed the Namibian Occupational Exposure Limits (OEL) and are well above the ACGIH Biological Exposure Index (BEI). The biomonitoring data generally demonstrate that the overall Personal Protective Equipment (PPE) programme is not working optimally. Specifically, the reduction brought about by the PPE falls substantially short of the protection factors able to reduce exposure below the OELs. Suggested reasons for underperformance are set out in the specialist assessment in Appendix 5 of Appendix I. This confirms that reliance on PPE should not be the main device of exposure reduction, but that further engineering solutions should be implemented in order to ensure compliance with occupational exposure limits and guaranteeing safe working conditions.

DPMT has developed a Health & Hygiene Plan 2017 – 2021 in order to help improve occupational health management at Tsumeb. Key activities have been identified for implementation under each the following strategic focus areas:

- Achieve and Maintain Compliance;
- Improve and Sustain Exposure Controls;
- Plan and prepare for future challenges; and
- Continuous Improvement.

An Arsenic Advisory Panel was appointed in 2019, consisting of 3 experts on Arsenic in the environment and community, and to date DPMT has implemented the following mitigation measures in order to help improve occupational health and safety:

- An improved occupational health risk assessment process was rolled out, with assessments and subsequent risk profiles updating currently in progress. Improvements were also made in the assessment and management of pregnant and breastfeeding females;
- Fugitives and source emissions are being targeted as per the Arsenic Exposure Reduction Action Plan. Current focus is on fugitive dusts (spills etc.), baghouses, stable operation of the plant and facilities. An arsenic materials management plan is being compiled, in line with the Corporate Standard on Arsenic Materials Management;
• Arsenic and SO₂ specific training / induction is given to employees and contractors, on an annual basis;
• Management plans have been put in place for key occupational health stressors, with training and imbedding ongoing. These include noise, confined spaces, heat, asbestos, mobile equipment, legionella and drinking water;
• Drinking water systems were upgraded in several areas and chemical and biological parameters of drinking water are monitored. Services of cleaning contractors were engaged for regular cleaning of drinking water dispensers;
• An asbestos phase-out plan is in place for the next 3 years, with removal of a large portion of asbestos planned for 2019;
• An illumination upgrade project is ongoing, with all operational areas being targeted over the next 2 to 3 years;
• A study was conducted into skin rashes in 2018, to identify the causes, modes of action, whether it is allergic or irritant contact dermatitis, and to look into measures to prevent rashes; and
• Criteria for any new installations, upgrades, equipment etc. were rolled out and are used to define minimum requirements in scopes of work.
5 DESCRIPTION OF CURRENT OPERATIONS, IMPROVEMENTS AND THE EXPANSION PROPOSED PROJECT

This section describes the current facilities and operations at the DPMT smelter and proposed new components as part of the upgrade and optimisation project.

5.1 BACKGROUND

Various metals have been mined at the DPMT site for over a hundred years. Between 1961 and 1963 the original smelter was replaced with a new copper and lead smelter while an arsenic plant and a cadmium plant were also established for the processing of by-products originating from the smelting process. At the time, the combination of the copper and lead smelter with an arsenic and cadmium plant allowed for the interchange of intermediate products between the smelter lines and provided a suitable bleed for the arsenic and cadmium.

In mid-1998 Goldfields Namibia, the holding company of Tsumeb Corporation Limited (TCL) went into liquidation and the Tsumeb Smelter was shutdown. In 2000, the former TCL assets were taken over by Ongopolo Mining and Processing Limited (OMPL) and the copper and arsenic plants were re-commissioned. The cadmium plant was decommissioned and no lead processing has taken place since re-commissioning. In July 2006 the assets of OMPL were sold to Weatherly Mining International who owned and operated the plant for four years before selling it to Dundee Precious Metals Inc. (DPM) in March 2010. The company now operates as Dundee Precious Metals Tsumeb Ltd, a wholly owned subsidiary of DPM that is listed on Canada’s Toronto Stock Exchange.

The smelter was constructed in the early 1960s to process concentrate from the Tsumeb copper mine and is capable of processing concentrates with a high arsenic content. Currently, it receives copper concentrate from El Brocal (Peru), Chelopech (Bulgaria) and Opuwo (Namibia) for processing in the smelter.

5.2 IMPROVEMENTS SINCE 2010

Following the purchase of the smelter complex in 2010, DPMT embarked on a series of upgrades and improvement projects in order to modernise the plant. These include the following:

- Construction of a hazardous waste disposal site (2012);
- Addition of a second oxygen plant (2012);
- Improvement of the off-gas handling systems (2012-2013);
- Closure of the reverberatory furnace (2013);
- Addition of a 1,540 t/d sulphuric acid plant (mid 2015);
- Addition of two new and larger Peirce-Smith converters (end 2015);
- Installation of an extraction system at the Ausmelt launders;
- A new effluent treatment plant and sewage treatment plant;
• Decommissioning of the arsenic plant and discontinuation of arsenic trioxide production (first quarter of 2017);
• Improvement in solid waste storage and handling, with the first phase of construction of a formal general waste disposal site to be completed in 2018; and
• Concrete lining of the main stormwater trench through the smelter site during the first quarter of 2018.

Through the above improvements, DPMT has succeeded in significantly reducing its pollution footprint and total air emissions. Although air quality standards are still occasionally being exceeded at ambient air quality monitoring stations outside of the smelter boundary (see Section 4.8), the improvements made by DPMT, most notably through the commissioning of the sulphuric acid plant, have led to a significant reduction in all measured parameters.

A number of further improvements are currently underway and/or planned for the near future. Some of these are listed below.

• The ongoing 3-year stormwater management improvement project;
• Improvement of surface water management system through the construction of pollution control dams (to commence in 2018);
• Storage and transport of concentrate in bags in order to limit dust emissions. Various options are being investigated in this regard and are expected to be implemented towards the end of 2018.
• Following successful laboratory trials, a pilot verification plant for testing the processing and safe disposal or reuse of arsenic waste, was commissioned in February 2019. The pilot plant will be in operation for six months. The aim of the pilot plant is to test the viability of the technology in an industrial environment.

With regards to occupational health and hygiene within the facility, a number of improvements were made. Some of these include the following:

• Updated and improved hygiene, environmental and biological monitoring programmes and associated action plans;
• Launching of a skin rash study focusing on the causes of skin rashes and development of effective controls;
• Development of a drinking water management plan, including monitoring, maintenance and awareness;
• Undertaking hearing protector fit testing;
• Development of an asbestos management plan, including a register of asbestos material within the facility and a phased removal plan; and
• Implementing a wellness programme of offering food to manual labourers and shift workers.

Through the above improvements, there has been a marked improvement in employee health and hygiene. Although some spikes were still recorded in the exposure to arsenic during 2017, ongoing improvement was observed during 2018.

Apart from being a large employer within the Tsumeb area, DPMT currently positively contributes to the Tsumeb community through its corporate social responsibility initiatives. When considering its 2017 investment, community initiatives were supported that relate to schools, sport activities, maintenance of potable water infrastructure, programs of minority groups in resettlement farms and foster care homes, to name but a few. Some of the specific projects that DPMT contributed to in 2017 included the following:

• Preparation for the construction of employee houses and the redevelopment of the informal market;
• Capacity building program for teachers in support of early childhood development;
• Establishment of a youth development forum and programs designed to target community youth development and entrepreneurial skills;
• Support for additional winter holiday classes for learners; and
• Running the vocational program for secondary school learners to prepare them for institutions of higher learning.

In addition to the above, more than US$ 400 000 were contributed to the Community Trust Fund in 2017 alone. These funds were invested in education, Small Medium Enterprises, social welfare, arts and culture, the environment and other general uses.

5.3 DESCRIPTION OF CURRENT OPERATIONS

This section provides a description of the existing approved operations at the DPMT smelter. The Tsumeb Smelter now comprises of one primary smelting furnace, the refurbished Ausmelt furnace. Blister copper is produced from the copper concentrate and delivered to refineries for final processing. As mentioned previously, arsenic trioxide \((\text{As}_2\text{O}_3)\) was also produced from the copper concentrate through the arsenic plant and sold to third parties. With the decommissioning of the arsenic plant in the first quarter of 2017, all \(\text{As}_2\text{O}_3\) production has ceased.

The general layout of the smelter site and its main operating infrastructure is provided in Figure 5-1. A larger layout plan indicating the location of tailings facilities and stockpile areas is provided in Figure 5-2.

A simplified process flow diagram of the current operations is provided in Figure 5-3 and a more detailed flow diagram is provided in Figure 5-4.
FIGURE 5-1: GENERAL LAYOUT OF THE DPMT SITE AND INFRASTRUCTURE
FIGURE 5-2: LAYOUT OF GREATER SMELTER AREA, INDICATING TAILINGS STORAGE FACILITIES AND OTHER STOCKPILES AND SUPPORTING INFRASTRUCTURE
FIGURE 5-3: SIMPLIFIED FLOW DIAGRAM OF THE CURRENT SMELTER OPERATIONS

FIGURE 5-4: FLOW DIAGRAM OF THE CURRENT SMELTER OPERATIONS AS AT MARCH 2019
5.3.1 Walvis Bay Port Storage and Transport

Concentrate from international sources is received at the Walvis Bay port. An average of one ore carrier per month docks at the port, taking on average 8 to 10 days to offload. Ships are offloaded at the Grindrod bulk handling facility with approximately 30 000 to 40 000 tons of copper concentrate and 40 000 tons of coal temporarily stored at the facility. The storage facility is ISO 14 000, 18 000 and 9 000 certified. In order to prevent wind-blown dust from open stockpiles and contaminated stormwater run-off, the following management measures are in place:

- Offloading of ships is done via covered overhead conveyor belt lines direct to the stockpile areas;
- The stored material has an 8-10% moisture content in order to reduce dust emissions during handling;
- The stockpile areas are concrete lined and have sumps to collect contaminated run-off. Run-off is, however, not deemed a major issue due to the very low rainfall experienced;
- Trucks transporting concentrate are covered with tarpaulin;
- The ISO certification includes a dust collection and monitoring system. NamPort also monitors dust and Grindrod’s operations; and
- Worker health is monitored by a local health and safety consultant. All workers are instructed to wear suitable PPE, shower on the site after work and overalls are cleaned by the company.

Transport of concentrate to Tsumeb and processed product back to Walvis Bay takes place via rail and road. DPMT has appropriate emergency response plans in place to manage transport along both these routes.

5.3.2 Receiving Bay

The majority of materials and concentrates are received by rail and are off loaded at the receiving bay. Materials received include coal, silica and, concentrates. These are stockpiled in different sections for use.

During the preparation of charge for the Ausmelt furnace the necessary fuel, concentrates and additional materials are (crushed and) blended for introduction into the furnaces. The charge for the Ausmelt is pelletized in a small pelletizing plant.

5.3.3 Ausmelt Furnace

The Ausmelt furnace has been refurbished to smelt copper concentrates and was re-commissioned in 2008. The Ausmelt is a Top Submerged Lance (TSL) furnace that is charged with pelletized copper concentrates and fuelled with heavy furnace oil and coal. The melt consist of two phases, namely matte (molten metal sulphide phase formed during the smelting of copper concentrate) and slag (silicate waste product from smelting) which are tapped separately at different elevations. During the smelting process however, the molten material which has a relatively low volume, experiences intensive stirring which does not allow for good separation between the two phases. Matte from the TSL goes directly to the converters. The slag is transferred to the slow cooling
process and is then crushed. The crushed material is transferred to the slag mill and float plant where the entrained valuable metals, consisting mainly of copper, are recovered.

Off-gases from the Ausmelt pass through evaporative coolers and are then filtered through the baghouse where the dust which contains arsenic, is captured. The filtered gas containing $SO_2$ is transferred to the sulphuric acid plant gas cleaning system. Fugitive gases from the tap holes and matte launder are captured and filtered through the hygiene baghouse and are released to the atmosphere via the copper stack. Alternatively, gases from the Ausmelt are bypassed to the Ausmelt stack for short periods during start-up and shutdown or during emergency plant stoppages. Arsenic-containing dust recovered at the baghouses is disposed of at the Hazardous Waste Disposal Site. Approximately 25% of this collected dust was previously processed at the arsenic plant for the production of arsenic trioxide ($As_2O_3$).

5.3.4 Peirce Smith Converter Furnace

Molten matte material tapped off the Ausmelt furnace is transferred to the converter furnace for the final production of blister copper. Oxygen enriched air is added to the matte material and the oxygen reacts with sulphur, iron, lead and zinc. The sulphur from the metal sulphides provides the energy (exothermic reaction) to complete the conversion of matte to blister copper. The blister copper (98.5 % Cu) is cast into 1.62 tonne bars for shipment to refineries.

Slag formed in the converter is either recycled to the converter if it contains large amounts of entrained matte for further smelting or it is slow cooled and crushed prior to treatment at the slag mill.

The hot primary off-gases (more than 90 % of the total gas stream) from the convertor pass through a wet scrubber gas cleaning system and the clean gas is then directed to the sulphuric acid plant gas cleaning system. The remaining fugitive gasses that are captured during slag and matte tapping are passed through a balloon flue before being cooled in a series of U-tubes, followed by further cooling in the new gas cooling tower. The tower was installed in February 2010 in order to provide additional cooling of the gases before they pass through the convertor section of the copper baghouse prior to being released through the copper stack at the southern section of the smelter. The ducting required to carry the off-gases has subsequently been replaced. The baghouse has also been extended to increase its capacity.

5.3.5 Reverts

Some of the molten material, that flows through launders and is transferred in ladles, freezes on the walls of these transfer vessels and form coatings referred to as skulls or shells. The skulls, along with material that is inadvertently spilled, are collected as so-called reverts and are recycled to the Ausmelt.

5.3.6 Gas Cleaning

The gas cleaning plant processes off-gases containing a variety of impurities with different concentrations from
both the Ausmelt furnace and the Peirce-Smith converters.

The primary gases from the Ausmelt and the converters have different properties and impurity loads. While the gas from the Ausmelt has already been cooled down in evaporation coolers and de-dusted in a baghouse filter prior to the sulphuric acid plant, the gas from the converter contains a high dust load, depending on the blowing cycle of the converter.

The gases from the converter as well as the gas from the smelter are directly quenched and scrubbed in high efficiency scrubbers with an integrated quench section, each followed by a droplet separator and an ID Fan. The gas streams from the converter and the smelter are combined and then treated in a common gas cooling tower and four wet electrostatic precipitators (WESP’s).

5.3.7 Arsenic Plant and Bag house

Concentrates and other secondary material processed at the smelter are traditionally high in arsenic. The majority of the arsenic passes through the smelter and is captured from the off-gases in the bag houses. Up until December 2016, arsenic was processed in an arsenic plant, producing 99% arsenic trioxide for transport to market. With the decommissioning of the arsenic plant, bag house dusts with high arsenic levels are directly disposed of at the hazardous waste disposal site.

The bag house has been improved in recent years as per the currently approved EMP requirements. The original bag house was removed and replaced with a newer facility in order to improve efficiency.

5.3.8 Slag Mill

Slag material skimmed from the various furnaces is slow-cooled and crushed before being passed to the slag mill for milling and concentration of copper by conventional flotation. The concentrates produced are re-incorporated into the smelting process. The tailings produced during the flotation process are deposited on the old tailings dam located to the west of the smelter.

5.3.9 Power Plant

Electrical power for the majority of the smelter operations was historically supplied by an on-site power plant. The power plant has been decommissioned in recent years and electrical power is drawn from the national grid as required. However, the cooling component of the power plant is still in use.

5.3.10 Oxygen Plant

An oxygen plant was commissioned in February 2010 in order to increase production at the Ausmelt. The oxygen plant extracts oxygen from air and produces oxygen (96% O₂). The oxygen is injected into the Ausmelt furnace where it will react predominantly with iron and sulphur through exothermic reactions. As a result of the additional heat in the Ausmelt it is possible to smelt greater quantities of copper concentrate and thus
increase production. Burning of the sulphur in the concentrate also reduces the consumption of fuels such as coal and heavy furnace oils. The additional heat from the sulphur and oxygen provides for a higher smelting rate.

A new oxygen plant and associated infrastructure was commissioned in January 2014.

5.3.11 Sulphuric Acid Plant
The plant is located in a brownfield development site within an existing footprint of the plant and was commissioned in 2015. The sulphuric acid plant has two main steps in its process, the pre-treatment of gas (gas cleaning) and gas conversion. A simple overview of these two steps is discussed in the subsequent sub-sections.

5.3.12 Gas Pre-Treatment (Gas Cleaning)
Gas cleaning takes place as described in Section 5.2.5, after which it is fed to the sulphuric acid plant.

5.3.13 Gas Conversion
The single-train Sulphuric Acid Plant is based on the double absorption process with a catalytic converter consisting of three beds. After gas pre-treatment, the sulphur dioxide in the gas is converted to sulphur trioxide in a contact process that takes place in a catalytic converter, containing a vanadium pentoxide and a caesium (final bed) catalyst. During this process a high efficiency of conversion of sulphur dioxide to sulphur trioxide takes place. The double contact double absorption technology allows absorption of sulphur trioxide into 98.5% sulphuric acid. This occurs by means of exothermal chemical reactions.

The sulphuric acid that is produced is stored in three onsite storage tanks from where it is loaded into rail (this is a primary form of transport) and road tankers and transported to local and international clients.

5.3.13 Sulphuric Acid Plant Components
The main components of the Sulphuric Acid Plant are listed below.

**Gas Pre-treatment**
The gas pre-treatment section includes a:
- Scrubber;
- Gas cooler;
- Wet Electrostatic precipitator;
- Effluent stripper, including a holding tank; and
- Weak acid area, including a sump.

**Contact Section**
The catalytic converter section includes the:
- Drying tower, with an acid mist eliminator;
• Converter with three (3) catalyst beds;
• Stack - The diameter of the stack will be 2.7m with the top section tapered to 1.8m. The height of the stack will be approximately 60m – 80m;
• Preheater;
• An inter-pass absorbing tower and a final absorbing tower with acid mist eliminators; and
• The strong acid area, including a drying acid pump tank, absorbing acid pump tank and a drying acid cooler.

Product Storage
The product storage area includes:
• Three product acid storage pump tanks and associated infrastructure;
• Rail car and road tanker loading facilities; and
• An acid storage area sump.

Utilities
The associated utilities include the:
• Water treatment plant;
• Tempered water tank (tempered water is water in the temperature range between 29°C and 43°C, which is required for eye wash and safety showers); and
• Safety showers and water pumps.

5.3.14 Effluent Treatment Plant
The Effluent Treatment Plant is designed to treat effluents from the gas cleaning plants of the smelter and converter plant area. Effluents from the gas cleaning plants (including wash down water, accidental spills, cooling water blow down, precipitate collected in containment sumps, laboratory wastewater and stormwater) are pumped to the effluent treatment plant where they are purified in a precipitation process. Sulphuric acid, arsenic, and other soluble impurities are precipitated by adjusting the pH (i.e. adding milk of lime). The Effluent Treatment Plant process consists of areas for neutralization, clarification, filtration, and an area for reagent preparation. The purified effluent is discharged from the effluent treatment plant at the process pH of approximately 11 (required to remove arsenic below the target level) and joins the smelter return water stream. Solid wastes from the effluent treatment process are disposed of at the onsite hazardous waste site.

5.3.15 Sewage Treatment Plant
Construction of the sewage treatment plant was completed in 2014. After not being in full operation for some time due to oil and other waste water entering the sewage system, the facility is now fully operational with treated sewage discharged to a reed bed area in compliance with a valid discharge permit. DPMT is currently
investigating options for reuse of treated sewage within the smelter facility.

5.2.16 Kliplime Quarry

DPMT requires limestone for its operations and currently holds an ECC for mining operations at the Kliplime Quarry to the east of Tsumeb (see Figure 5-5). The ECC allows DPMT to continue quarrying for limestone from the existing Kliplime Quarry in order to meet its operational requirements. Quarrying operations include drilling, blasting and loading of limestone onto trucks for transport to the Tsumeb Smelter complex. Drilling only takes place in daylight hours on weekdays. Biannual blasting operations release approximately 8 000 to 10 000 tonnes of limestone from the quarry. Additional blasting only takes place if back-up stock is required. Once blasting is complete, a front-end loader collects all blasted rock, which is placed on a transport contractor truck for transport.

During 2016, approximately 16 000 tonnes of limestone was blasted. At the current consumption, 25 700 tonnes of limerock would be required to smelt 375 000 tonnes of concentrate. Transport from the quarry is currently on average 43 truckloads (23 tonnes per load) per month, which could increase to an average of 70 to 90 loads per month with an increase in production. Transport is seldom in monthly batches, as all material that is released after blasting is transported as soon as possible to avoid material becoming compacted at the quarry. A stockpile of around 2 000 tonnes is currently kept onsite, which would likely need to be increased with an increase in production.

![Figure 5-5: Location of the Kliplime Quarry to the East of Tsumeb (Synergistics, 2013)](image-url)
5.2.17 Other Infrastructure and Operational Components

Other infrastructure present on site includes:
- Admin and support buildings;
- Offices (container offices);
- General warehouse;
- Engineering workshops;
- Canteen;
- Reservoirs;
- Roads (gravel and tar); and
- Rail loop.

5.2.18 Waste sites

Blast Furnace Slag Dump

Slag originating from the blast furnace in the lead section of the smelter was historically disposed on site and resulted in the formation of an extensive blast furnace slag dump which is still present on site. The blast furnace has not been in operation since the operations ceased around 1994 and thus blast furnace slag is no longer produced.

Tar Pits

The tar present on the site originated as a waste product produced from a “gas producer” that was in operation in the past. The gas producer was utilised to generate gas used to fire the lead furnaces the sinter plant as well as the arsenic roasters at the arsenic plant. A combination of coal and wooden blocks were used as a fuel for the gas produced. The wooden blocks were supplied by local farmers in the area. The process resulted in the production of tar and ash and this material was frequently cleaned from the cyclones and gas pipes at the gas producer plant. The plant has not been operated for many years.

The tar was disposed of in drums or directly onto surface at various sites at the smelter. Four existing tar disposal sites are currently known. Cleaning up of these tar pits is currently managed by the approved EMP.

Old Slag Mill Tailings Dump

Historically the tailings originating from the slag mill were deposited north of the slag mill adjacent to the access road to the smelter. The dump contains high levels of metals including copper. The newer tailings dam to the east of the smelter was used for the disposal of slag mill tailings under the previous Smelter owner’s operations. DPMT currently disposes of the slag mill tailings in the reworked section of the old tailings dam located west of the smelter.
Mine Tailings Dumps

Tailings originating from the Tsumeb Concentrator were deposited on a tailings dam located within the Tsumeb Smelter Complex, referred to as the “old tailings dam”. TCL decided to rework a section of this tailings dam, necessitating the need for a new tailings dam which was established as a valley fill to the east of the smelter complex.

The new tailings dam was used by OMPL both for slag mill and mine tailings originating from the Tsumeb Concentrator (when it was in operation). The eastern tailings dam is no longer in use and requires rehabilitation. DPMT have made use of the reworked section of the old tailings dam for the disposal of slag mill tailings.

Linked to the old tailings dam is a return water dam, evaporation ponds and associated pump houses. Also linked is an old building and transformer (seeping) at the floor of the old tailings dam. Only the return water dam is, however, currently being used by DPMT.

Arsenic Calcines Dumps

Calcines are produced in the arsenic roasters as a waste product. When the lead smelter was in operation the calcines were used as a feed into the blast furnace. However, from 1988 the quantity of calcines produced was in excess of what could be used as a feed into the lead smelter. The excess material was dumped on a section of the blast furnace slag dump, west of the arsenic plant. Some calcines were also produced by OMPL and dumped adjacent to the TCL material. It must be noted that this is deemed to be historical waste not produced by DPMT.

Hazardous Waste Disposal Site (HWDS)

The HWDS is located within an old rock quarry located south of the Smelter Complex on a ridge separating the Smelter from the town of Tsumeb. The site is within the DPMT property boundaries, approximately 650 m north east of the old Tsumeb Mine (19° 14’ 10”S & 17° 43’ 20”E). The quarry (and hence the approved landfill footprint) covers an area of approximately 5 ha.

Quarrying activities at the proposed site have resulted in the formation of two terraces, with the northern section having been excavated to a depth of approximately 8 m lower than the southern section. The waste site has been developed in the lower section along the northern section of the site.

The HWDS was constructed in 2012 and has been designed with both a synthetic (HDPE) and clay liner, an under drainage system for the collection of leachate originating within the waste and a leachate detection system which provides for the monitoring of the competency of the liners. The facility has approved capacity to contain approximately 201 500 m³ of hazardous waste. Some optimisation of the site within the approved/permitted boundaries was undertaken in 2014/2105. As per the existing approved EIA, a further
small construction within the existing (old) quarry footprint is allowed and is currently in the process of being developed.

The current estimated lifespan of the site and expected impact of the increased throughput capacity of the smelter is further discussed in Section 5.4.8.

**General Waste Disposal Site**

General waste including domestic waste and office waste is disposed of within the smelter property. Workshop waste is disposed together with this waste at a site located to the east of the old tailings dam and immediately south of the smelter buildings.

Recyclable general waste (cans, papers, plastics, glass) is collected at three recycling stations on site and removed by an independent waste contractor for recycling and processing off-site.

The option of adding an incinerator for the handling of general waste was at one point considered in place of a formal general landfill site within the Smelter Complex. A cost-benefit analysis was undertaken to investigate the two options (see Section 9 in Appendix D). DPMT currently holds an ECC for a general landfill site and will commence with construction of this site during 2019. If an incinerator is to be used, a separate EIA application process will be followed.

A review of DPMT’s current waste management practices was undertaken by SLR (see Section 5.3 and Appendix D). A number of shortcomings were identified and recommendations made for improvement. These measures have been included in the Consolidated ESMP (see Appendix K).

**RCC Quarry Operations**

The Namibian Roads Contractor Company (RCC) operates a quarry in the property of the smelter. The quarry was established to produce construction material used for the Northern Extension Railway development from Tsumeb to Ondangwa.

The quarry does not operate on a full time basis and when it does it is responsible for its own dust suppression and general environmental management. DPMT provides general oversight of the operations of the quarry insofar as they have the potential to contribute to DPMT’s overall environmental impact.

**5.2.19 Transport requirements**

In terms of transport requirements to Tsumeb, DPMT depend on both road and rail services for its incoming and outgoing concentrate and product streams. DPMT’s current transport needs are provided in Table 5-1. DPMT relies on companies such as Grindrod for handling and storage of concentrate at the Walvis Bay port bulk terminal. The company employs 26 staff and it was determined that Grindrod currently relies on DPMT for a substantial portion of its turnover (Van Zyl, 2016). Also refer to Section 5.3.1.
**TABLE 5-1: DPMT’S CURRENT TRANSPORT REQUIREMENTS (VAN ZYL, 2016)**

<table>
<thead>
<tr>
<th>Direction and nature of load</th>
<th>Approximate volume per month</th>
<th>Current Truck trips per month</th>
<th>Train wagons per month (wagon capacity 42 Mt)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inbound</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentrate and other imports through Walvis Bay</td>
<td>20 000 - 24 000 Mt</td>
<td>404</td>
<td>238</td>
</tr>
<tr>
<td>Coal imports through Walvis Bay</td>
<td>800 t</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>404</strong></td>
<td><strong>258</strong></td>
</tr>
<tr>
<td><strong>Outbound</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blister exports through Walvis Bay</td>
<td>3 000 - 4 000 Mt</td>
<td>115</td>
<td>0</td>
</tr>
<tr>
<td>Sulphuric acid to Rossing Mine</td>
<td>18 000 Mt</td>
<td>0</td>
<td>400</td>
</tr>
<tr>
<td>Sulphuric acid to Tschudi Mine</td>
<td>2 500 Mt</td>
<td>60</td>
<td>0</td>
</tr>
<tr>
<td>Arsenic exports through Walvis Bay</td>
<td>300 - 400 t</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Arsenic exports to South Africa</td>
<td>80 - 100 t</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>178</strong></td>
<td><strong>408</strong></td>
</tr>
</tbody>
</table>

Four transport companies currently transport concentrate from Walvis Bay to Tsumeb. Between these companies, an average of 120 trips are undertaken per week, with the balance transported by rail.

5.2.20 Emergency Preparedness and Response

The potential unplanned events associated with this project has not been identified yet; however, DPMT is required to conduct a Hazard and operability study (HAZOP) study prior to the construction of new plants in order to determine key hazards and mitigation requirements in terms of HSE, prior to the construction/installation of such plants. As a minimum, the HAZOP shall include environmental, safety, process safety, occupational hygiene and operational aspects and concerns. Following installation of the plant, an audit shall be conducted in order to verify if controls suggested during the HAZOP were installed.

Robust HAZOPs will be conducted for the Project, but that for the purposes of this ESIA it is expected that unplanned events will be similar to those currently considered, and mitigated, for operations (e.g. fire, spillages, loss of containment, equipment failure, etc.). These unplanned events are considered to be of low probability.

DPMT also implements a Health, Safety & Environmental Criteria for Design, Purchasing, Installation, Refurbishment and Upgrading procedure which sets out the process and checks to be carried out by DPMT personnel and contractors in relation to the design, purchasing, installation, refurbishment and/or upgrading of any item that may have a hazardous impact on the environment and/or on health and safety.

In addition, DPMT has an overarching Emergency Preparedness and Response Plan (EPRP) in order to manage emergency situations and to confirm with the Local Authorities Fire Brigade Services Act, 2006 and the Disaster
Risk Management Act, 2012. The following emergency events are described in the EPRP:

- Earthquakes;
- Radioactive Contamination;
- Flooding;
- Natural Fires;
- Radiation events;
- Man-made fires;
- Tailings emergencies;
- Hazardous waste facility emergencies; and
- Chemical spillages.

5.2.21 Contract HSE Management

DPMT also has a Vendor/Contractor HSE Agreement (Ref 8-01-MS-PR-03) which sets out the health, safety and environmental standards that contractors need to adhere to. DPMT also adopted ten Safety Golden Rules which every employee and Vendor/Contractor must comply with. These Golden Rules cover the following:

- Contact with Electricity;
- Confined Spaces;
- Working at heights;
- Suspended loads;
- Molten metals;
- Isolation;
- Heavy Mobile Equipment;
- Fit for work;
- Permit to work; and
- Driving.

5.4 WASTE MANAGEMENT REVIEW

As part of the current ESIA process, a review was undertaken by SLR of DPMT’s current waste management strategies and operational procedures for both general and hazardous waste. This was undertaken in order to
identify any shortcomings prior to the proposed expansion of operations at the Tsumeb smelter and to recommend additional waste management measures for inclusion in the Consolidated ESMP (see Appendix K). A summary of the findings is provided below.

5.4.1 Current Waste Management Practices

Key waste management facilities were visited and discussions held with DPMT’s Environmental Department. The following issues were identified and mitigation is required:

Hazardous waste disposal site
The hazardous waste disposal site is being managed and operated in accordance with operational specifications. This is further supported by the fact that there appeared to be no definitive contamination of groundwater in the vicinity of the waste site. However additional dedicated monitoring boreholes should be installed to confirm this and for long term monitoring.

The HWDS operational manual and procedures are adequate, but the addition of an effective dust suppressant chemical to the water used for dust suppression, which is harmless to the environment, as well as temporarily covering unused areas with a tarpaulin, are needed to further increase the efficacy of the dust control on site and prevent offsite arsenic contamination.

Scrap yard:
There was no indication in the Scrap Management Procedure for the differentiation or separation of scrap from waste. Neither was there indication of how the scrap yard manager returns post-scrap wastes into the waste management system. A procedure should be put in place to ensure that any scrap is appropriately decontaminated before going to the scrap yard.

Building rubble stockpiles:
A variety of building rubble and demolition waste heaps were observed. Such wastes should be inert, but some mixing of rubble with hazardous (e.g. refractory bricks, gas canisters, hydrocarbon drums and paint tins) and general waste items were observed. A process should be put in place to review the content of the existing building rubble heaps to identify hazardous waste components. Those that continue to result in risk to the environment should be removed. A procedure should be put in place to regulate the establishment of any further building rubble and demolition waste stockpiles.

Contractor workshops and yards:
There was evidence of inadequate waste management practices at some contractor yards. Contractors will be advised on the Waste Management Procedure and contractually obliged to comply with the requirements thereof.

Bins and skips around facilities:
A consistent approach to the use of coloured and labelled containers in line with the Waste Management Procedure should be implemented. Bins and skips for hazardous waste must be located in bunded areas, and preferably under roof or such containers should have lids.

**General waste handling area:**
The current general waste handling area was identified as a cause of concern and its operation is likely to be resulting in impacts to the environment as well as occupational health risks. General waste handling is not currently taking place in a formalised central location and some hazardous waste items were identified within the handling area (e.g. Tyvek suits). This approach is not considered to be in line with responsible best practice waste management, as general and hazardous wastes should be managed separately from source.

The second concern is that the general waste handling area is operating as a waste burning and disposal area without appropriate facilities and subject to limited management. Site operations are not currently in line with best practice for waste management. The following measures should be implemented in the waste handling area:

- Management and operations of this general waste handling area need to be revised as a soon as possible and a waste disposal solution added.
- No hazardous wastes should be delivered to the general waste handling area, or the general waste site handling area could be upgraded to include a dedicated area and facilities (bunded and under roof) for the storage and handling of hazardous wastes.
- The source practices which are resulting in hazardous wastes being included in the general waste stream are to be altered immediately.
- Recyclable materials should be collected and stored at one location for further sorting and or processing (only be relevant if a market can be established for recycling of such materials).
- The residual portion of the waste stream requiring disposal should be subject to improved management. Open air burning of such wastes is not an acceptable waste management solution and should be stopped immediately. An alternative, improved solution must be implemented for the disposal of residual waste.
- If such burning were to continue in the short-term (for practical reasons) then the disposal of the resultant ash onto the ground at the general waste handling area must be stopped immediately. It is recommended that the ash should be disposed to the Hazardous Waste Site.

The general waste disposal site used by the Tsumeb Municipality is neither a designed nor approved landfill site, but rather a dumpsite (pers. comm., Tsumeb Municipal official). As an international company, it would not be appropriate for DPMT to dispose of waste at that facility. The alternative for DPMT to undertake responsible disposal of general waste would be the establishment of a general waste disposal site at the Tsumeb Smelter or
the installation of a small incinerator to manage the residual, general waste stream. A third alternative would be to liaise with the Tsumeb Municipality and work together to ensure that a licensed, properly designed facility is constructed for the town. DPMT could then make use of the municipal landfill for general waste disposal. This alternative would also resolve the municipal waste issues.

Since the waste management review, DPMT has continued to formalise waste collection points by providing skips for the sorting and collection of different waste items. This is regarded as a positive development in terms of improving general waste management on site. Further, design for the waste management facility comprises of general waste landfill and associated infrastructure, recycling facility, interim storage facility for hazardous waste (non-arsenic) and on-site offices was completed in early 2019 and construction phase is planned to commerce in 2019/2020.

**Sewage plant:**
The sewage plant is relatively new and therefore anticipated to be adequate to manage the sewage requirements of the DPMT. An investigation into the source of hydrocarbons entering the sewage plant was completed in 2017 and the sewage plant is now again fully operational. Untreated effluent is no longer being discharged to the lagoon/reed bed near the calcine dump. Treated sewage is being discharged to the reed beds in terms of a valid discharge permit issued by the Ministry of Agriculture, Water and Forestry.

**Projects yard:**
A number of wastes or redundant/damaged materials and containers were noted. Measures should be put in place to ensure that:

- All wastes are removed from these yards to appropriate storage or disposal sites;
- Contractors or project teams are made responsible to remove and manage appropriately all wastes during, and at the end of, a project or contract.
- A project yard does not become a storage site for wastes, or materials that become wastes due to the exposure received.

**Storm Water Management:**
Few, if any, of the waste management facilities are equipped with storm water management systems. Exposed wastes are likely to be contributing to a reduction in the quality of storm water. In addition the sediments derived from the waste management facilities are likely to be contributing to blockages of the drainage systems. DPMT have conducted an assessment for the remediation of the storm water management systems which includes the containment of contaminated surface water runoff in new lined pollution control dams, the construction of concrete lined stormwater channels to replace the existing damaged system and the separation of clean and dirty runoff water with an earth embankment. The required upgrades to the stormwater management systems are currently being undertaken by DPMT in phases.
General Waste Landfill Site:
DPMT obtained environmental clearance from the MET (dated 9 August 2013) for the establishment of a General Waste Landfill Site at the Tsumeb Smelter. The general waste landfill site has not yet been constructed, but the approved design will form part of the current consolidated ECC being applied for and related management measures for the future waste site are included in the Consolidated ESMP in Appendix K. It is anticipated that construction of the general waste landfill site will commence in 2019/2020.

In the absence of the formalised general waste landfill site, general waste management operations at the Tsumeb Smelter are likely to be resulting in human health risk as well as contributing to environmental pollution. In the cumulative context of the Tsumeb Smelter it is likely that many of these impacts would, however, not be significant, or detectable. Without the general waste landfill site, impacts that should have been managed will have occurred and will continue to occur until such time as the site is constructed, or measures are implemented to enable sanitary general waste management at the Tsumeb Smelter. In order to address these concerns raised by the waste specialist, DPMT improved waste storage and separation practices by starting to use clearly signed and colour coded waste skips on the site in 2017 (see Plate 1 below).

Plate 1: Colour coded waste skips for separate storage of solid waste.

The development of the general waste landfill site should be undertaken as soon as possible in line with the approved design.

As stated in Section 5.2.15.7, an alternative option for DPMT may be the development of a general waste incinerator to enable the disposal of non-recyclable components of general waste arising at the Tsumeb Smelter. This option is no longer being considered by DPMT. If it is, however, revisited in future, it would be the subject of a separate EIA process.
Laboratory Waste Management Practices

Chemical wastes from the laboratory are neutralised where necessary and then pumped to the effluent treatment plant. This practice is appropriate, provided that none of the chemical wastes compromise the treatment efficacy at the effluent treatment plant. Records should be kept of all chemical wastes disposed from the laboratory.

Recycling Practices

Very limited recycling is undertaken at the smelter. Other than the active recycling of scrap metal, SLR did not observe any meaningful recycling practices. Despite the presence of recycling stations at some of the facilities, it was evident from observations that paper, cardboard, plastic, polystyrene, wood, cans and glass are currently burnt rather than being recycled. This is not in line with best practice. It is, however, acknowledged that it would not be responsible to recycle wastes from areas where it could’ve been contaminated with arsenic dust.

It is understood that recycling practices in the Tsumeb region are not economically viable due to the long transport distances. Thus while DPMT generates wastes that are recyclable (and in reasonable volumes) prevailing market economics may prevent recycling from being viable. It is possible that new recycling industries are established in the future and therefore, the DPMT should continue to investigate any opportunities. It is suggested that the DPMT consider implementing a Corporate Social Initiative project in order to enable the establishment of initiatives for recycling of key recyclables generated at DPMT (perhaps to subsidise the transport of recyclables). Such a project could incorporate wastes from DPMT and Tsumeb town in general.

Tailings Facility

Concerns were identified regarding the current condition and management of the tailings storage facility. These included major erosion that has taken place on the side walls of the tailings dam and the fact that contamination of soil and groundwater is highly likely taking place beneath the tailings dam due to the facility not being lined.

DPMT are already exploring options for the requisite rehabilitation of the tailings facility to deal with these issues, based primarily on phytoremediation, which would appear a reasonable approach – this should be quantitatively illustrated to be comparable to best practice options such as the installation of a non-infiltrating capping layer going forward. SLR concluded that for the active portion of the tailings dam, it would be advisable to continue operations and any future expansion in accordance with South Africa’s Department of Environmental Affairs (DEA) GN R.632 Regulations Regarding the Planning and Management of Residue Stockpiles and Residue Deposits. These regulations provide details on the design of stockpiles in relation to height, slope angles, handling of stormwater, etc. This will not only bring DPMT in line with local and international best practice but will also help to ensure the long term stability and safety of the tailings dam. Propagation of suitable plant species for phytoremediation is already underway at the onsite nursery.
Conclusion

There is room for improvement with regards to current waste management practices. The formalising of the general waste disposal site (either on site or in collaboration with the Tsumeb Municipality) as well as implementation of recommended waste management measures as set out in the Consolidated ESMP, would ensure an improvement in waste management on the site in line with international best practice.

5.4.2 Legacy wastes

Historic or legacy wastes from smelter and mining operations by previous owners of the facility are stockpiled around the DPMT site. These comprise mostly of slags (from the furnaces and convertors) and arsenic calcines and dusts. This waste has been generated over decades of operation at the Smelter and is widely distributed across the site. None of the legacy wastes (other than approximately 390 tons of arsenic calcine) are located in facilities that are designed or managed in terms of current best practice. The nature of these materials is such that they may be hazardous and may have resulted in ongoing environmental pollution and degradation.

The owners of the smelter prior to DPMT's purchase of the facility established a Trust to deal with historical environmental liability and remediation. Liability for historical contamination is the responsibility of the Trust and not DPMT, as responsibility did not vest to DPMT upon purchase. The present status of the Trust is unknown and would need to be confirmed by MET. DPMT's asset retirement obligations (ARO) has a draft Closure Plan in place for the smelter, together with a set financial provision which has been independently calculated.

The Closure Plan is due to be revised in 2019/2020. DPMT is obligated to report their ARO provision on its books. The Closure Plan is required by government and commits to, at the end of the life of the facility ("scheduled closure"), rehabilitate all contaminated land owned by DPMT following independently verified procedures. Being the current owners of the smelter, DPMT recognises that there is a reasonable responsibility to assess and address management actions in line with Government requirements. DPMT further recognises that it has a role to play in addressing immediate risks from historical contamination and therefore commissioned a detailed Contaminated Land Assessment in order to quantify these risks and identify practicable management measures.

A perched water-table and pollution plume derived from the plant, auxiliary infrastructure, and waste areas exists in certain areas of the site. These water-tables are a historical problem due to layout/design issues implemented by a number of previous owners of the smelter since the year 1905. Jones and Wagener undertook studies (JW 49/01/7818 in 2001 and JW 48/11/C391 in 2011) to investigate the contamination risks to groundwater of operations at the Tsumeb Smelter site. The investigation included subjecting samples of the slags and calcines to the Acid Rain Leach Procedure and comparing these to the Acceptable Environmental Risk levels as advocated by the South African Minimum Requirements series (DWAF, 1998). In general, these
investigations found that the slags would pose a relatively low risk to groundwater, due largely to the low mobility of chemicals of concern. It has, however, been found by Ettler et al. (2009) that with respect to older, weathered slags such as those on the legacy slag flotation tailings dam, that complex arsenate phases can readily dissolve during the rainy season (October to March) and potentially flush significant amounts of arsenic, lead and copper into the environment in the vicinity of the slag dump.

The baghouse dust and calcines were also noted to pose a significant risk to soils and groundwater and the removal of these materials to the HWDS was recommended. To date, disposal of all of the legacy baghouse dust and calcines stockpiles at the HWDS has not been undertaken (except for a small portion of arsenic calcine waste that was disposed) and these materials continue to contribute to the contamination of groundwater. SLR’s review of groundwater quality at the Tsumeb Smelter (October 2016) concluded that “It is clear that the waste storage facilities (calcines, slag, tailings and return water dams) are major sources of pollution. Monitoring results and groundwater modelling indicates that this pollution is moving off-site, to the north of the smelter and will continue to do so unless remedial action is taken”.

The appropriate disposal of all arsenic calcines to the HWDS was documented as a commitment in the ESMP approved by MET. This commitment has currently only partially been met and disposal of all of these wastes to the HWDS or via another suitable disposal pathway is still to be completed. As stated previously, the ongoing Contaminated Land Assessment (outside the scope of this ESIA process) will aim to quantify the extent of legacy wastes and recommend appropriate remediation measures within the smelter boundary.

5.5 PROPOSED UPGRADE AND OPTIMISATION COMPONENTS

With additional custom concentrates available and further areas for operational improvements identified, DPMT conducted a high level investigation in 2014 to consider options for increasing the smelter capacity. This was followed by a pre-feasibility study conducted by Worley Parsons in 2015. The current proposed Upgrade and Optimisation Project was selected as the preferred option and would increase the concentrate throughput capacity from 240 000 tpa to 370 000 tpa. The new and upgraded components required in order to reach the increased throughput capacity include the following:

- Upgrading of the existing Ausmelt feed and furnace;
- Installation of a rotary holding furnace (RHF);
- Implementation of slow cooling of the RHF and converter slag;
- Upgrading of the slag mill to improve copper recovery and handle the increased tonnage from slow cooled slags;
- Option to install an additional Peirce-Smith (PS) converter; and
- Additional related infrastructure and utility upgrades (air, water and electricity supply).

THE ABOVE COMPONENTS ARE DESCRIBED IN FURTHER DETAIL BELOW AND ILLUSTRATED IN THE PROCESS
5.5.1 Ausmelt Feed System and Furnace Upgrades

Concentrates are received by rail car and are unloaded with an overhead clam or by truck and unloaded to separate, covered storage piles. Fluxes and remaining feed materials are received by trucks and dumped into the same covered storage area. Coal is scraped off outside the receiving bay. Revert materials from the Ausmelt furnace, converters and slag mill are also brought to this area and mixed together. The feed materials are then conveyed to a series of bins and feeders. The concentrates are blended, along with the plant reverts and fed to the Ausmelt furnace along with silica and limestone fluxes and coal. With the proposed increased 370,000 tpa concentrate feed requirement, the concentrate and reverts feeders would need to be upgraded or replaced.

The Ausmelt furnace makes use of top submerged lance technology (TSL) and this type of furnace is sometimes referred to as a TSL furnace. For the smelting operation, air and oxygen are injected into the bath through a submerged lance to produce a 60% Cu matte plus slag. The total air and oxygen flow rate capacity of the existing lance, lance trolley piping, hoses and valve train is approximately 23,500 Nm³/h. The oxygen enrichment limitation with the existing lance is ~67% O₂ by volume. For the expanded capacity, lance flow requirement is 20,000 to 22,000 Nm³/h at ≤ 65% O₂ enrichment (by volume), which the existing lance system can achieve. The existing furnace diameter and height will be sufficient for the expanded capacity.

The Ausmelt currently has curtain cooling in the bath zone and external jacket cooling in the freeboard, uptake and down comer areas. In order to improve refractory life the furnace bath zone, freeboard, kettle, roof and bull nose will be fitted with copper coolers. The cooling load for the furnace cooling water system is expected to significantly increase. A new closed loop cooling system with pumps and heat exchangers and additional pumps on the cold side of the heat exchangers are also proposed. The existing cooling tower will require upgrading to handle the significantly increased cooling load from the copper coolers.

Varying bath levels in the Ausmelt have led to poor furnace refractory life and availability. For this reason the furnace tapping will be converted from separate slag and matte tap holes to a single continuous discharge weir. Direct tapping to the RHF (see Section 5.4.2) was not deemed suitable due to the fact that the RHF would have to be located in a pit. Therefore the matte/slag mixture from the Ausmelt will be transferred to the RHF using ladles. The matte/slag mixture will continuously overflow the Ausmelt weir and be transferred into ladles via a water-cooled tilting launder.

FLOW DIAGRAM IN

Figure 5-6.

All new project components would be constructed within the current facility footprint in accordance with good international practice and no greenfield areas would need to be cleared.
Tests are currently being carried out on various oxygen injection locations to optimise the efficiency of the afterburner and off-gas system while controlling uptake build-up.

The existing Ausmelt hygiene ventilation system includes two tap-hole hoods and a moveable canopy hood to service both the matte and slag ladles. For the upgraded Ausmelt the existing tapping hoods will be removed and replaced with a new hood at the weir. Design improvement of the existing moveable canopy hood for the ladles is also being considered.
5.5.2 Rotary Holding Furnace (RHF)

Matte and slag from the Ausmelt will be transferred by ladle to a new RHF with inside shell dimensions of 4.7 m (diameter) by 15.2 m (long).

Feed to the RHF would be via a stationary water-cooled tundish protruding through the south end wall of the furnace. In order to minimise the chance of spillage and rapid dumping of material into the furnace, a ladle tilter would be included to slow pour into the RHF feed tundish. The tilter is sized to provide 5 to 10 minute pour durations.

A bank of 4 to 6 porous plugs are provided in the feed end of the vessel to facilitate heat transfer from the burners in the vessel to the bath in order to reduce the amount of build-up. The plugs are supplied with nitrogen from a pressure swing adsorption plant. A 30 m³ receiver has been allowed for to provide a minimum of two hours storage of nitrogen.
Cooling water would be provided to different components within the RHF by the new closed loop cooling water circuit proposed for the Ausmelt furnace.

A furnace ventilation system would be installed in order to capture off-gas from the furnace as well as gas and fume captured via hoods from the feed ladle and matte spout during pouring. Off-gas from the furnace is primarily combustion gas from the end wall and roof burners. The combustion gas would travel along the length of the furnace from the slag spout end to the feed end where it would exit through an opening in the top of the barrel. The off-gas then enters the off-gas hood, along with dilution air which lowers the mix temperature to 150 °C. The furnace ventilation system would simultaneously draw fumes from the furnace off-gassing and three different ventilation hoods. The combined gas from the three RHF ventilation hoods would be routed to a baghouse on the north side of the converter aisle (see Figure 5-7). A cooling air damper would be used to add additional cooling air (if required) to the gas stream to limit the baghouse inlet temperature to 120°C for protection of the filter bags and to ensure that any volatilized arsenic in the fume is condensed and can be collected as dust. Cleaned gas from the baghouse outlet would be drawn through two induced draft fans and discharged to the atmosphere via a new 70 m high steel stack.

---

**FIGURE 5-7: SMELTER LAYOUT PLAN SHOWING THE LOCATION OF EXISTING AND PROPOSED NEW MAIN INFRASTRUCTURE COMPONENTS**
A building extension is required on the north side of the converter aisle to accommodate a section of the RHF. The upper level of this extension would house an overhead service crane to lift pig iron skips and perform maintenance tasks. A nitrogen pressure swing adsorption plant would be located in a room in the upper level of the building extension. Platforms are required above and around the RHF for pig iron charging, dip bar bath level measurement, maintenance, valve racks, etc.

5.5.3 Peirce-Smith Converter

In order to increase the processing capacity to 370,000 tpa concentrate, the option of installing a third 13 x 30 ft Peirce-Smith converter is also considered. The addition of a third converter would allow for the other two converters to be online while the third converter could be offline for maintenance. Due to limitations on the acid plant only one converter can be blowing at a time. The third converter would be similar to the existing two converters with some differences in the flux/reverts feed system arrangement due to the plant layout. The third converter would be located on the north side of the converter aisle between the two 13 ft x 30 ft converters and the new RHF.

Matte tapped from the RHF would be transferred by ladle to the Peirce–Smith converters. High grade copper scrap and some crushed ladle skulls will also be treated in the converters. Slag from the converters would be skimmed into 5.7 m³ (nominal) ladles and then transferred to the larger 12.6 m³ slag pots by the converter aisle cranes. The slag pots would then be hauled to the slag slow cooling area. Blister copper would be tapped from the converters after the copper blow and cast into billets.

Flux and reverts would be supplied to the new converter feed bins via two new inclined conveyors which would require some modification of the existing transfer tower. At the converter there is a flux feed bin and reverts feed bin. A diverter gate routes the feed to the appropriate bin. Belt feeders meter the flux and reverts onto a final feed conveyor that discharges into a feed chute that protrudes through the wall of the hood and discharges into the converter mouth.

Since only one converter will be blowing at a time, there will be no increase to the required blast air demand with the addition of the third converter.

Converter primary off-gas will be collected in a water cooled hood and will flow through a drop out chamber before going through a wet scrubber and then to the acid plant gas cleaning circuit. The wet gas from the scrubber on the third converter will tie in to the duct from the other two 13 ft x 30 ft converters leading to the acid plant cooling tower. Weak acid bleed and solids collected from the gas cleaning section will be treated in an Outotec-supplied effluent treatment plant with lime slurry at pH 12. The treated water will go to the reclaim water pond. The gypsum from this plant is bagged and shipped to a hazardous landfill. Converter dust would be treated separately.
It is not expected that the addition of the third converter will increase the secondary gas flows to the existing hygiene system. This is due to the fact that only two of the three converters will be hot at any given time which is the design basis of the two converters being installed currently. Gas from the third converter secondary hood will be routed to the secondary gas header for the other two 13 ft x 30 ft converters.

The capacity of the cooling system would need to be increased in order to provide cooling water for the primary hood of the third converter.

5.5.4 Slag Slow Cooling

After slow cooling, the slag pots will be brought to the crushing plant where the slag will be discharged and broken after further cooling into 20 cm size lumps to be fed to the crusher. Trials are currently still underway to determine whether slow cooling will take place in pots or in pits before crushing. Slag hauling, dumping, breaking and crushing will be done by an independent contractor.

5.5.5 Slag Mill Upgrades

The following key changes/additions are proposed for the slag milling:

- An upgrade of the milling and classification circuits;
- Rationalization of flotation capacity by elimination of oxide rougher bank #2 and oxide cleaner cells;
- Replacement of concentrate vacuum drum filter with a 4-leaf 6ft.(1.83m) diameter disc filter;
- Addition of instrumentation in the grinding and flotation circuits and improved sampling practices to enhance metallurgical control and stability; and
- Organizational changes suggested include measures to reinforce operator training and preventative maintenance to achieve 90% slag mill availability.

5.5.6 Utility Upgrades

An assessment of the existing smelter utilities and future demand requirements for the upgraded smelter was carried out by Worley Parsons (2015) as part of their pre-feasibility study for the upgrade and optimisation project. Plant air, compressed air, instrument air, oxygen, water, fuel and electricity requirements were assessed.

The assessment found that no additional capacity would be required for plant air, low pressure air or converter blast air. A new instrument air dryer would, however, be included in the smelter upgrade to accommodate the increase in demand for instrument air.

The existing high and low pressure oxygen supply would have sufficient capacity to supply the additional demand for the smelter upgrade.

The current raw water supply was found to be insufficient to meet the estimated increased demand. The
pump capacity from the old mine shaft would need to be increased from 300 m\(^3\)/h to 375 m\(^3\)/h through the addition of a 75 m\(^3\)/h raw water supply pump and 500 m pipe.

Due to the low increase in reclaim water demand at the higher throughput capacity, it is expected that the current 150 m\(^3\) storage tank would have sufficient capacity.

Light fuel oil (LFO), a mixture of diesel and recycled oils, is used for process applications within the smelter. LFO is currently stored in three tanks: an 83 m\(^3\) main storage tank, an auxiliary 7 m\(^3\) tank for the Ausmelt furnace and a 40 m\(^3\) tank located at the arsenic recovery plant. Two additional LFO supply pumps and piping are proposed for installation at the 83 m\(^3\) tank to supply the RHF and converter burners.

Heavy fuel oil (HFO) is currently stored in two main 100 m\(^3\) storage tanks and a third 20 m\(^3\) storage tank located at the arsenic recovery plant. It is proposed to install two (1+ 1 standby) additional HFO supply pumps and two (1+1 standby) HFO heaters as part of an HFO supply ring for the RHF burners.

Electricity would be supplied to the new RHF and converter from an 11 kV feed. This feed will either be a tap off an existing 11 kV line, or else will be fed from an existing line of switchgear. The 11 kV feed would supply a new 11/0.525 kV, 2500 kVA transformer, which, in turn, would power a new motor control centre (MCC). The new MCC and all required variable speed drives (VSDs) and other electrical equipment would be housed in a new electrical building to be constructed to the south of the existing HFO storage area.

5.5.7 Stormwater Management

As mentioned in Section 4.5, DPMT is currently implementing a new stormwater management plan in phases. The plan includes the following components:

- Pollution Control Dams;
- Drainage channels to Pollution Control Dams;
- Concrete lined channels to replace the existing damaged open channels. Lining of the a portion of the main stormwater channel crossing the site was completed in 2018 and this project is ongoing;
- Lining of the No 10 Dam;
- Recovering and rerouting contaminated water sources using bunding and pumps;
- Separation of process water and stormwater;
- Clean water separation via an earth embankment/berm and sump; and
- Treatment of effluent for recycling.

As part of the first phase a new pollution control dam was constructed in 2018 with an effective storage capacity of 5 000 m\(^3\).
5.5.8 Transport

With the proposed increase in throughput capacity of the Smelter, the transport requirements to and from Tsumeb would also increase proportionately.

The Namibian National Logistics Master Plan identifies Walvis Bay as a key component of the development of the country as an International Logistics Hub. The plan involves expanding the port and the volume of traffic through the port. The volume of heavy traffic along the road between Walvis Bay and Tsumeb is therefore likely to increase. This increase is also supported by the vision to establish Namibia as an International Logistics Hub. Therefore, while the increase in smelter production will result in an increase in the volume of heavy trucks, this increase is inevitable and is supported by the vision to develop Namibia as a logistic hub. The Master Plan also notes that the road and rail transport system does not meet international standards and identifies the need to upgrade key sections of trunk roads. Of relevance to the DPMT smelter expansion project the report recommends that the trunk roads between Swakopmund and Karibib and between Karibib and Otjiwarongo be upgraded. These upgrades would assist in reducing potential safety concerns for road users.

The Namibian Roads Authority is currently already undertaking largescale upgrades to the road between Walvis Bay and Swakopmund, which would route the majority of truck traffic around Swakopmund, further reducing the impact of increased traffic volumes on local roads from the Walvis Bay port. Ongoing maintenance of the transport route between Walvis Bay and Tsumeb is also the responsibility of the Namibian Roads Authority.

Based on the volumes transported by rail and road, it has been estimated that an additional two to five truckloads of copper concentrate would need to be transported to Tsumeb per day from Walvis Bay. It is not expected that the composition of loads to be transported to and from Tsumeb by road would differ considerably from the loads currently being transported. It is not expected that an additional two to five trucks per day on the transport route between Walvis Bay and Tsumeb would have a measurable impact on traffic accommodation on the regional road network. There would thus be no need for additional road upgrades due to the additional truck loads. The option of increasing the percentage of concentrate transported by rail would further reduce truck traffic on the regional road network.

Based on the above, the potential traffic impact will thus not be assessed further as part of this EIR. Reference is, however, made to impacts associated with transport as part of the socio-economic assessment (see Appendix H).

5.5.9 Hazardous Waste Site

As part of the waste management specialist report (Appendix D), calculations were performed in order to ascertain the volumes of additional hazardous waste to be produced and disposed of at the Hazardous Waste Disposal Site. A summary of the findings is provided below:

Golder, in their report, “Engineering for the Future Development and Extension of the Hazardous Waste
Disposal Site” (Golder, 2015) calculated the remaining life of the HWDS for various scenarios which highlight the proposed options for continued disposal of hazardous waste to an onsite facility. Based on this and taking into consideration the waste added since 2015, the current facility has a lifespan of approximately 3.5 years (from end of May 2016). DPMT calculated that the life of the site would be 12.75 years from May 2016, assuming that the site is extended to its full capacity in line with what was previously permitted.

SLR (2016) performed further calculations to determine the remaining life as at end of June 2016. These calculations are detailed below:

**Based on current waste volumes**

- Airspace of existing cell as at June 2015 = 47 480 m³ (Golder, 2015)
- Airspace of remaining permitted landfill area = 153 047 m³ (DPMT, 2016)
- Volume deposited up to and including June 2016 = 8 242 m³ (DPMT records and using density of 2 tons/m³)
- Airspace available as at July 2016 = 47 480 – 8 242 = 39 238 m³
- Life of existing cell = 39 238/999 m³/month (DPMT) = 3.3 years
- Life of entire permitted landfill area = (153 047 + 47 480 – 8 242)/999 = 16 years

**Based on future waste volumes with expansion of the facility**

The proposed expansion of the facility is forecast to increase the production of end product from 240 000 tpa to 370 000 tpa (Worley Parsons, 2015), which equates to a 55% increase, commencing at the end of February 2017 (date used in calculations). Although there is likely to be some increase in efficiency, and therefore a decrease in the percentage of waste produced as a by-product, it is not possible to predict with any degree of certainty what this decrease in waste production will be and it thus has not been considered. DPMT also ceased operation of the arsenic plant which will result in an approximate 25% increase in arsenic dust generation. An increase of 80% has therefore been directly applied to the current waste generation volumes in the calculation below in order to determine the likely future volumes that will be disposed of at the Hazardous Waste Disposal Site.
Existing Cell:

- Airspace as of July 2016 = 39 238m³
- Input July 2016 to Feb 2017 = 999m³/month x 7 months = 6 993m³
- Remaining Airspace as of February 2017 = 32 245m³
- Input after Feb 2017 = 999m³/month x 80% = 1 798m³/month
- Life of Existing Cell = 7 months + (32 245 / 1 798) = 18 months (or one and a half years)

Entire Permitted Landfill:

- Airspace as of July 2016 = 184 043m³
- Input July 2016 to Feb 2017 = 999m³/month x 7 months = 6 993m³
- Remaining Airspace as of February 2017 = 177 050m³
- Input after Feb 2017 = 999m³/month x 180% = 1 798m³/month
- Life of Entire Permitted Landfill = 7 months + (177 050 / 1 798) = 98.5 months (or 8 years and 2 months)

This illustrates the immediate need to begin developing the western portion of the landfill site so that once the air space in the Eastern portion is depleted DPMT can continue disposing of arsenic dust at the Hazardous Waste Disposal Site. This is based on the conservative assumption that all arsenic waste would be disposed of at this site and that no other options for disposal are considered. DPMT is planning to soon commence with development of the second cell in line with its total approved site capacity of 201 500 m³. Design work for the second cell is currently being peer reviewed with construction expected to be completed in 2019. An independent audit of the existing site was completed by SRK in the third quarter of 2017 and it was found to be operating at the highest standards and in line with the operations manual and design.

DPMT are, however, focused on pursuing alternatives to long-term use of this facility and are currently also investigating the feasibility of other disposal options. These include the implementation of arsenic stabilisation technology, disposal to a potential future regional site in Namibia and or to transport the wastes to hazardous waste sites in South Africa. Some details regarding these alternatives are set out below.

**Arsenic Stabilisation Technology**

Early in 2017, Dundee Sustainable Technologies conducted an experimental study into the vitrification of arsenic dust. The expected outcomes of arsenic vitrification are:

- Reduction of arsenic concentration in the final product to below the guideline levels, i.e. 5 ppm;
- Conversion of arsenic dust to an inert state, i.e. a glasslike product which renders the arsenic immobile and non-hazardous and prevents any leaching into the environment via water, soil and air; and
- Creating opportunities for other disposal methods, e.g. using the final glasslike product in the rehabilitation of tailings dumps or as backfill material.
Following the positive results from the experimental study, a decision was made to install an Arsenic Vitrification Demonstration Plant in Tsumeb which would run for six months. Approval for the pilot plant was received from MET in August 2017 and the plant commissioned in February 2019.

**National Hazardous Waste Disposal Facility**

Consultation with relevant authorities regarding the establishment of a national hazardous waste disposal facility commenced in 2017, with a concept proposal drafted early in 2017. The aim of this proposal is to ultimately establish a national site with adequate holding capacity and at a suitable location approved by Government. Such a national site would not only cater for arsenic dust disposal and DPMT, but would be able to accommodate other hazardous wastes from industries and mining operations in the country.

This proposal is still at a feasibility assessment stage and consultation with industries and mining companies in Namibia are underway.

Although the focus is on pursuing other long-term alternatives for the disposal or treatment of arsenic waste, the expansion of the current waste facility was deemed to be unavoidable in order to allow for sufficient time to determine the best path forward and to accommodate the permitting, design and construction timelines for the alternative solutions. Some further details regarding potential alternative disposal pathways are provided in Section 3.6 of Appendix D.

5.5.10 Construction Phase

5.5.10.1 Schedule

It is currently anticipated that the construction period for the proposed new project components would be between 18 and 24 months.

5.5.10.2 Employment and Housing

The total estimated construction phase employment opportunities to be created by the proposed project during the 18 month construction period would be in the order of 185 person years. This estimate does not specify the average number of people who will be employed at any given time during construction, a figure which will probably vary considerably, with more workers at some times and less at others. Most of the construction phase jobs will be in the medium skill (100 person-years) and high skill (57 person-years) categories, with 29 person-years’ worth of the employment requiring people with a low level of skill. This is due to the highly technical nature of the construction.

It is anticipated that approximately 90 of these person years of work would be allocated to people from the local area and 47 to those from the rest of the Oshikoto Region. Note that these estimates are based largely on a fairly broad assessment of the availability of labour in these areas and it is DPMT’s intention to use a greater
proportion of labour from the local area, where possible. See Table 5-2 and Appendix H1 for further details in this regard.

**TABLE 5-2: LIKELY SPREAD OF CONSTRUCTION JOBS PER AREA**

<table>
<thead>
<tr>
<th>Low skill</th>
<th>Medium skill</th>
<th>High skill</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>80%</td>
<td>50%</td>
<td>30%</td>
<td>90</td>
</tr>
</tbody>
</table>

With regards to housing, workers from outside of the local area would be accommodated within existing accommodation facilities within Tsumeb, as well as at DPMT’s contractor’s camps.

### 5.5.10.3 Transport Requirements

Construction materials and pre-fabricated plant components would be transported by service providers to the construction site via existing smelter access and internal roads.

### 5.6 DECOMMISSIONING AND CLOSURE

Should the smelter operations cease in future, DPMT must ensure that adequate rehabilitation and closure of the facilities takes place following the conclusion of operations. At a conceptual level, decommissioning can be considered a reverse of the construction phase with the demolition and removal of the majority of infrastructure and activities. DPMT currently has a draft Closure Plan (Golder, 2016) that is continuously updated as operations change, additional specialist investigations are conducted and new techniques for rehabilitation are identified. A significant update of the closure plan is scheduled for 2019/2020.

### 5.6.1 Closure Objectives

According to DPMT’s current Closure Plan, the main closure vision will be to “leave a rehabilitated site behind that is physically stable, with limited residual contamination on land and in groundwater, to facilitate a wilderness end land use, largely via progressive rehabilitation during operations, within an appropriately delineated/defined buffer zone, negating intensive human use” (in this context, ‘wilderness’ is defined by exclusion, i.e. land which does not qualify as wetland, arable land or grazing land). If this vision is not fully
achieved and self-sustaining at closure, it will be on a well-established trajectory towards achieving a walk-away and/or positive legacy situation (Golder, 2016).

The following main closure objectives have been set:

- **Physical stability:** To remove and/or stabilise surface infrastructure and unavoidable mining and mineral processing residue which are present on the DPMT site to facilitate the implementation of the planned end land use;
- **Environmental quality:** To ensure that local environmental quality is not adversely affected by possible physical effects and chemical contamination arising from the DPMT site during the tenure of DPMT, as well as to sustain catchment yield as far as possible after closure;
- **Health and safety:** To limit the possible health and safety threats to humans and animals using the rehabilitated site as it becomes available;
- **Land use and land capability:** To re-instate suitable land capabilities over the various portions of the site to facilitate the progressive implementation of the planned land use;
- **Aesthetic quality:** To leave behind a rehabilitated DPMT site that, in general, is not only neat and tidy, giving an acceptable overall aesthetic appearance, but which in terms of this attribute is also aligned to the respective land uses;
- **Biodiversity:** To encourage, where appropriate, the re-establishment of indigenous vegetation on selected rehabilitated sites such that terrestrial ecosystems are largely re-instated over time; and
- **Socio-economic mitigation:** To ensure that the infrastructure transfers, if applicable, measures and/or contributions made by the facility towards the long-term socio-economic benefit of the local communities are sustainable.

The above principles and concepts will be refined as part of ongoing detailed closure planning and costing during the life of the project. Further detailed closure objectives are set out in the Consolidated EMP in Appendix K.

### 5.6.2 Closure Measures

As part of the current Closure Plan, closure measures have been devised for the following:

- Infrastructure;
- Residue and stockpile facilities;
- Waste facilities;
- Quarries and pits;
- Contaminated land management;
- General surface rehabilitation;
- Water management, including surface water and groundwater; and
- Post closure aspects, including monitoring and after care.

6 ALTERNATIVES

DPMT has been processing complex copper concentrates at the Tsumeb Smelter since its purchase from Weatherly in 2010. The proposed Expansion Project within the current facility footprint would ensure the long term efficiency and sustainability of the operations by increasing the throughput capacity to 370 000 tpa.

6.1 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

The smelter was constructed in the early 1960s to process concentrate from the Tsumeb copper mine and is capable of processing concentrates with a high arsenic content.

The smelter was commissioned in 1963 and has had various owners prior to DPM acquiring it in 2010. Therefore the site was purchased as a going brownfield concern and hence site alternatives and site design alternatives that would be made when planning a new smelter to avoid environmental and social impacts had already been considered by the original developers and were not choices available to DPM.

The provision of holding furnaces should enable more consistent operations, optimise the process and emission abatement and prevent upset conditions.

Historic activities on the smelter site had already caused significant environmental and social impacts at the site and surroundings at the time DPM purchased the facility. Since 2010 DPMT operations have contributed to and continue to contribute to the overall contamination loads but the majority of the measured contamination levels and related impacts (i.e. groundwater and community health) are attributable to historic operations prior to DPMT taking control.

Since taking control, DPM has made significant investments to address occupational health and safety ("OHS"), including industrial hygiene, and environmental and social legacy issues associated with historic and current operations. Key investments include a sulphuric acid plant, which has significantly reduced SO2 emissions to the atmosphere and improved local air quality; engineering improvements to reduce fugitive emissions, including the installation of new bag houses to capture process dust; construction of a secure hazardous waste disposal facility for arsenic containing waste disposal; as well as improved monitoring and medical surveillance.

A number of studies (e.g. contaminated land studies and closure plan update) are ongoing and will inform further facility improvements in environmental and social performance.

6.2 LOCATION ALTERNATIVES

All components of the proposed Tsumeb Smelter Upgrade and Optimisation Project would be contained within the existing facility footprint. From an environmental perspective, this would be beneficial as the overall
footprint of the new components would be limited to already developed areas with no further natural areas to be disturbed, and it would not result in any physical/economic displacement of people. It would also not be technically or economically feasible to construct any of the new project components outside of the current facility footprint. Containing all new project components within the facility footprint would thus make environmental, technical and economic sense.

6.3 PROCESSING ALTERNATIVES

Detailed pre-feasibility studies undertaken by Berakhah (Bezuidenhout, 2014) and Worley Parsons (2015) considered a number of different options for expanding and optimising the Tsumeb Smelter operations. The current proposal was selected as the most economically feasible for expanding the processing capacity to 370 000 tpa. The pre-feasibility process and different alternatives considered prior to selecting the current proposal are described below.

With additional custom concentrates available and further areas for operational improvements identified, DPM conducted a high level scoping study in 2014 (Bezuidenhout, 2014) to look at options for increasing the smelter capacity. Five alternatives for moving forward were identified and evaluated. The alternatives considered were:

1. Spend limited capital and operate sustainably at 240 000 tpa new concentrate.
2. Construct an electric holding/ settling furnace with no extra converter (two converters only). The mass balance showed that 320 000 tpa new concentrate could be handled and that converter operation would be the next bottle neck.
3. Construct a rotary holding/ settling furnace with no extra converter (two converters only). As with Alternative 2, the mass balance showed that 320 000 tpa new concentrate could be handled and that converter operation would be the next bottle neck.
4. Construct an electric holding furnace and construct a third Peirce-Smith converter to alleviate the converting bottleneck. The mass balance showed that a throughput of 370 000 tpa new concentrate could be handled and that the Ausmelt would then limit throughput at 65% oxygen enrichment and 22 000 Nm$^3$/h gas flow through the lance system.
5. Construct a rotary holding furnace and Peirce Smith converter. As with Alternative 4, the mass balance showed that a throughput of 370 000 tpa new concentrate could be handled and that the Ausmelt would then limit throughput at 65% oxygen enrichment and 22 000 Nm$^3$/h gas flow through the lance system (current proposal).

Alternative 1 is very similar to the current situation and would result in the Ausmelt furnace, which has a low volume, experiencing intensive stirring. This does not allow good separation between the matte and slag resulting in excessive entrainment of matte in the slag with increased potential for pollution from the leaching of metals from the slag. Transfers of matte would be transferred to the converters on demand, as per the
current operation. Since the Peirce-Smith converters cannot accept matte during the copper blow and blister casting, the capacity would be limited to 240,000 tpa. The lower throughput would result in a high fixed cost contribution on the plant. The high capital investment of the past 3 years (acid plant, oxygen plant, converters, etc.) would also contribute to a high depreciation cost per tonne. Throughput would, therefore, need to be increased in order to utilise the plant capacity optimally and to increase profitability.

Alternative 2, which involves the installation of an electric holding furnace (EHF) would allow a higher throughput, whilst recoveries would be improved and reverts (metal lock-up) would be reduced but would only result in a throughput of 320,000 tpa with converter capacity being the next bottleneck. An EHF would, however, be very costly. It also requires an open bath or partially open bath in order to avoid As and Sb reversion from the slag to the matte phase. This would require extensive cooling on the upper sidewalls and roof (which poses a risk for water leakage into the furnace) and would increase the cost of the furnace. In addition, there is the complexity of ladle transfer between the TSL and the EHF, crane utilization and scheduling of tapping of the TSL and the EHF.

Alternative 3 involves the construction of a rotary holding/settling furnace with no extra converter and has the same advantages as Alternative 2. It, however, appears to have a better fit at the Tsumeb Smelter, mainly on financial grounds, but also because the problems associated with operating with an open bath, and tapping/ladle transfer for the EHF are avoided.

Alternatives 4 and 5 incorporate a third converter, thereby removing the bottleneck due to insufficient converting capacity, making a throughput of 370,000 tpa possible. Alternative 5 is, however, preferred on financial grounds and avoids the other problems associated with an EHF as required for Alternative 2.

A rotary furnace operation has been selected for the following reasons:

- High arsenic material feed restricts coke addition to the EHF. Less versatility to absorb reverts and converter slag feed is therefore available to DPMT. Electric furnace design and maintenance is complicated due to the required open bath operation.
- The rotary furnace can be fed directly via a weir and launder. Less handling is therefore required. Continuous tapping allows good level control in the Ausmelt, contributing to high availability.
- The mill and float circuit acts as safety net on valuable metal content lost in rotary furnace slag. The RHF presents the highest recovery option.
- The RHF option presents the lower initial capital investment.

The recommended alternative (Alternative 5) results in 370,000 tpa concentrate processing capacity which can be implemented as follows:

- Upgrade the Ausmelt to improve availability (includes copper coolers and the addition of a continuous
discharge weir to stabilize the bath level in the furnace);

- Install a rotary holding furnace (RHF);
- Implement slow cooling of RHF and converter slag;
- Upgrade the TSF;
- Upgrade slag mill to improve copper recovery and handle increased tonnage from slow cooled slags; and
- Install an additional 13 x 30 ft. Peirce-Smith converter.

### 6.4 THE “NO PROJECT” OPTION

The financial viability and future sustainability of the Tsumeb Smelter depends on the upgrade and optimisation of current operations in order to be able to process additional available complex copper concentrates. The “No Project” option would mean that the potential increase in local and national revenue, additional employment opportunities and indirect financial spin-offs to businesses in Tsumeb would not be realised as the Tsumeb Smelter would not be functioning at an increased optimum throughput capacity.

The implementation of the project also allows for the replacement of equipment to ensure improved efficiencies from a process/financial perspective as well as from an environmental impacts perspective. Environmental impacts associated with the proposed amendments to the existing Tsumeb Smelter will be assessed cumulatively (i.e. taking the existing operations and the proposed amendments into consideration) as part of the ESIA process.
7 ENVIRONMENTAL IMPACT ASSESSMENT

7.1 INTRODUCTION

Potential environmental impacts were identified by SLR in consultation with IAPs, regulatory authorities, specialist consultants and DPMT. In the case of human-related impacts, an ESIA normally does not focus on health and safety impacts on workers because the assumption is that these aspects are separately regulated by health and safety legislation, policies and standards. As worker health was, however, identified as a concern from the public during the scoping phase, the community health and socio-economic specialist assessments made reference to worker health aspects as well (further details are provided in Appendices H and I).

The impacts are discussed under issue headings in this section. Impacts are considered in a cumulative manner where possible such that the impacts of the proposed expansion and optimisation project are seen in the context of the baseline conditions (including existing DPMT activities and facilities) described in Section 4. Information that has been included in Section 4 will not be repeated in this section.

As described in Section 5.2, the construction activities associated with the proposed expansion would be contained within the existing facility footprint. These construction activities will be similar in nature to previous construction and ongoing maintenance related activities on site and potential (additional) environmental impacts associated with most of the construction phase aspects are not regarded as significant. Therefore, the potential impacts associated with the construction facilities, activities and other construction-related issues will not be assessed for all environmental issues below.

Mitigation measures to address the identified impacts are discussed in this section and included in more detail in the consolidated ESMP report that is attached in Appendix K. In most cases (unless otherwise stated), these mitigation measures have been taken into account in the assessment of the significance of the mitigated impacts only.

Both the criteria used to assess the impacts and the method of determining the significance of the impacts is outlined in Table 7-1. This method complies with the Environmental Impact Assessment Regulations: Environmental Management Act, 2007 (Government Gazette No. 4878) EIA regulations. Part A provides the approach for determining impact consequence (combining severity, spatial scale and duration) and impact significance (the overall rating of the impact). Impact consequence and significance are determined from Part B and C. The interpretation of the impact significance is given in Part D. Both mitigated and unmitigated scenarios are considered for each impact. In addition, a comment on SLR’s confidence in the significance rating is provided for each impact. The confidence options range from high, to moderate to low and must be read in the context of the assumptions, uncertainties, and limitations set out in Section 8.

An example, showing how this chapter has been structured is provided in Box 1 below.
7.2 SURFACE WATER

7.2.1 ISSUE: CHANGES IN SURFACE WATER RUNOFF

Assessment of impact

Description of the issue and associated impact in terms of severity, duration, spatial scale, consequence, probability and significance – considering all phases of project including any cumulative impacts

Tabulated summary of the assessed impact

<table>
<thead>
<tr>
<th>Management</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Mitigated</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

Conceptual description of mitigation measures

Identification of mitigation objectives and conceptual description of mitigation actions

Emergency situation

Description of any emergency situations where relevant with reference to relevant procedures
### TABLE 7-1: CRITERIA FOR ASSESSING IMPACTS

<table>
<thead>
<tr>
<th>PART A: DEFINITION AND CRITERIA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition of SIGNIFICANCE</strong></td>
<td>Significance = consequence x probability</td>
</tr>
<tr>
<td><strong>Definition of CONSEQUENCE</strong></td>
<td>Consequence is a function of severity, spatial extent and duration</td>
</tr>
<tr>
<td>Criteria for ranking the SEVERITY/NATURE of environmental impacts</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action. Irreplaceable loss of resources.</td>
</tr>
<tr>
<td>M</td>
<td>Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints. Noticeable loss of resources.</td>
</tr>
<tr>
<td>L</td>
<td>Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints. Limited loss of resources.</td>
</tr>
<tr>
<td>L+</td>
<td>Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.</td>
</tr>
<tr>
<td>M+</td>
<td>Moderate improvement. Will be within or better than the recommended level. No observed reaction.</td>
</tr>
<tr>
<td>H+</td>
<td>Substantial improvement. Will be within or better than the recommended level. Favourable publicity.</td>
</tr>
<tr>
<td>Criteria for ranking the DURATION of impacts</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>Quickly reversible. Less than the project life. Short term</td>
</tr>
<tr>
<td>M</td>
<td>Reversible over time. Life of the project. Medium term</td>
</tr>
<tr>
<td>Criteria for ranking the SPATIAL SCALE of impacts</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>Localised – Within the site boundary.</td>
</tr>
<tr>
<td>M</td>
<td>Fairly widespread – Beyond the site boundary. Local</td>
</tr>
<tr>
<td>H</td>
<td>Widespread – Far beyond site boundary. Regional/ national</td>
</tr>
</tbody>
</table>
## PART B: DETERMINING CONSEQUENCE

### SEVERITY = L

<table>
<thead>
<tr>
<th>DURATION</th>
<th>Long term</th>
<th>Medium</th>
<th>Medium</th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium term</td>
<td>M</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Short term</td>
<td>L</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
</tr>
</tbody>
</table>

### SEVERITY = M

<table>
<thead>
<tr>
<th>DURATION</th>
<th>Long term</th>
<th>Medium</th>
<th>High</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium term</td>
<td>M</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Short term</td>
<td>L</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
</tr>
</tbody>
</table>

### SEVERITY = H

<table>
<thead>
<tr>
<th>DURATION</th>
<th>Long term</th>
<th>High</th>
<th>High</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium term</td>
<td>M</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Short term</td>
<td>L</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
</tbody>
</table>

### SPATIAL SCALE

- Localised
- Fairly widespread
- Widespread
- Within site boundary
- Beyond site boundary
- Site
- Local
- Far beyond site boundary
- Regional/national

## PART C: DETERMINING SIGNIFICANCE

### PROBABILITY (of exposure to impacts)

<table>
<thead>
<tr>
<th>PROBABILITY</th>
<th>Definite/ Continuous</th>
<th>M</th>
<th>Possible/ frequent</th>
<th>Medium</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlikely/ seldom</td>
<td>L</td>
<td>M</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
<td>H</td>
</tr>
</tbody>
</table>

## PART D: INTERPRETATION OF SIGNIFICANCE

<table>
<thead>
<tr>
<th>Significance</th>
<th>Decision guideline</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>It would influence the decision regardless of any possible mitigation.</td>
</tr>
<tr>
<td>Medium</td>
<td>It should have an influence on the decision unless it is mitigated.</td>
</tr>
<tr>
<td>Low</td>
<td>It will not have an influence on the decision.</td>
</tr>
</tbody>
</table>
7.1 SURFACE WATER

The information in this section was sourced from the Ground- and Surface water Specialist Input to the ESIA (SLR, 2016) (refer to Appendix D).

7.1.1 Issue: Changes in Surface Water Runoff

7.1.1.1 Introduction

The local drainage across the smelter site will have infrequent surface water flow during extreme rainfall events, but the catchment is already modified with existing infrastructure around the site and the area for the proposed expansion falls within the contact water section of the stormwater management system. This means that runoff water will be collected and stored on site, thus leading to a potential reduction in downstream surface water runoff.

The proposed expansion would result in additional volumes of tailings being produced, which could require additional space on the tailings dam. Mitigation measures would thus be required in order to ensure that the stormwater system capacities would be sufficient to handle any additional contact runoff generated. The proposed expansion would not change the current situation with regards to runoff potential, assuming that the stormwater system has not been spilling into the Jordan River system after previous extreme rainfall events.

There are no identified downstream surface water users between the smelter site and the Jordan River which has a limited flow for a short distance downstream. Any small reduction in the ephemeral runoff would thus not impact on any downstream water users. The currently planned stormwater management measures include a clean (non-contact) water diversion channel around the northern edge of the main smelter site in order to channel clean runoff away from the smelter site and to the Jordan River. This measure will improve the runoff from the site, as less water will flow into the smelter area and be retained in the dirty (contact) water system at the site.

Surface water runoff is largely related to operational activities, but could also increase minimally during the initial construction phase.

7.2.1.2 Assessment of impact

Severity

There is currently no significant contribution to downstream runoff from the smelter site and the severity is thus considered to be low in both the unmitigated and mitigated cases.

Duration

The duration of the potential reduction in runoff would be for the life of the project with the related impacted considered to be medium.
**Spatial scale**

The area of influence would extend beyond the site boundary, but not a significant distance downstream to the Jordan River. The influence is thus considered as medium in both the unmitigated and mitigated cases.

**Consequence**

Based on the above assessment the determining consequence is low in both the unmitigated and mitigated cases.

**Probability**

The probability of occurrence is low in the unmitigated case.

**Significance**

Summarizing the above assessment, the overall significance is rated as low in both the unmitigated and mitigated cases. SLR’s confidence level is moderate to high for this significance rating.

### Tabulated summary of the assessed cumulative impact – changes in surface water run-off

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Mitigated</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

7.2.1.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the consolidated ESMP (Appendix K).

**Objective**

The objective of the mitigation measures is to ensure that no additional contact runoff is produced that could overload the stormwater management system.

**Actions**

- Ensure that additional waste material is appropriately stored so that it does not generate additional contact runoff.
- Upgrade sections of the stormwater system where design capacity is reached.
- Review stormwater calculations to consider increased contact water from additional material/waste storage.

**Emergency situations**

None identified for the proposed expansion.

7.2.2 Issue: Surface Water Pollution

7.2.2.1 Introduction

The main factors which could affect surface water quality are chemicals which are stored and used on the site and waste material from the smelter, as well as fuels and oils from industrial equipment.
The unmitigated impact on surface water quality was assessed assuming that the proposed improved stormwater management system has been completed. With this in place, there should be only a small likelihood of any contact water leaving the site, but with further upgrading of the stormwater system to accommodate the proposed smelter expansion, this likelihood would be reduced even further. With the implementation of recommended mitigation measures, the likelihood of polluted surface water reaching the Jordan River would be reduced.

### 7.2.2.2 Assessment of Impacts

**Severity**

There is a possibility that polluted runoff may be transported downstream from the smelter site to the Jordan River. There is a likelihood of water quality deterioration, especially in proximity to the smelter site. The severity for the unmitigated case is thus rated as medium, reducing to low in the mitigated case.

**Duration**

The duration of the potential for pollution of surface water extends beyond the life of the project and is considered as medium for both the unmitigated and mitigated cases.

**Spatial scale**

The area of influence stretches beyond the site boundary and possibly downstream to the Jordan River. There would, however, be some dilution effect in the Jordan River and the spatial influence is thus rated as medium for both the unmitigated and mitigated cases.

**Consequence**

Based on the above assessment, the determining consequence is considered to be medium in the unmitigated case and low in the mitigated case.

**Probability**

The probability of occurrence is medium in the unmitigated case and low in the mitigated case.

**Significance**

Summarising the above assessment, the overall significance is rated as medium in the unmitigated case and low in the mitigated case. SLR’s confidence level is moderate for this significance rating.

### Tabulated summary of the assessed cumulative impact – surface water pollution

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Mitigated</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>
7.2.2.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the consolidated ESMP (Appendix K).

**Objective**

The objective of the mitigation measures is to ensure that any additional contact runoff from the smelter expansion does not overload the stormwater management system and that efficient management practices are implemented on the site to ensure that all potential pollution sources are contained.

**Actions**

- Implement the components of the stormwater management plan (refer to Section 5.4.7) and construct additional infrastructure to manage contact water around the smelter expansion site, if required.
- Upgrade any areas of the stormwater system where the design capacity is reached.
- Ensure that possible pollution sources are stored appropriately and used safely.
- Ensure that there are no blockages of stormwater infrastructure and that contact water is efficiently contained through effective site supervision and monitoring.
- Measure the remaining extent of contaminated soil on the smelter property (in progress) and plant a shelter belt of indigenous trees or shrubs along the edges of these areas in order to prevent erosion and transport of contaminated soil into the Jordan River.
- Continue regular sampling of runoff water and the Jordan River in order to monitor pollution levels.
- Implement phytoremediation and stabilisation of stream banks along the Jordan River in order to prevent erosion of polluted riparian soils.
- Ensure site rehabilitation is undertaken in line with the Closure Plan in order to remove or effectively contain polluting materials and prevent future contamination of runoff from the site.
- Ensure that the new sewage plant is repaired as a matter of priority and fully commissioned and the reed beds rehabilitated to remove sewage contaminant risks.

**Emergency situations**

None identified for the proposed expansion.

7.2.3 Issue: Surface Water Pollution

7.2.3.1 Introduction

The main factors which could affect surface water quality are chemicals which are stored and used on the site and waste material from the smelter, as well as fuels and oils from industrial equipment.

The unmitigated impact on surface water quality was assessed assuming that the proposed improved stormwater management system has been completed. With this in place, there should be only a small
likelihood of any contact water leaving the site, but with further upgrading of the stormwater system to accommodate the proposed smelter expansion; this likelihood would be reduced even further. With the implementation of recommended mitigation measures, the likelihood of polluted surface water reaching the Jordan River, approximately 1 km north of the site, would be reduced.

### 7.2.3.2 Assessment of impacts

**Severity**

There is a possibility that polluted runoff may be transported downstream from the smelter site to the Jordan River. There is a likelihood of water quality deterioration, especially in close proximity to the smelter site. The severity for the unmitigated case is thus rated as medium, reducing to low in the mitigated case.

**Duration**

The duration of the potential for pollution of surface water extends beyond the life of the project and is considered as medium for both the unmitigated and mitigated cases.

**Spatial scale**

The area of influence stretches beyond the site boundary and possibly downstream to the Jordan River. There would, however, be some dilution effect in the Jordan River and the spatial influence is thus rated as medium for both the unmitigated and mitigated cases.

**Consequence**

Based on the above assessment, the determining consequence is considered to be medium in the unmitigated case and low in the mitigated case.

**Probability**

The probability of occurrence is medium in the unmitigated case and low in the mitigated case.

**Significance**

Summarising the above assessment, the overall significance is rated as medium in the unmitigated case and low in the mitigated case. SLR’s confidence level is moderate for this significance rating.

### Tabulated summary of the assessed cumulative impact – surface water pollution

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Mitigated</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

### 7.2.3.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the consolidated ESMP (Appendix K).
Objective

The objective of the mitigation measures is to ensure that any additional contact runoff from the smelter expansion does not overload the stormwater management system and that efficient management practices are implemented on the site to ensure that all potential pollution sources are contained.

Actions

- Implement the components of the stormwater management plan (refer to Section 5.4.7) and construct additional infrastructure to manage contact water around the smelter expansion site, if required.
- Upgrade any areas of the stormwater system where the design capacity is reached.
- Ensure that possible pollution sources are stored appropriately and used safely.
- Ensure that there are no blockages of stormwater infrastructure and that contact water is efficiently contained through effective site supervision and monitoring.
- Measure the remaining extent of contaminated soil on the smelter property (in progress) and plant a shelter belt of indigenous trees or shrubs along the edges of these areas in order to prevent erosion and transport of contaminated soil into the Jordan River.
- Undertake regular sampling of runoff water and the Jordan River in order to monitor pollution levels.
- Implement phytoremediation and stabilisation of stream banks along the Jordan River in order to prevent erosion of polluted riparian soils.
- Ensure site rehabilitation is undertaken in line with the Closure Plan in order to remove or effectively contain polluting materials and prevent future contamination of runoff from the site.
- Ensure that the new sewage plant is repaired as a matter of priority and fully commissioned and the reed beds rehabilitated to remove sewage contaminant risks.

Emergency situations

None identified for the proposed expansion.

7.3 GROUNDWATER

The information in this section was sourced from the specialist groundwater assessment in Appendix D.

7.3.1 Issue: Groundwater Quantity

7.3.1.1 Introduction

The only activities that have the potential to reduce the local groundwater level is a significant increase in water abstraction due to the increase in throughput capacity of the smelter that could amplify the cone of depression caused by pumping of groundwater. This can have the following potential impacts on the hydrogeology of the area surrounding the Smelter Complex, which are considered in the assessment below:

- Lowering of groundwater levels and reduction in aquifer supply
- Declining yield in existing 3rd party boreholes due to declines in water levels.
- Impacts on groundwater dependent ecosystems.

Groundwater abstraction is largely related to operational activities, but could also increase during the initial construction phase (although minimal additional water required for construction).

### 7.3.1.2 Assessment of Impact

#### Severity

Increased abstraction of groundwater for the expansion could cause a local cone of depression at the abstraction shaft. Current abstraction, however, does not show a measurable impact and indications are that no significant abstraction increase is planned for the expansion project.

#### Duration

The duration of the potential for a significant cone of depression forming would be for the life of the facility, but causing a low impact.

#### Spatial scale

According to the groundwater models, the spatial scale does not extend beyond the facility boundary fence; therefore, there would be a low influence in both the unmitigated and mitigated cases.

#### Consequence

Based on the above assessment the determining consequence is low in both the unmitigated and mitigated cases.

#### Probability

The probability of occurrence is medium in the unmitigated case. A radius of influence is likely but could not be detected due to the lack of monitoring. With mitigation, the impact probability is reduced to low.

#### Significance

Summarizing the above assessment, the overall significance is rated as medium in the unmitigated scenario reducing to low in the mitigated scenario. SLR’s confidence level is moderate to high for this significance rating.

### Tabulated summary of the assessed cumulative impact – dewatering

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Mitigated</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

### 7.3.1.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the consolidated ESMP (Appendix K).
Objective

The objective of the mitigation measures is to reduce the impact of the cone of depression caused by groundwater abstraction.

Actions

- Monitor water levels in boreholes on the smelter site and offsite (including the Tsumeb Municipality and Ministry of Agriculture, Water and Forestry monitoring and production boreholes) in order to monitor possible cones of depression caused by pumping water from Shaft 1.
- Monitoring results are to be used in future groundwater model updates.
- Develop a dynamic water balance model for the site to inform future remedial action.
- Maintain and comply with the abstraction permit from the Ministry of Agriculture, Water and Forestry.

Emergency situations

None identified for the proposed expansion.

7.3.2 Issue: Groundwater Quality

7.3.2.1 Introduction

The assessment found that groundwater quality could potentially deteriorate as a result of the proposed expansion project based on modelled data. Based on measured data for heavy metal and sulphate concentrations, the baseline groundwater quality before the proposed expansion indicates that historic activities on the smelter site has already impacted significantly on groundwater quality on site. Modelled data showed that polluted groundwater could potentially migrate offsite. The expansion could potentially increase this modelled impact, though not significantly higher than what may already be experienced. Updated contamination plume modelling undertaken in 2018 showed that arsenic contaminated groundwater is moving in a north-easterly direction. Even with an extremely conserved modelling approach, assuming that no action is taken to prevent further contamination, the results showed that it is unlikely that contaminated groundwater would move offsite and reach irrigation farms to the north over a 200 year modelling period. This relates to the presence of a geological formation to the north of the smelter site which acts as a barrier to groundwater movement.

The groundwater impact assessment includes a review of previous groundwater reports and groundwater model and includes an updated 2018 groundwater model as an addendum (see Appendix D)

7.3.2.2 Assessment of impacts

Severity

Groundwater impacts are largely related to historic groundwater contamination. The assessment found that groundwater quality could potentially deteriorate as a result of the proposed expansion project based on
modelled data. The expansion could potentially increase this modelled impact, though not significantly higher than what may already be experienced. Based on the 2018 groundwater model, it is also not expected that contaminated groundwater would reach the irrigation farms to the north. In the unmitigated case, the severity of the impacts currently being experienced is considered as high. In the mitigated case, the severity can be reduced to medium, since the Group B Namibian drinking water standard and WHO drinking water quality limit could be reached with the implementation of mitigation measures.

**Duration**
The duration of potential ground water pollution extends beyond the life of the project and is thus considered as high for the unmitigated case and medium for the mitigated case, since remedial action could reduce the period of impact.

**Spatial scale**
Groundwater modelling showed that polluted groundwater could spread beyond the site boundary as contamination transport is expected to follow the groundwater flow patterns. A high rating is thus assigned to both the unmitigated and mitigated cases with regard to spatial scale.

**Consequence**
Based on the above assessment, the determining consequence is considered to be high in the unmitigated case and medium in the mitigated case.

**Probability**
The probability of occurrence is high in the unmitigated case and medium in the mitigated case.

**Significance**
Summarizing the above assessment, the overall significance is rated as high in the unmitigated case and medium in the mitigated case. SLR’s confidence level is moderate for this significance rating. The assessment is based on a conservative approach.

**Tabulated summary of the assessed cumulative impact – groundwater pollution**

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Mitigated</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
</tbody>
</table>

**7.3.2.3 Conceptual description of mitigation measures**

Conceptual discussion of the mitigation measures is provided below and detailed in the consolidated ESMP (Appendix K).

**Objective**
The objective of the mitigation measures is to reduce the offsite spread of contaminated groundwater.
Actions

- Complete the study on sources of contamination and potential remedial action (currently still underway).
- Investigate targeted solutions for groundwater treatment and pollution source elimination in order to reduce potential offsite pollution.
- Rehabilitate polluting dumps in line with the revised Closure Plan and good international practice.
- Dispose of waste material at a suitable disposal site. This would require the establishment of a formal waste site or addition of incinerator for the additional waste volumes to be generated (formal waste site to be developed in 2019).
- Implement the phytoremediation trials in line with the revised Closure Plan.
- Drill additional monitoring boreholes offsite in the downgradient direction and into different geological / hydrogeological environments (set for completion in March 2019).
- Include regional groundwater monitoring from existing farm and municipal boreholes and produce a detailed groundwater monitoring schedule.
- Regularly sample monitoring boreholes in order to timeously identify changes in groundwater quality.
- Undertake regular monitoring of on-site drinking water sources in order to ensure quality complies with Namibian drinking water standards.
- Implement erosion control measures, such as interception drains, contour planting, silt fences, establishment of groundcover species, optimal drainage construction, and silt ponds, where appropriate.

Emergency situations

None identified for the proposed expansion.
7.4 AIR QUALITY

The information in this section was sourced from the air specialist study in Appendix F (Airshed, 2018).

7.4.1 Introduction

As stated in Section 4.6, there have been notable decreases in air emissions from smelter operations since DPMT commenced operations, more specifically since 2016. Decreases in SO\textsubscript{2} and PM\textsubscript{10} levels in 2016 can be ascribed to the commissioning of the sulphuric acid plant and decommissioning of the reverberatory furnace.

As the Namibian Atmospheric Pollution Ordinance (No. 11 of 1976) does not include any ambient air quality standards, interim World Health Organisation (WHO) guidelines, South African National Ambient Air Quality Standards (NAAQS) and EU Standards were considered in the assessment of air quality impacts. The guidelines and standards used for SO\textsubscript{2} and PM\textsubscript{10} in the assessment are set out in Table 7-2.

**TABLE 7-2: ASSESSMENT GUIDELINES AND STANDARDS CONSIDERED IN THE ASSESSMENT**

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging period (exposure period)</th>
<th>Limit value (µg/m\textsuperscript{3})</th>
<th>Limit value (ppb)</th>
<th>Limit value reference</th>
<th>Permitted frequency of exceedance</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM\textsubscript{10}</td>
<td>24-hour</td>
<td>75</td>
<td>Not applicable</td>
<td>WHO IT-3 and SA NAAQS</td>
<td>4</td>
<td>WHO and SA NAAQS</td>
</tr>
<tr>
<td></td>
<td>1-year</td>
<td>40</td>
<td>Not applicable</td>
<td>SA NAAQS and EU standard</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SO\textsubscript{2}</td>
<td>10-minute</td>
<td>500</td>
<td>191</td>
<td>SA NAAQS</td>
<td>526</td>
<td>SA NAAQS</td>
</tr>
<tr>
<td></td>
<td>1-hour</td>
<td>350</td>
<td>134</td>
<td>SA NAAQS and EU standard</td>
<td>88</td>
<td>SA NAAQS and EU</td>
</tr>
<tr>
<td></td>
<td>24-hour</td>
<td>125</td>
<td>48</td>
<td>WHO IT-1, SA NAAQS and EU standard</td>
<td>4</td>
<td>SA NAAQS and EU</td>
</tr>
<tr>
<td></td>
<td>1-year</td>
<td>50</td>
<td>19</td>
<td>SA NAAQS</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

For the potential health impacts associated with non-criteria pollutants, arsenic and H\textsubscript{2}SO\textsubscript{4}, guidelines of the California Environmental Protection Agency (CALEPA) and WHO were used. The CALEPA guidelines were used in the absence of Namibian, South African and specific WHO standards for these pollutants. The CALEPA guideline was considered as the latest and most stringent for use in the assessment. Chronic and acute inhalation criteria and unit risk factor (URF) (applicable to pollutants with a carcinogenic impact) for arsenic and H\textsubscript{2}SO\textsubscript{4} considered in the assessment are set out in Table 7-3.

Dispersion models were used to predict spatial air quality concentrations for the operational phase, based on an increased processing rate of 370 000 t/a. The results for the measured emissions are summarised below. Dispersion modelling for the construction and decommissioning phases was considered to be unrepresentative of the actual activities that will result in dust and gaseous emissions, due to the overly conservative emission rate calculation and was thus not assessed separately.
TABLE 7-3: CHRONIC AND ACUTE INHALATION SCREENING CRITERIA AND CANCER UNIT RISK FACTORS

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Chronic Screening Criteria (µg/m³)</th>
<th>Acute Screening Criteria (µg/m³)</th>
<th>Inhalation URF (µg/m³)⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>0.015 (CALEPA)</td>
<td>0.2 (CALEPA)</td>
<td>1.5E-03 (WHO)</td>
</tr>
<tr>
<td>H₂SO₄</td>
<td>1 (CALEPA)</td>
<td>120 (CALEPA)</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

**SO₂**

It is expected that SO₂ emissions will increase most notably because of the introduction of the RHF where SO₂ will be released during charging and pouring.

In order to determine the dispersion of SO₂ from the smelter as a result of the proposed expansion, SO₂ concentrations were simulated at ambient air quality monitoring locations. As the sulphuric acid plant utilisation was on average at 75% during 2016, a 75% utilisation rate was used in the simulations. The 75% utilisation rate is considered to be a worst case scenario and it is expected that the acid plant would reach between 90 and 95% utilisation on average. Conservatively, the 53% increase in SO₂ emissions from the smelter is expected to result in similar increases in ambient SO₂ concentrations. The simulation results showed that with a 75% acid plant utilisation rate, SO₂ concentrations associated with the proposed plant expansion would exceed the South African 1-year average assessment criterion of 50 µg/m³ at the on-site Sewerage Works and western parts of Tsumeb (see Figure 7-1). The 24-hour average criterion (4 days of exceedance of 125 µg/m³) is exceeded at the Sewerage Works and large parts of Tsumeb (see Figure 7-2).

With a minimum acid plant utilisation rate of 90%, it would be possible to ensure that ambient SO₂ levels remain largely within the adopted SO₂ assessment criteria (see Figures 7-3 and 7-4). Since the addition of the converter off-gasses during late 2016, the sulphuric acid plant has achieved an increase of 30% in gas capturing efficiency.

**PM₁₀**

The proposed increased throughput capacity is expected to increase both long and short term ambient PM₁₀ concentrations by a factor of approximately 1.2. Simulated levels associated with the proposed upgrade project do, however, not exceed PM₁₀ air quality limits off-site (see Figures 7-5 and 7-6).

**Arsenic**

Simulations for the proposed project scenario showed that 1-year average arsenic concentrations exceed the EU standard of 0.006µg/m³ off-site to the west and northwest of the smelter boundary as well as across the northern parts of town. These simulated annual average levels at the complex boundary were found to be comparable to annual means reported for arsenic at the Plant Hill and Sewerage Works monitoring stations in 2016. It was found that building fugitives (fumes escaping primary and secondary capture systems), as well as emissions from the Ausmelt and Copper stacks, contribute significantly to off-site exceedances.
Modelled ground level ambient arsenic levels could potentially increase by approximately 54% due to the proposed upgrade project (see Figure 7-7). The increase is attributed to the conservative assumption that furnace building fugitive emissions will increase linearly with increased production rates. The contribution of additional arsenic emissions from the proposed RHF to ground level arsenic concentrations is, however, minimal. Efforts should therefore be made to reduce building and other fugitive emissions through suitable and effective engineering controls (see recommended actions under Section 7.4.2.1 below and further details in Appendix F).

Given the above, the impact of arsenic on the receiving environment and nearby AQSRS at Ondundu and Endombo are predicted to be somewhat above the EU annual exposure criteria for the expansion scenario. It is essential that attention be paid to the reduction of arsenic-containing dust emissions, especially the handling and disposal of such dust at the hazardous waste disposal site. Based on the findings of the community health assessment, the air exposure pathway is, however, not considered to significantly contribute to elevated urine arsenic levels measured for community members resident in the northern parts of Tsumeb. According to the community health assessment, arsenic in air levels are considered low and unlikely to impact urine arsenic levels or to pose a meaningful lung cancer risk for Tsumeb residents. A further discussion of this is provided in Section 7.7 below.

$\text{H}_2\text{SO}_4$

For sulphuric acid, dispersion from the acid plant stack was simulated. Ambient $\text{H}_2\text{SO}_4$ levels are expected to increase by a factor of 1.5 due to the proposed increased throughput capacity. Both 1-year and 1-hour average off-site concentrations were, however, found to be well within ambient air quality limits (see Figure 7-8).
FIGURE 7-1: SIMULATED 1-YEAR AVERAGE SO₂ CONCENTRATIONS AT A 75% ACID PLANT UTILISATION RATE (EU STANDARD = BLACK LINE)

FIGURE 7-2: 99th PERCENTILE OF SIMULATED 24-HOUR AVERAGE SO₂ CONCENTRATIONS AT 75% ACID PLANT UTILISATION RATE (EU STANDARD = BLACK LINE)
FIGURE 7-3: SIMULATED 1-YEAR AVERAGE SO₂ CONCENTRATIONS AT 90% ACID PLANT UTILISATION RATE (EU STANDARD = BLACK LINE)

FIGURE 7-4: 99TH PERCENTILE OF SIMULATED 24-HOUR AVERAGE SO₂ CONCENTRATIONS AT 90% ACID PLANT UTILISATION RATE (EU STANDARD = BLACK LINE)
FIGURE 7-5: SIMULATED 1-YEAR AVERAGE PM$_{10}$ CONCENTRATIONS

FIGURE 7-6: 99$^{th}$ PERCENTILE OF SIMULATED 24-HOUR AVERAGE PM$_{10}$ CONCENTRATIONS
FIGURE 7-7: SIMULATED 1-YEAR AVERAGE ARSENIC CONCENTRATIONS
(EU STANDARD = BLACK LINE)

FIGURE 7-8: SIMULATED 1-YEAR AVERAGE H₂SO₄ CONCENTRATIONS
7.4.2 Assessment of Impact

Severity
During the operational phase of the proposed upgrade and optimisation project, $SO_2$ emissions will increase most notably because of the introduction of the RHF where $SO_2$ will be released during charging and pouring. $PM_{10}$, arsenic and $H_2SO_4$ emissions will increase mostly because of increased material throughput and production rates. Conservatively, the increase is expected to be proportional to the increase in the concentrate processing rate.

Regardless of the expected emission increases, dispersion simulations indicated no exceedances of air quality limits or screening criteria for $PM_{10}$ and $H_2SO_4$ off-site due to the increased throughput capacity.

Although a significant decrease in ambient $SO_2$ levels have been recorded after commissioning of the sulphuric acid plant, exceedances of short-term $SO_2$ assessment criteria are still currently being experienced. Based on a 75% sulphuric acid plant utilisation, dispersion simulations indicated that short-term (24-hour and 1-hour) screening criteria for $SO_2$ is still expected to be exceeded at the AQRs in Tsumeb with the proposed increased throughput capacity.

The impact of arsenic in air on the receiving environment and nearby AQRs was found to be at the upper level of what might be considered acceptable, from a non-carcinogenic and carcinogenic inhalation health exposure perspective (see Section 7.7 for a detailed assessment of community health risks).

Based on the above findings, the severity of the potential health risk to AQRs in the Tsumeb area due to the proposed increased throughput capacity of the smelter is considered to be medium, since exceedance of the assessment criteria at AQRs would occur given current performance levels of the sulphuric acid plant and fugitive emissions management systems. With mitigation, impact severity may be reduced to low-medium.

Duration
The duration would be for the life of the project and is considered medium term in both the unmitigated and mitigated scenarios.

Spatial scale
The spatial scale of the potential cumulative impact is directly related to the spatial scale of the dispersion of any air pollution that in turn has the potential to impact on human health. Impacts would be experienced on a local scale. The rating is considered medium without mitigation and low-medium with mitigation.

Consequence
Based on the above assessment, the consequence is medium in the unmitigated scenario and low-medium in the mitigated scenario.
**Probability**

The probability of occurrence of the impact is considered definite and the rating is thus high for both scenarios.

**Significance**

Summarising the above assessment, the overall significance is rated as medium. After mitigation, the significance would reduce to low-medium.

**Cumulative impacts**

The assessment of the increased throughput capacity is considered to be cumulative to current operational impacts.

**Tabulated summary of the assessed cumulative impact – air quality impacts**

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Mitigated</td>
<td>L-M</td>
<td>M</td>
<td>L-M</td>
<td>L-M</td>
<td>H</td>
<td>M</td>
</tr>
</tbody>
</table>

**7.4.2.1 Conceptual description of mitigation measures**

Conceptual discussion of the mitigation measures is provided below and detailed in the Consolidated ESMP (Appendix K).

**Objective**

The objective is to minimise impacts to AQRSFs by ensuring ambient air quality limits are not violated off-site.

**Actions**

- The RHF baghouse stack must be at least 70 m high (at a release height of 70 m, emissions released will result in ground level pollutant levels of no more than 25% of the ambient air quality limits);
- Position the movable hoods to be used at the RHF accurately during all cycles of the process in order to ensure maximum fume capture;
- The fume capture and extraction systems at the Ausmelt and converters and future RHF must be maintained and operated to specifications to ensure minimal fugitive emissions during charging, holding and pouring cycles. This could include upgrading/retro-fitting secondary extractions systems to more efficiently evacuate fumes from buildings;
- Improve fugitive dust management measures to minimise PM$_{10}$ and arsenic emissions which will increase proportionally to increased production rates. Specific measures must include the following:
  - Proper handling and disposal of arsenic containing dusts at the hazardous waste disposal site;
  - Good housekeeping on plant and road areas to reduce fine material re-entrainment by wind and vehicles. This could include the use of mechanical broom or vacuum sweepers in order to collect dust from paved roads;
  - Enclosure, extraction and fabric filters on slag plant crusher section;
o Unpaved roads: paving, traffic calming measures or the use of binding materials.

- Improve materials handling by reducing mass transfers and drop heights, using wind shelters and wetting materials;
- Reduce windblown dust from large exposed areas by limiting the creation of new disturbed areas, preventing spillage, preventing wind exposure through enclosures or wind fences and treating exposed surfaces through wet suppression, chemical stabilisation, covering with less erodible aggregate material or vegetating open areas;
- The sulphuric acid plant utilisation must be at least 90%.
- Keep interruptions of the sulphuric acid plant operations to a minimum during hours of atmospheric instability, i.e. between the hours of 11am and 4pm;
- Undertake continuous monitoring of SO\textsubscript{2} emissions released through the acid plant stack. This will enable plant operators to monitor plant efficiency and provide a true reflection of SO\textsubscript{2} emissions over time.
- Implement additional general management measures and monitoring systems as detailed in the Consolidated ESMP (see Appendix K).

**Emergency situations**

None identified.

**7.5 NOISE**

The information in this section was sourced from the noise specialist study in Appendix G (Airshed, 2017).

**7.5.1 Introduction**

Noise Sensitive Receptors (NSR) generally include places of residence and areas where members of the public may be affected by noise generated by industrial activities. The closest NSRs to the smelter complex include the town of Tsumeb and its suburbs to the south and southwest, as well as farmsteads.

The main meteorological parameters affecting the propagation of noise include wind speed, wind direction and temperature. These along with other parameters such as relative humidity, air pressure, solar radiation and cloud cover affect the stability of the atmosphere and the ability of the atmosphere to absorb sound energy. For the purpose of this assessment, use was made of recorded on-site data (15 September 2016 when the plant was offline and 5 to 6 October 2016 when the plant was fully operational) as presented in Appendix G.

Upgrades proposed as part of the expansion will add additional sources of noise. The installation of the new RHF, its feed, fuel and mechanical systems as well as off-gas extraction, cleaning and venting systems will result in localised noise level increases. The increase in overall processing and production rates will also affect noise levels because of more frequent vehicle trips, increased material handling rates etc.
A noise impact assessment was undertaken in order to investigate the potential for annoyance as a result of increased noise levels.

The assessment referred to the following guidelines and criteria:

The IFC General Environmental Health and Safety Guidelines on noise address impacts of noise beyond the property boundary of the facility under consideration and provides noise level guidelines. The IFC states that noise impacts should not exceed the levels presented in Table 7-4, or result in a maximum increase above background levels of 3 dBA at the nearest receptor location off-site. For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. $\Delta = 3$ dBA is, therefore, a useful significance indicator for a noise impact.

**TABLE 7-4: IFC NOISE LEVEL GUIDELINES**

<table>
<thead>
<tr>
<th>Area</th>
<th>One Hour $L_{AEq}$ (dBA) 07:00 to 22:00</th>
<th>One Hour $L_{AEq}$ (dBA) 22:00 to 07:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial receptors</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Residential, institutional and educational receptors</td>
<td>55</td>
<td>45</td>
</tr>
</tbody>
</table>

SANS 10103 also provides a useful guideline for estimating community response to an increase in the general ambient noise level caused by intruding noise. If $\Delta$ is the increase in noise level, the following criteria are of relevance:

- $\Delta \leq 0$ dB: There will be no community reaction;
- $0$ dB $< \Delta \leq 10$ dB: There will be ‘little’ reaction with ‘sporadic complaints’;
- $5$ dB $< \Delta \leq 15$ dB: There will be a ‘medium’ reaction with ‘widespread complaints’. $\Delta = 10$ dB is subjectively perceived as a doubling in the loudness of the noise;
- $10$ dB $< \Delta \leq 20$ dB: There will be a ‘strong’ reaction with ‘threats of community action’; and
- $15$ dB $< \Delta$: There will be a ‘very strong’ reaction with ‘vigorous community action’.

The categories of community response overlap because the response of a community does not occur as a stepwise function, but rather as a gradual change.

Due to the most notable noise levels being related to operational activities of the smelter, it is expected that additional noise impacts during the construction and decommissioning phases would be minimal and was thus not assessed separately.

**7.5.2 Assessment of Impact**

**Severity**

Based on the main meteorological parameters, it is expected that noise impacts would on average be most notable to the northwest and south of the smelter facility.
The noise study findings showed that the only NSR where activities from the smelter complex were audible was the farmstead on the property of Mr Danie Potgieter, approximately 650 m northwest of the smelter boundary and 600 m east of the M75 road. It was found that noise levels in the town are greatly affected by community activities and highly dependent on wind speed.

Noise simulations indicated that the proposed increased throughput capacity would not result in exceedances of noise levels guidelines at NSRs. The increases in noise levels above the measured background level of 44.8 dBA during the day and 39.4 during the night are less than 3 dBA at all NSRs.

Presently, residents on the farm of Mr Potgieter and close to the Tsumeb Private hospital are able to hear smelter activities under calm wind conditions and especially at night. The increases in noise levels are, however, less than 3 dBA and not sufficiently higher as to result in annoyance.

The simulated overall increase in noise levels from the proposed increased throughput capacity is less than 1 dBA. Since, for a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable, it is unlikely that NSRs will be affected by the expansion project from an environmental noise perspective.

Additional simulations were included to assess the impact noise from the No. 2 oxygen plant during its start-up cycle. Simulations indicate that residents on the farm of Mr Potgieter are exposed to noise levels that are close to the night-time noise level guideline of 45 dBA. At day and night-time background levels of 44.8 dBA and 38.4 dBA, the plant will result in an increase of 2.9 dBA during the day and 6.6 during the night. According to SANS 10103 ‘little’ to ‘medium’ reaction with ‘sporadic complaints’ to ‘widespread complaints’ can be expected. Although not considered part of normal operating conditions, it is essential that noise from this plant be addressed to improve the overall acoustic performance of the smelter complex.

Based on the above, the severity is considered low, with no exceedances of noise level guidelines at NSRs outside the smelter boundary.

**Duration**

Duration would be for the life of the project and is thus considered medium term.

**Spatial scale**

Noise impacts will be localised in both the unmitigated and mitigated scenarios. This is a low spatial scale.

**Consequence**

Based on the above assessment, the consequence of potential noise impacts is low.

**Probability**

The probability of the noise levels exceeding the criteria at any of the receptors is low. Whether this results in a negative impact will depend on the expectations of the third parties and their response to the audible noise.
The related probability is assumed to be low.

**Significance**

Summarising the above assessment, the overall significance is rated as low in both the unmitigated and mitigated scenarios.

**Tabulated summary of the assessed cumulative impact – noise impacts**

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Mitigated</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

7.5.3 Conceptual Description of Mitigation Measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Consolidated ESMP (Appendix K).

**Objective**

The objective of the measures is to minimise the impact on NSRs by ensuring that noise level guidelines are not violated.

**Actions**

- Record and respond to complaints by conducting regular noise monitoring;
- All diesel-powered equipment and plant vehicles should be kept at a high level of maintenance. This should particularly include the regular inspection and, if necessary, replacement of intake and exhaust silencers. Any change in the noise emission characteristics of equipment should serve as trigger for withdrawing it for maintenance.
- For new equipment to be installed as part of the upgrade and expansion, equipment with lower sound power levels must be selected. Vendors should be required to guarantee optimised equipment design noise levels.
- In managing noise specifically related to truck and vehicle traffic, efforts should be directed at:
  - Minimizing individual vehicle engine, transmission, and body noise/vibration. This is achieved through the implementation of an equipment maintenance program.
  - Maintain road surface regularly to avoid corrugations, potholes etc.
  - Avoid unnecessary idling times.
  - Minimizing the need for trucks/equipment to reverse. This will reduce the frequency at which disturbing but necessary reverse warnings will occur. Alternatives to the traditional reverse ‘beeper’ alarm such as a ‘self-adjusting’ or ‘smart’ alarm could be considered. These alarms include a mechanism to detect the local noise level and automatically adjust the output of the alarm so that it is 5 to 10 dB above the noise level near the moving equipment.
• Where possible, noisy activities such as construction, decommissioning, start-up and maintenance, should be limited to day-time hours.

• In the event that noise related complaints are received short term (24-hour) ambient noise measurements should be conducted as part of investigating the complaints. The results of the measurements should be used to inform any follow up interventions.

Emergency situations
None identified.

7.6 SOCIO-ECONOMIC

The information in this section was sourced from the social and economic specialist studies in Appendices H1 and H2 (Van Zyl, 2016 and Barbour, 2017 with 2019 update).

7.7.1 Introduction

In the broadest sense the activities associated with the proposed project will have socio-economic impacts in all phases. Some of these are considered to be positive impacts and others are considered to be negative impacts. The separate groups of impacts are discussed below and must be read in the context of the baseline information included in Section 4.

7.6.2 Issue: Impacts Associated with Project Expenditure: Construction Phase

The construction phase of the project would result in spending injections that would lead to increased economic activity. This aspect is best measured in terms of impacts on employment and associated incomes focusing on the local area and region.

All expenditures will lead to linked direct, indirect and induced impacts on employment and incomes. In the case of employment, impacts would be direct where people are employed directly for the construction of new project components (e.g. jobs such as construction workers). Indirect impacts would be where the direct expenditure associated with the project leads to jobs and incomes in other sectors (e.g. purchasing building materials maintains jobs in that sector) and induced impacts where jobs are created due to the expenditure of employees and other consumers that gained from the project. Ordinarily, direct impacts are the most important of these three categories as they are the largest and more likely to be felt in the local area. They can also be estimated with the highest degree of certainty. The quantification of indirect and induced impacts is a less certain exercise due to uncertainty surrounding accurate multipliers.

Construction expenditure would constitute a positive injection of new investment. Preliminary estimates indicate that a total of around N$722 million would be spent on all aspects of construction over the roughly one and half year construction period (see Table 7-5)
The project would have a positive impact on commercial activity particularly in the local area and region during construction given its size and the expenditure associated with it outlined above. During the construction phase the building construction, civil and other construction and specialist industrial machinery sectors would benefit substantially. The structural metal products, wholesale and retail trade and construction materials sectors would also stand to gain due to indirect linkages.

A tentative indication of what percentage of construction expenditure would go to suppliers from Tsumeb, the rest of Oshikoto, the rest of the country and what would be imported is provided in Table 7-5. Imports would primarily comprise specialised machinery and equipment not available in Namibia. Table 7-6 sets out the likely construction spend per geographic area using the overall amounts and percentages in Table 7-5. It is expected that about N$155.8 million should be spent in the local area. A further N$26.2 million is expected to be spent in the other parts of Oshikoto; N$127.4 million in the remaining parts of Namibia and a further N$413.5 million is projected to be spent on imports.

### TABLE 7-6: CONSTRUCTION PHASE EXPENDITURE PER GEOGRAPHIC AREA

<table>
<thead>
<tr>
<th>Expenditure category</th>
<th>Spend on suppliers in the local municipal area (ie Tsumeb) (N$ million)</th>
<th>Spend on suppliers in the rest of Oshikoto (N$ million)</th>
<th>Spend on suppliers in the rest of Namibia (N$ million)</th>
<th>Spend on direct imports (N$ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civils, structural</td>
<td>31.6</td>
<td>7.9</td>
<td>45.5</td>
<td>-</td>
</tr>
<tr>
<td>Machinery and equipment</td>
<td>32.8</td>
<td>10.9</td>
<td>26.2</td>
<td>244.1</td>
</tr>
<tr>
<td>Electrical and instrumentation</td>
<td>10.9</td>
<td>3.6</td>
<td>29.2</td>
<td>25.2</td>
</tr>
<tr>
<td>Indirects</td>
<td>80.6</td>
<td>3.8</td>
<td>26.5</td>
<td>144.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>155.8</strong></td>
<td><strong>26.2</strong></td>
<td><strong>127.4</strong></td>
<td><strong>413.5</strong></td>
</tr>
</tbody>
</table>
Employment and incomes during construction

As set out in Section 5.4.9, it is estimated that a total of 185 person-years of direct temporary employment would be generated during the one and a half year construction period.

Another way to quantify the positive impacts resulting from construction phase employment is to consider the salaries which would be paid to employees. Table 7-7 shows the estimate that just over N$53 million would be paid as salaries during construction based on likely salary averages. The divisions between the various skill levels are also shown.

<table>
<thead>
<tr>
<th>Skill Level</th>
<th>Total Salaries (N$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low skill</td>
<td>2 782 000</td>
</tr>
<tr>
<td>Medium skill</td>
<td>24 815 000</td>
</tr>
<tr>
<td>High skill</td>
<td>25 543 000</td>
</tr>
<tr>
<td>Total</td>
<td>53 140 000</td>
</tr>
</tbody>
</table>

In addition to the above direct employment and associated income opportunities, a significant number of temporary indirect and induced opportunities would be associated with the project. These would stem primarily from expenditure by the applicant in the local area and region as well as expenditure by workers hired for the construction phase.

7.6.2.1 Assessment of impact

Severity

The construction phase of the project would create a number of temporary direct and indirect employment opportunities and related expenditure within the local, regional and national economy.

Based on the above analysis, the severity of the potential impact is considered low positive in both the unmitigated and mitigated scenarios.

Duration

The duration of these positive impacts is considered low as it would be limited to the construction period of between one and a half and two years.

Spatial scale

Impacts would primarily be experienced at the local to national scale, although the local spend on construction will generate the most significant economic benefits for the town of Tsumeb. The spatial scale is considered medium.

Consequence

Based on the above assessment, the consequence of the positive economic impacts during the construction phase is low.

Probability
The probability of these impacts occurring is medium for the unmitigated and high for the mitigated scenario.

**Significance**

The overall significance is rated as low to medium for both the unmitigated and mitigated scenarios. SLR’s confidence level is high for this significance rating.

**Tabulated summary of the assessed impact – project expenditure: construction**

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>L+</td>
<td>L</td>
<td>M</td>
<td>L+</td>
<td>H</td>
<td>L-M+</td>
</tr>
<tr>
<td>Mitigated</td>
<td>L+</td>
<td>L</td>
<td>M</td>
<td>L+</td>
<td>H</td>
<td>L-M+</td>
</tr>
</tbody>
</table>

### 7.6.2.2 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Consolidated ESMP in Appendix K.

**Objective**

To maximise benefits to the local and previously disadvantaged population.

**Actions to enhance the positive impacts**

- Set targets for how much local labour should be used.
- Maximize opportunities for the training of unskilled and skilled workers from local communities.
- Utilise local sub-contractors where possible.
- Ensure that contractors that tender for work from outside the local area meet targets for how many local employees are appointed.
- Explore ways to enhance local community benefits with a focus on well-conceived projects that are clearly aligned with local needs and acceptable to the municipality.
- In consultation with the Tsumeb Municipality, develop a database of local companies, specifically Small Medium and Micro Enterprises (SMME’s), which qualify as potential service providers (e.g. construction, catering, waste collection and security companies). Notify these companies of tender processes for contracts at the smelter.
- Undertake ongoing clear and transparent stakeholder engagement in order to address perceptions of high employment numbers for non-Tsumeb residents and to manage expectations that the proposed expansion project would create more direct job opportunities.

Additional enhancement measures are detailed in the Consolidated ESMP in Appendix K.

**Emergency situations**

None identified.
7.6.3 Issue: Impacts Associated with Project Expenditure: Operational Phase

Similar to the construction phase of the project, the operational phase would result in spending injections that would lead to increased economic activity.

Indirect economic impacts are an important aspect of the proposed project’s overall impact, as it will have limited direct impacts during the operational phase. Indirect impacts were thus assessed in detail, focusing on first round indirect impacts based on primary data from suppliers and thereby avoiding multiplier analysis and its associated uncertainties. Other unquantified indirect and induced impacts were also borne in mind by the economic specialist.

The expansion will basically entail a substantial increase in the plant’s capacity to treat copper concentrate, leading to an increase in production as outlined in Section 5. The key operational phase impacts associated with the project would flow from increased expenditure on operations at the plant following the expansion. Once the full expanded production has been reached (370,000 tpa), total operational expenditure associated with the plant should be approximately N$1.577 billion per annum in 2016 terms, up approximately N$288 million from the N$1.289 billion budgeted for 2017.

Aside from the amounts involved, the nature of this expenditure will play a key role in determining impacts. For example, while there would be increased expenditure on key suppliers, the expansion would not require the hiring of new staff. In the following sections, current levels of employment and supplier expenditure at the plant are outlined in order to provide context after which the impacts of the expansion are assessed with a focus on first round indirect employment impacts.

The expansion will not require that additional staff be hired at the plant. There is an exception in the case of contractors, in that two additional staff will be required for refactory and mechanical maintenance. Additional direct employment due to the expansion would be limited to these two contractors.

The bulk of additional employment resulting from the expansion would result from indirect job opportunities. These would stem primarily from increased expenditure by DPMT in the local area and region, predominantly on the following items described in more detail below:

- Electricity
- Transport and handling services
- Engineering services
- Local municipal services

Electricity is currently supplied directly to DPMT by NamPower and would need to increase for the expansion. Due to the economies of scale associated with electricity provision, increased employment would be minimal despite the substantial increase in expenditure on electricity.
DPMT relies on companies such as Grindrod for handling and storage of concentrate at the Walvis Bay port bulk terminal. The company employs 26 staff and it was determined that Grindrod currently relies on DPMT for a substantial portion of its turnover. It will be a key beneficiary from the expansion due to increased volumes through the part of the port which it manages.

Engineering and maintenance services are primarily provided to DPMT by a few companies located in Tsumeb and Windhoek. Quant is, for example, a significant supplier of such services and it employs a total of 181 employees. It was estimated that over half of Quant’s turnover comes from DPMT. It is also likely that Quant and other engineering and maintenance suppliers will receive moderately larger amounts of work from DPMT if the expansion goes ahead.

DPMT relies on the municipality primarily for the provision of potable water. The municipality currently generates about N$2.7 million per year from water sales to DPMT, and this will likely increase by about 20% with the finalization of the expansion. As with electricity, this would provide financial benefits, but is unlikely to result in additional jobs due to economies of scale.

In order to get an adequate indication of additional indirect employment at DPMT’s suppliers as a result of the expenditure increases outlined above, DPMT’s supplier database was used to obtain expenditure on suppliers, categorised according to the degree to which they rely on DPMT for their business turnover. Data were also obtained on the number of employees working at these suppliers. A roughly direct relationship between turnover and employment was then assumed in order to estimate the number of jobs at all local suppliers reliant on DPMT business. For example, if a supplier has 20 employees, and that supplier is reliant on DPMT for 50% of their turnover, then DPMT was assumed to support roughly 10 jobs. Each supplier was then analysed to determine the extent to which they would experience increased demand resulting from the expansion. The results are presented in Table 7-8. The table shows that DPMT currently indirectly supports between 337 and 510 jobs at its suppliers. Between 16 and 32 first round indirect jobs are likely to be generated by the expansion, of which between 7 and 14 jobs are likely to be created in Tsumeb, with the remainder split between Walvis Bay and Windhoek.

The income associated with the above indirect first round jobs can be estimated by considering a likely average income for each of the additional employees. Assuming that the average additional employee earns N$250 000 per annum, we can estimate that the total additional income associated with the above jobs in Namibia is between N$4 million and N$8 million. For Tsumeb the additional income was estimated to be between N$1.7 million and N$3.5 million.

Note that the estimates above take into consideration the ‘first round’ of expenditure on DPMT’s suppliers thereby capturing a significant portion of total eventual impacts which would include indirect and induced impacts from subsequent rounds of spending (i.e. supplier that benefit from first round expenditure would, in
turn, spend on their suppliers and so on). Impacts from subsequent rounds of spending were not quantified, but their likely magnitude was taken into consideration when impact significance ratings were determined.

TABLE 7-8: INDIRECT FIRST ROUND EMPLOYMENT DURING THE OPERATIONAL PHASE

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>After upgrade</th>
<th>Additional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect jobs supported in Tsumeb</td>
<td>86 - 138</td>
<td>93 - 152</td>
<td>7 - 14</td>
</tr>
<tr>
<td>Indirect jobs supported in Walvis Bay</td>
<td>28 - 42</td>
<td>32 - 49</td>
<td>4 - 7</td>
</tr>
<tr>
<td>Indirect jobs supported in the rest of Namibia</td>
<td>220 - 322</td>
<td>224 - 333</td>
<td>5 - 11</td>
</tr>
<tr>
<td>Indirect jobs supported in other countries</td>
<td>3 - 8</td>
<td>3 - 8</td>
<td>0 - 0</td>
</tr>
<tr>
<td>Total</td>
<td>337 - 510</td>
<td>353 - 542</td>
<td>16 - 32</td>
</tr>
</tbody>
</table>

7.6.3.1 Assessment of impact

**Severity**

Based on the above, the severity of the positive impact associated with increased expenditure during the operational phase will be low without mitigation and low-medium with mitigation.

**Duration**

The duration would be for the life of the project and is thus considered as medium term.

**Spatial scale**

Impacts would be experienced on the local to national scale, although the local spend on operations will generate the most significant economic benefits for the town of Tsumeb. The rating is considered high with and without mitigation.

**Consequence**

Based on the above assessment, the determining positive consequence is low in the unmitigated scenario and medium in the mitigated scenario.

**Probability**

The probability of this impact occurring is high.

**Significance**

Summarising the above assessment, the overall significance is rated as low to medium positive in the unmitigated scenario and medium positive in the mitigated scenario. This assessment is based only on additional opportunities to be created.
**Tabulated summary of the assessed positive impact – operational phase expenditure**

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>L+</td>
<td>M</td>
<td>H</td>
<td>L+</td>
<td>H</td>
<td>L-M+</td>
</tr>
<tr>
<td>Mitigated</td>
<td>L-M+</td>
<td>M</td>
<td>H</td>
<td>M+</td>
<td>H</td>
<td>M+</td>
</tr>
</tbody>
</table>

When assessed as cumulative to current operational expenditure, the significance rating is increased to high positive.

**7.6.3.2 Conceptual description of mitigation measures**

Conceptual discussion of the mitigation measures is provided below and detailed in the Consolidated ESMP (Appendix K).

**Objective**

To maximise benefits to local and previously disadvantaged populations.

**Actions**

Actions are similar to those recommended for the construction phase in Section 7.6.2 and in the Consolidated ESMP in Appendix K.

**Emergency situations**

None identified.

**7.6.4 Issue: Increased Corporate Social Responsibility Expenditure**

Being the largest company in Tsumeb, DPMT is well positioned to support the surrounding community through its corporate social responsibility (CSR) programmes. DPMT’s CSR budget for 2016 was approximately N$12 million. Of this, N$7 million was allocated to spending on housing for company employees, while the remaining N$5 million was earmarked for spending on the Tsumeb Community Trust (N$3.75 million) and on other donations (N$1.24 million). Spending allocations within the Tsumeb Community Trust between 2010 and 2015 are set out in Table 7-9. Further details regarding the different spending allocations are provided in Appendix H.

**7.6.4.1 Assessment of impact**

**Severity**

In line with the increases in operational expenditure which will accompany the proposed expanded operations, there will also be changes in revenue and foreign exchange flows. On the basis of recently increased budget allocations to the Tsumeb Community Trust, the expectation is that there will also be an increase in the quantity of revenues which are directed to CSR spending. It is, however, difficult to ascertain the magnitude of this increase and how proportional it will be to increased revenue or profit.
Improvements in social wellbeing from CSR investment are predicted to increase in line with increased revenue generated by the plant. The severity is considered low to medium in both the unmitigated and mitigated cases.

**TABLE 7-9: SPENDING ALLOCATIONS WITHIN THE TSUMEB COMMUNITY TRUST, 2010 - 2015**

<table>
<thead>
<tr>
<th>Spending Area</th>
<th>Current target allocation of spending</th>
<th>Total spent between 2010 and 2015 (N$)</th>
<th>Actual allocation of spending</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>40%</td>
<td>4,470,000</td>
<td>44%</td>
</tr>
<tr>
<td>SME Development</td>
<td>30%</td>
<td>2,428,000</td>
<td>24%</td>
</tr>
<tr>
<td>Social Welfare</td>
<td>15%</td>
<td>1,497,000</td>
<td>15%</td>
</tr>
<tr>
<td>Environment</td>
<td>7.5%</td>
<td>639,000</td>
<td>6%</td>
</tr>
<tr>
<td>Arts, Culture</td>
<td>7.5%</td>
<td>347,000</td>
<td>3%</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>427,000</td>
<td>4%</td>
</tr>
<tr>
<td>Administration costs</td>
<td></td>
<td>332,000</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100%</td>
<td>10,140,000</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Duration**

The duration would be for the life of the project and is thus considered of medium term.

**Spatial scale**

The CSR investments target the local area specifically. The spatial scale is thus rated as low to medium.

**Consequence**

The consequence of these positive impacts is low to medium in both the unmitigated and mitigated cases.

**Probability**

The probability that CSR spending will increase in line with the increased revenue generated by the project is considered medium in both the unmitigated and mitigated cases.

**Significance**

Summarising the above assessment, the significance of these positive impacts is rated as low to medium without mitigation and medium with mitigation.

**Tabulated summary of the assessed positive impact of increased CSR spending**

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>L-M+</td>
<td>M</td>
<td>L-M</td>
<td>L-M+</td>
<td>M</td>
<td>L-M+</td>
</tr>
<tr>
<td>Mitigated</td>
<td>M+</td>
<td>M</td>
<td>L-M</td>
<td>M</td>
<td>M</td>
<td>M+</td>
</tr>
</tbody>
</table>

When assessed as cumulative to current CSR contributions, the significance rating is increased to high positive given the already significant contributions being made.
7.6.4.2 Conceptual description of mitigation measures

Objective
To maximise CSR spending in order to benefit the local and regional economy.

Actions
As the programmes invested in already aim to maximise DPMT’s contribution to the welfare of the local population, no specific enhancement measures are proposed. It is, however, suggested that the option of developing the Tsumeb Sports Club into a youth resource centre be investigated.

Emergency situations
None identified.

7.6.5 Issue: Macro-Economic Benefits
The scale of the proposed expansion and its export orientation should ensure that it makes a significant contribution in terms of macro-economic benefits

7.6.5.1 Assessment of impact
Severity
The key variable chosen for the measurement of these benefits is foreign exchange earnings bearing in mind that DPMT does not pay corporate tax due to its Export Processing Zone status.

Current and likely post-expansion foreign exchange earnings were calculated as shown in Table 7-10, based on information provided by DPMT. Foreign exchange earnings resulting from the expansion would average around US$66 million per year for copper blister and sulphuric acid exports. These would be in addition to current earnings of approximately US$140 million per year. Further details regarding the calculations of potential macro-economic benefits are provided in Appendix H.

Foreign exchange earnings are likely to have a strong positive impact on the economy. The severity of this impact is thus considered medium to high for both the unmitigated and mitigated cases.

Duration
The duration would be for the life of the project and is thus considered of medium term.

Spatial scale
Foreign exchange earnings will be used to fund operational expenditure and CSR investments and improve the country’s balance of payments, which will have both local and national impacts. The spatial scale is thus rated as high.
TABLE 7-10: THE RELATIONSHIP BETWEEN INPUTS, OUTPUTS AND FOREIGN EXCHANGE EARNINGS

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>Once expansion complete</th>
<th>Additional due to expansion once fully operational</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st year after construction (2019)</td>
<td>2nd year onwards (2020)</td>
<td></td>
</tr>
<tr>
<td>Inputs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imports of concentrate (tpa)</td>
<td>240,000</td>
<td>300,000</td>
<td>370,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>130,000</td>
</tr>
<tr>
<td>Outputs/production</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper blister</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Export volumes (tpa)</td>
<td>60,000</td>
<td>75,000</td>
<td>92,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>32,500</td>
</tr>
<tr>
<td>Net forex revenue (US$)</td>
<td>126,829,000</td>
<td>155,536,000</td>
<td>182,625,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>55,796,000</td>
</tr>
<tr>
<td>Sulphuric acid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of sulphur dioxide than can be sold</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Export volumes (tpa)</td>
<td>182,000</td>
<td>257,000</td>
<td>323,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>141,000</td>
</tr>
<tr>
<td>Revenue from exports (US$)</td>
<td>13,650,000</td>
<td>19,275,000</td>
<td>24,225,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10,575,000</td>
</tr>
<tr>
<td>Namibian sales volumes (tpa)</td>
<td>40,000</td>
<td>40,000</td>
<td>40,000</td>
</tr>
<tr>
<td>Revenue from local sales</td>
<td>4,211,000</td>
<td>4,211,000</td>
<td>4,211,000</td>
</tr>
</tbody>
</table>

Consequence

Based on the above assessment, the determining consequence is medium to high positive in both the unmitigated and mitigated cases.

Probability

The probability of the occurrence is high.

Significance

Given the levels of foreign exchange which would be generated as a result of the proposed expansion, but also considering the potential for some outflows, the significance of this positive impact is rated as medium to high.

Tabulated summary of the assessed positive impact related to macro-economic benefits

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>M-H+</td>
<td>M</td>
<td>H</td>
<td>M-H+</td>
<td>H</td>
<td>M-H+</td>
</tr>
<tr>
<td>Mitigated</td>
<td>M-H+</td>
<td>M</td>
<td>H</td>
<td>M-H+</td>
<td>H</td>
<td>M-H+</td>
</tr>
</tbody>
</table>

When assessed as cumulative to the significant foreign exchange earnings associated with existing DPMT operations, the significance rating is increased to high positive.

7.6.5.2 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Consolidated ESMP (Appendix K).

Objective

Ensure that Namibian suppliers of goods and services are favoured by DPMT where possible.

Actions
DPMT are to purchase from Namibian suppliers where possible.

**Emergency situations**

None identified.

### 7.6.6 Issue: Impact of Construction Workers on Local Communities

The presence of construction workers from outside of the area associated with large construction projects can impact on local communities, specifically for projects located in rural areas or small towns. While the presence of construction workers does not in itself constitute a social impact, the manner in which construction workers conduct themselves can impact on the local community. In this regard the most significant negative impact is associated with the disruption of existing family structures and social networks. This risk is linked to the potential behaviour of male construction workers, including:

- An increase in alcohol and drug use;
- An increase in crime levels;
- An increase in teenage and unwanted pregnancies;
- An increase in prostitution; and
- An increase in sexually transmitted diseases (STDs).

DPMT does have an Internal (Employee) Grievance Policy and Procedure (2017) in place for workers and contractors, as well as a “Receiving Suggestions, Opinions and Grievances Procedure” that outlines the process of receiving opinions, suggestions and grievances from the community. The DPMT Information Centre is available for the general public to submit grievances, and DPM has a “Speak Up” process which is available to internal and external parties. This process provides a direct connection to the Chair of the HSE and Audit Committee. DPMT is also in the process of revising their Stakeholder Relationship Management and Engagement Framework whereby local communities and other interested parties are informed of operations at the smelter and are invited to voice grievances.

### 7.6.6.1 Assessment of impact

**Severity**

As stated in Section 4.10.2, there has been a rapid increase in the population of Tsumeb in the last five years with a significant influx of people into the town. This influx is in line with general internal migration patterns in Namibia linked to movement from rural to urban areas. In addition, Tsumeb is the gateway to northern Namibia and Angola and large numbers of truck drivers and other road users pass through the town on a monthly basis. The presence of additional workers from outside the area over a period of 18-24 months is therefore unlikely to have a significant impact on the local community. The potential risk posed by construction workers from outside the area is therefore likely to be low.
While these impacts will be low at a community level, at an individual and family level they may be more significant, especially in the case of contracting an STD or an unplanned pregnancy.

Taking the above into consideration, the severity in both the unmitigated and mitigated scenarios is rated as low.

**Duration**
The duration of impacts would be limited to the construction phase and is thus considered as short term, resulting in a low rating.

**Spatial scale**
The spatial scale is medium as the impacts are local but beyond the site boundary.

**Consequence**
The consequence in both the unmitigated and mitigated scenarios is considered low.

**Probability**
The impact will be possible without mitigation and unlikely with mitigation, resulting in a medium rating for the unmitigated scenario and low rating for the mitigated scenario.

**Significance**
Summarising the above assessment and considering the higher severity of the impact to individuals in the unmitigated scenario, the significance of this potential impact is rated as medium without mitigation, reducing to low with mitigation.

**Tabulated summary of the assessed impacts of construction workers on local communities**

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Mitigated</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

7.6.6.2 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Consolidated ESMP (Appendix K).

**Objectives**
To minimise the impact of construction workers on the local communities.

**Actions**
Some of the specific actions include the following:

- Where possible, DPMT should make it a requirement for contractors to implement a ‘locals first’ policy for construction jobs, specifically for semi and low-skilled job categories;
Consider the establishment of a Monitoring Forum (MF) in order to monitor the construction phase and the implementation of the recommended mitigation measures. The MF should be established before the construction phase commences, and should include key stakeholders, including representatives from local communities, local councillors, and the contractor(s). The MF should also be briefed on the potential risks to the local community associated with construction workers;

- DPMT and the appointed contractor(s) should implement an HIV/AIDS awareness programme for all construction workers at the outset of the construction phase;
- The contractors should make the necessary arrangements for allowing workers from outside the area to return home over weekends and/or on a regular basis. This would reduce the risk posed to local family structures and social networks. DPMT should investigate how to contractually compel contractors to make the necessary arrangements; and
- The contractor must ensure that all construction workers from outside the area are transported back to their home towns within a day of their contracts ending. This will reduce the risk of construction workers remaining in the area once their contracts come to an end.

- Ensure the “Receiving Suggestions, Opinions and Grievances Procedure” is implemented for the project.
- Finalise and implement the DMPT Stakeholder Relationship Management and Engagement Framework.

Additional measures are detailed in the Consolidated ESMP in Appendix K.

**Emergency situations**

Stakeholders are best handled through a transparent Public Consultation and Disclosure Plan which is regularly reviewed to ensure stakeholders’ concerns and grievances are addressed promptly.

### 7.6.7 Issue: Impacts Associated with Storage and Transport of Concentrate from Walvis Bay

#### 7.6.7.1 Assessment of impact

Concentrate is offloaded at the Grindrod bulk handing facility at the Port of Walvis Bay from where it is transported to Tsumeb via road and rail. The key environmental concerns raised by the public and neighbouring businesses surrounding the Walvis Bay facility include wind-blown dust and, to a more limited extent, contaminated run-off.

The potential impacts associated with the transport of concentrate from the Port of Walvis Bay to Tsumeb are linked to safety issues posed by large trucks and dust. In terms of safety issues, the National Logistics Master Plan identifies Walvis Bay as a key component of the development of an Namibia as an International Logistics Hub. The plan also involves expanding the port and the volume of traffic through the port. The volume of heavy traffic along the road between Walvis Bay and Tsumeb is therefore likely to increase. This increase is also supported by the vision to establish Namibia as an International Logistics Hub. Therefore, while the increase in
in production will result in an increase in the volume of heavy trucks, this increase is inevitable and is supported by the vision to develop Namibia as a logistics hub. An increase in the volume of concentrate and product to be transported by rail would limit the additional numbers of trucks required for road transport. The use of rail will also reduce the damage to roads caused by heavily loaded vehicles.

As set out in Section 5.3.1, a number of environmental measures have been put in place in order to manage impacts at the Walvis Bay facility and it is being operated at the appropriate ISO standards.

Without mitigation, the potential negative environmental and health and safety impacts related to increased storage and transport could be rated as of medium severity.

**Duration**
The duration of these negative impacts is considered to be medium as it would persist for the duration of the project lifetime, but is deemed to be reversible.

**Spatial scale**
The spatial scale is considered as local to regional, as it is likely to affect current service providers in the Port of Walvis Bay and road users along the route to Tsumeb.

**Consequence**
The consequence is considered medium without mitigation and low with mitigation.

**Probability**
The probability of these impacts occurring is medium without mitigation, but low with mitigation.

**Significance**
Summarising the above assessment, the significance of the impacts is rated as medium without mitigation and low with mitigation.

**Tabulated summary of the assessed socio-economic impacts due to increased storage and transport from Walvis Bay**

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Mitigated</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

**7.6.8.2 Conceptual description of mitigation measures**

**Objectives**
The mitigation objective is to minimise the impacts associated with the storage and transport of concentrate and product between Tsumeb and Walvis Bay.
**Actions**

- Investigate alternative options for the storage of concentrate, e.g. loading concentrate into bags for storage and transport or other enclosed storage structures.
- Increase the percentage of concentrate to be transported by rail.

**Emergency situations**

DPMT has the required safety and emergency response plans in place for both road and rail transport between Walvis Bay and Tsumeb. DPMT must ensure that these plans are kept up to date and in line with any government road and rail safety initiatives.

**7.6.8 Issue: Smelter Decommissioning and Closure**

**7.6.8.1 Assessment of Impact**

Given the relatively high number of permanent employees (667) the potential impacts associated with potential future decommissioning and closure of the smelter would be significant. The major social impacts associated with the decommissioning phase are linked to the loss of jobs and associated income. This has implications for the households who are directly affected, the communities within which they live, and the relevant local authorities.

The impacts for the households who are directly affected by the retrenchment and loss of income associated with decommissioning include the inability to pay bills (such as household bonds, lights, water and property rates, buy food, pay school fees, etc.). Despite every effort to manage the decommissioning process, some employees who lose their jobs may feel that they let their families down. The resultant loss of self-esteem can cause depression, etc. Retrenchments can therefore have a significant impact on the directly affected households.

The impact on communities in which the people live can also be severely impacted upon by loss of jobs associated with decommissioning. The impacts may include increase in crime, alcohol and drug abuse, decreased economic activity, etc. Likewise, local authorities can also be severely affected by the loss of jobs associated with decommissioning. The impacts are linked to the inability of residents to pay bills, increased crime, alcohol and drug abuse, etc. All of these issues impact on the ability of the local authorities to provide a living environment that is conducive to the community’s well-being.

In the absence of an effective plan to manage the social and economic impacts associated with smelter closure and decommissioning the impacts will be significant. However, the potential impacts associated with the decommissioning phase can be effectively managed with the implementation of an effective and well planned retrenchment and downscaling programme. The current proposed project would extend the viability of the smelter and thus defer the ultimate negative impacts related to decommissioning and closure.
The severity of potential negative social impacts associated with a loss of employment due to decommissioning is rated as medium without mitigation and low with mitigation, assuming effective planning.

**Duration**

The duration of these negative impacts is considered to be low as it is deemed to be reversible.

**Spatial scale**

The spatial scale is considered as local to regional, as it is also likely to affect current service providers in the Port of Walvis Bay.

**Consequence**

The consequence of closure-induced negative economic impacts is considered low without and with mitigation.

**Probability**

The probability of these impacts occurring is high without mitigation, but low with mitigation.

**Significance**

Summarising the above assessment, the significance of the impacts is rated as medium without mitigation and low with mitigation.

**Tabulated summary of the assessed socio-economic impacts due to decommissioning and closure**

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Mitigated</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

**7.6.8.2 Conceptual description of mitigation measures**

**Objectives**

The mitigation objective is to minimise the impacts associated with job losses during decommissioning.

**Actions**

- Ensure that retrenchment packages are provided for all staff who stand to lose their jobs when the smelter is closed;
- Implement a skills training programme to equip employees with skills they can use when the smelter closes. The skills development programme should be designed to take into account current education and skills levels of employees. The skills training programme should be implemented from the outset of the operational phase and should be funded by DPMT;
- Provide employees with a basic financial management course to enable them to make informed decisions with regard to investing their earnings; and
- DPMT should ensure annually that its Asset Retirement Obligations are accurate and current in order to fund the revised Closure Plan objectives.
Emergency situations
Should DPMT any point decide to cease operations earlier and / or go into care and maintenance: employees, suppliers and all other key stakeholders should be informed promptly and given enough time to make financial adjustments.

7.7 COMMUNITY HEALTH

The information in this section was sourced from the community health assessment in Appendix I (Myers, 2016, updated in 2019). This section should be read with the air quality impact assessment findings (Section 7.4 and Appendix F). The potential impacts were considered as cumulative with the community health impacts being experienced, taking the current smelter operations as well as the proposed expansion into consideration.

Further community health impact studies and contaminated land assessments are currently underway in order to better understand the community health impact associated with DPMT’s operations. The recommendations/mitigation measures prescribed in these studies will be incorporated into the ESMP once they have been finalised,

7.7.1 Issue: Community Health Impacts Related to SO₂ and PM₁₀ Exposure

7.7.1.1 Assessment of impact

Taking into account the current health hazards, baseline community health status and exposure pathways as described in Section 4.15, no qualitatively new hazards are likely to be introduced as a result of the proposed increased production throughput at the smelter.

Severity

SO₂

Although a marked decrease in SO₂ emissions has been experienced after the installation of the sulphuric acid plant and other capital improvements at the smelter, exceedance of the EU and WHO 24-hour limit may still be experienced in the northern parts of Tsumeb (see Table 7-1 for relevant standards), causing a temporary irritant effect. Modelled air quality data for the proposed project scenario indicated exceedances of the EU standard (125 µg/m³) at the monitoring stations closest to the smelter (i.e. Plant Hill and Sewage Works), but not at the monitoring stations within Tsumeb (i.e. Info Centre and Sport Stadium). As DPM is an international company, the community health specialist also considered the stricter WHO standard (20 µg/m³) applicable to first world countries in his assessment. Significance ratings were, however, still comparable with the air quality assessment ratings for which the EU and interim WHO standard (125 µg/m³) was used. Linn et al. (1987) found that there was no irreversible adverse respiratory impact as measured by lung function on asthmatics and atopic individuals under conditions of exposure at least an order of magnitude higher than levels experienced in the Tsumeb area. These findings were also confirmed by the results of the respiratory health questionnaires.
completed by Tsumeb residents. The SO\textsubscript{2} exceedances, however, have an irritant effect on the respiratory system, causing a symptom burden for the receptor population, especially for those with asthma-related symptoms. While the level of exposure is not likely to cause a substantial symptom burden or irreversible effects, there is definitely a nuisance burden experienced by Tsumeb residents.

It was noted in the specialist assessment that capital improvements were not yet fully implemented during 2016 when the study was undertaken and that it can be assumed that when these improvements function optimally, they would result in further reduction in SO\textsubscript{2} exposures going forward. Improved ventilation extraction from new converters and new methods of slag cooling may be expected to bring about further future reductions in exposure. With the sulphuric acid plant functioning at its optimal design capacity, the appropriate use of hoods at the RHF and improved ventilation extraction, increasingly more efficient capture of SO\textsubscript{2} would be likely, notwithstanding any increase in the production throughput.

\textbf{PM\textsubscript{10} and PM\textsubscript{2.5}}

As set out in Section 4.15, the current burden of disease caused by PM\textsubscript{10} for Tsumeb residents is considered to be small (estimated as 2.5 days of life lost per individual). Simulation results of the air quality assessment showed that it is not expected that increased PM\textsubscript{10} emissions as a result of the expanded smelter operations would cause an exceedance of daily PM\textsubscript{10} EU standards (i.e. 50 µg/m\textsuperscript{3}) outside of the smelter footprint. Similarly, no exceedances of PM\textsubscript{2.5} monitoring criteria are expected outside of the smelter footprint. It is thus not expected that the proposed project would add cumulatively to the current burden of disease experienced from other PM\textsubscript{10} and PM\textsubscript{2.5} sources.

Based on the above, the severity of the impact largely relates to the upper and lower respiratory symptoms attributable to SO\textsubscript{2} exposures experienced in all areas of Tsumeb. The impact is assessed as cumulative to the current effects experienced by Tsumeb residents. The severity is rated as medium for both the unmitigated and mitigated scenarios.

\textbf{Duration}

Impacts of SO\textsubscript{2} exposure are considered to be irritative in nature and are thus short-lived and reversible over time. Duration is thus rated as low.

\textbf{Spatial scale}

Although the exposures are local to the Tsumeb area, it is considered relatively widespread beyond the smelter boundary and thus rated as medium without and with mitigation.

\textbf{Consequence}

Based on the above, the consequence is considered medium without mitigation and with mitigation.

\textbf{Probability}
The probability of these impacts occurring is high without mitigation, but low with mitigation.

**Significance**

Summarising the above assessment, the significance of the impacts is rated as medium without mitigation and low with mitigation.

**Tabulated summary of the community health impacts from SO$_2$ and PM$_{10}$ exposure**

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>M</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Mitigated</td>
<td>M</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

7.7.1.2 Conceptual description of mitigation measures

**Objectives**

The mitigation objective is to reduce the Tsumeb community’s exposure to SO$_2$ from the smelter operations in order to comply with the relevant air quality standards and limit irritation from SO$_2$ inhalation.

**Actions**

- Implement engineering solutions to better control fugitive emissions at all components of the smelter operations, particularly capturing emissions at the converters and from slow cooling of slag.
- Ensure monitoring stations are all functional for SO$_2$ and PM$_{10}$.

Also refer to air quality mitigation measures in Section 7.4 and the Consolidated ESMP in Appendix K.

**Emergency situations**

None identified.

7.7.2 Issue: Health Impacts of Arsenic Exposures to Tsumeb Communities

Similar to SO$_2$ exposures, no qualitatively new arsenic exposure pathways are likely to be introduced as a result of the proposed increased production throughput at the smelter.

When considering the latest emissions data together with results of the urine arsenic levels, elevated urine arsenic levels were found in Tsumeb when compared to unexposed control samples in Oshakati. The main findings of the community health investigation, however, showed that there did not seem to be a general systemic overexposure problem based on urine inorganic arsenic for Tsumeb residents as a whole. The geometric mean was actually found to be well below the most conservative international occupational hygiene standard of 35 µg/l (American Conference for Governmental Industrial Hygienists –ACGIH). The overall impacts on Tsumeb communities were thus estimated to be negligible.

Further detailed investigations were recommended for Ondundu in Town North, where mean arsenic levels
were significantly higher, and where there was a high proportion (18.9%) of outliers above the Namibian Biological Exposure Index for inorganic arsenic of 50 µg/g. As the results of the investigation showed that arsenic in PM$_{10}$ and in drinking water could not be responsible for the elevated urine arsenic levels in outlier samples from Ondundu, the most likely sources of arsenic exposure for this community are arsenic in dust from roadways and garden soil, arsenic in vegetables and fruit grown locally in Ondundu, and hand to mouth behaviour by both children and adults resulting in arsenic ingestion. Support for the soil exposure pathway was recently shown in preliminary soil sample results which identified areas with elevated arsenic levels linked to historic mining, exposed reefs and small scale mining activities in the surrounding area outside of the smelter boundary (see Figure 4-12).

The risk of additional lung cancer cases above baseline expectation due to environmental arsenic exposure is negligible for Tsumeb as a whole. This excludes Ondundu in Town North where the risk is considered to be low (further details regarding the calculations of cancer risk factors are provided in the community health assessment in Appendix I).

When considering the proposed increased throughput capacity, regression analysis of the throughput data and latest monitoring results of the Plant Hill monitoring station (immediately south of the hazardous waste disposal site) near Ondundu was undertaken. The results showed that there is no relationship between quantities of total concentrate processed at the smelter monthly and air quality, measured as arsenic in PM$_{10}$ at Plant Hill, or any of the other ambient air quality monitoring stations outside of the smelter complex. No significant increase in airborne arsenic exposures for residents might then be expected at the proposed increased throughput capacity. Alternative options for hazardous arsenic waste disposal are currently being investigated by DPMT, with investigations at an advanced stage. The closure and capping of the hazardous waste site once the approved capacity is reached would remove a further potential source of arsenic exposure for both the smelter employees and Tsumeb residents, particularly the closest residential areas at Ondundu. A recent boundary fence extension between the hazardous waste site and Ondundu (see Figure 4-12) further limits activities in areas where elevated arsenic levels in soil were recorded.

While the shutdown of the arsenic plant in February 2017 resulted in a reduction in arsenic exposure for employees at the plant, it also resulted in an increase in the volumes of arsenic waste to be disposed of at the hazardous waste disposal site. If not well managed, windblown arsenic-containing dust (albeit of a less concentrated form of arsenic) from the waste site could contribute to an increase in arsenic exposures which could potentially increase proportionately with an increase in the throughput capacity, as a worst case scenario. An independent audit of the hazardous waste site in 2017 showed that it was being operated at high standards and that it was not considered as a source of dust emissions at the time of the audit. Appropriate dust suppression measures, however, remain critical for arsenic containment.

It was noted in the specialist assessment that capital improvements were not yet fully implemented during
2016 and that it can be assumed that when these improvements function optimally, it would result in further reductions of arsenic exposure going forward.

**Severity**

For the community overall, the risk of lung cancer from arsenic exposure for both the unmitigated and mitigated scenarios are considered low. As the Ondundu area is a more highly exposed outlier, the overall risks of developing lung cancer from arsenic exposures are considered to be higher for this area. For Ondundu, the risk is considered medium for the unmitigated scenario and low for the mitigated scenario.

As the impact relates to the potential development of cancer, the severity of the arsenic-related impacts and increased cancer risk from the current operations and the proposed smelter expansion is considered as high.

**Duration**

The duration is rated as high for both the unmitigated and mitigated scenarios due to the impact of arsenic exposure potentially causing cancer.

**Spatial scale**

The assessment indicated that exposure beyond the smelter boundary for Tsumeb as a whole is rated as low (Tsumeb town area) to medium (Ondundu area) for the unmitigated and low for the mitigated scenarios.

**Consequence**

Based on the above, the consequence is considered high in both the unmitigated and mitigated scenarios.

**Probability**

It is considered unlikely that lung cancer would be developed from current and future exposures with the proposed smelter expansion for the unmitigated scenario for the Tsumeb town area. The probability is rated as low (for the overall town area) to medium (Ondundu area) in the unmitigated scenario and low in the mitigated scenario.

**Significance**

Summarising the above assessment, the significance of the impact for Tsumeb as a whole is rated as low (overall town area) to medium (Ondundu area) in the unmitigated and low in the mitigated scenario.

**Tabulated summary of the community health impacts from increased cancer risk due to arsenic exposure for Tsumeb as a whole**

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>H</td>
<td>H</td>
<td>L-M</td>
<td>H</td>
<td>L-M</td>
<td>L-M</td>
</tr>
<tr>
<td>Mitigated</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

**7.7.2.1 Conceptual description of mitigation measures**

**Objectives**
The mitigation objective is to minimise the community’s exposure to smelter inorganic arsenic as far as possible in order to comply with WHO limits.

**Actions**

- Closure of the arsenic plant (closed at the end of February 2017).
- Improved control of all fugitive emissions from the smelter.
- Future closure and covering of the hazardous waste disposal site after the permitted volume is utilised.
- Ensure that all devices at the ambient air monitoring stations are maintained in a functional state and rapidly repaired when necessary.
- Adapt the air quality monitoring stations to additionally test for the PM$_{2.5}$ parameter (already completed).
- Undertake further investigations to determine arsenic levels in soil and vegetables/fruit and the effect of hand to mouth behaviours, along with further comparing Ondundu and control areas within and outside of Tsumeb. Should soil and home grown food arsenic levels be high, initial prohibition of growing home crops and removal of the topsoil layer should be considered. These additional investigations should inform further actions, which may include an exclusion zone being negotiated around the smelter. This follow-up community health monitoring commenced in the fourth quarter of 2018.
- Further to the consideration of an exclusion zone, the Tsumeb Municipality would need to be consulted with regards to future land use planning for the residential and farming areas closest to the smelter property. In this regard, proposed plans for a large vegetable garden in the Ondundu area and possible relocation of Soweto residents to Ondundu should be reconsidered until the levels of arsenic and other chemicals of concern (e.g. lead) and the related potential risks can be confirmed through further soil investigations (The municipality is currently awaiting further results of the ongoing contaminated land assessment and related soil sampling before continuing with the planned vegetable garden).
- Undertake more urine arsenic sampling in the most affected and other under sampled areas within Tsumeb along with unexposed controls and set up a programme for ongoing periodic monitoring (this process commenced in the fourth quarter of 2018 and results are currently being analysed).
- Based on the results of the further recommended investigations, an action plan to address arsenic exposures will be developed.
- Include a specific component in the Stakeholder Engagement Plan for addressing uncertainties regarding the health implications from arsenic exposure in a simple and understandable format.

Also refer to air quality mitigation measures in Section 7.4 and the Consolidated ESMP in Appendix K.

**Emergency situations**

None identified.
### 7.7.3 Issue: Health Impacts of Arsenic Exposures to DPMT Employees

The assessment of occupational health impacts do not as a rule form part of an ESIA process as occupational health is not dealt with in terms of environmental legislation. To address concerns raised by unions and other I&APs during the scoping phase and to align with EBRD’s Performance Requirements, occupational health concerns were also addressed as part of an appendix to the community health assessment. This study component included a review of the use of personal protective equipment (PPE) by employees and assessed the likelihood of an increased cancer risk to employees from the proposed increased throughput capacity. Further details regarding the PPE review and occupational health hazards are provided in Appendix 5 of the community health assessment (see Appendix I). The likely impact on cancer risk to smelter employees is assessed below. This section is, however, only provided for information purposes, as the overall assessment focusses on third party impacts.

**Severity**

When assessing the relative risks for lung cancer, standards from the Agency for Toxic Substances and Disease Registry (ATSDR) as set out in Table 7-12 were considered.

#### TABLE 7-12: RELATIVE RISKS FOR LUNG CANCER (ATSDR)

<table>
<thead>
<tr>
<th>Risk</th>
<th>Average arsenic air concentrations relative to risk increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>$0.05 - 0.30 \text{mg/m}^3 = 2 \times \text{the risk}$</td>
</tr>
<tr>
<td>Medium</td>
<td>$0.30 - 0.60 \text{mg/m}^3 = 3 \times \text{the risk}$</td>
</tr>
<tr>
<td>High</td>
<td>$1.5 - 3.0 \text{mg/m}^3 = 3.5 \times \text{the risk}$</td>
</tr>
<tr>
<td>Very High</td>
<td>$5.0 \text{mg/m}^3 = 7 \times \text{the risk}$</td>
</tr>
</tbody>
</table>

Based on occupational hygiene exposure measurements, average airborne exposure levels are in the range of 0.01 to 0.60 mg/m$^3$ for the different business units of the smelter precinct. Average levels in the different business units range from the lowest at 0.01 mg/m$^3$ in the administration building to the highest at 0.6 mg/m$^3$ in the arsenic plant. The corresponding cancer risks shown in Table 7-8 are multiples of the baseline (or no excess risk) and range between 1 x (no additional risk), through 2 x (low additional risk) and 3 x baseline (Medium risk) according to the ATSDR.

Biomonitoring of employees for urine arsenic content is undertaken regularly by DPMT. From the biomonitoring results at the smelter, for the plant as a whole the average total arsenic in urine was 74µg/g in 2016. For highly exposed groups the total arsenic in the urine is virtually all inorganic and thus toxicologically relevant and deemed to be related to smelter operations. Assuming this to be the case the urine arsenic levels can be calculated (using an ACGIH equation) as yielding a corresponding average air concentration of 0.25 mg/m$^3$, and the associated risk according to the ATSDR is considered to be low (2 x baseline). Considering the above standards, and the fact that PPE and some engineering controls do not
seem to be working, there is an appreciable occupational lung cancer risk on average for the plant as a whole; more in some business units than in others, depending upon the average air concentration in those units.

The corresponding risks as per Table 7-8 are mostly 2 to 3 times the expected background risk for lung cancer at these levels of exposure and thus deemed as a low to medium risk.

In order to assess the potential increase in arsenic exposures and related cancer risk for employees due to the proposed increased throughput capacity, a regression modelling exercise was undertaken using monthly quantities of total concentrate throughput going back to 2011, urine arsenic data from smelter employees going back to 2011, as well as air quality arsenic data from the five DPMT ambient air quality monitoring stations going back to 2012 (refer to Section 14.2 of the community health assessment for details on the methodology). Considering the results for the individual business units for 2016 data only, three showed slight increases in urinary arsenic linked to increased concentrate throughput. These were the arsenic plant (which has since been closed), materials handling, and other (a small miscellaneous group of smelter employees roving about the smelter). For all the other business units the urine arsenic decreased slightly with increased throughput capacity. This result is likely due to the new capital improvements that have already been put in place and having an increasing effect in 2016 as a result of fixing teething problems with the new systems. Further improvements were evident in 2017 and 2018 data, but a few spikes in urine arsenic levels were still occasionally experienced.

Consequently, analysis of the data shows that, if continued improvement is maintained, there is little likelihood of increased exposure (increased urinary arsenic levels) going forward as part of the proposed increased throughput capacity. There is an overall inverse relationship in which urine arsenic levels will decline slightly in the smelter with increased throughput. With the closure of the arsenic plant and as the capital improvements are completed in the near future and point of emissions are better controlled, urinary arsenic levels will decline further. Attention will, however, need to be directed particularly towards the materials handling business unit and to roving employees, and any other urinary arsenic spikes that are observed going forward.

As the principal health risk is arsenic-related cancer, the severity is deemed to be high without and with mitigation.

**Duration**

The duration is rated as high for both the unmitigated and mitigated scenario due to the impact of arsenic exposure potentially causing cancer.

**Spatial scale**

The spatial scale is considered to be local and thus rated as low for both the unmitigated mitigated scenarios.

**Consequence**

Based on the above, the consequence is considered high without mitigation and with mitigation.
Probability

The current baseline cancer risk is raised by twice the background risk for the smelter as a whole and three times for the arsenic plant (which has since been closed). Probability is thus rated as medium in the unmitigated scenario, but low in the mitigated scenario.

Significance

Summarising the above assessment, the significance of the impact is rated as high in the unmitigated scenario, but reduces to low to medium, assuming that mitigation measures are implemented successfully.

Tabulated summary of the occupational health impacts from increased cancer risk due to arsenic exposure

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Severity</th>
<th>Duration</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability of Occurrence</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmitigated</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>Mitigated</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>L-M</td>
</tr>
</tbody>
</table>

7.7.3.1 Conceptual description of mitigation measures

Objectives

The mitigation objective is to reduce the workforce’s exposure to smelter inorganic arsenic to within acceptable occupational exposure limits.

Actions

- Closure of the arsenic plant (closed at the end of February 2017).
- Improved control of fugitive emissions from slow cooling of slag, potentially enclosing cooling areas.
- Improved control of fugitive emissions at the converters by ensuring that hoods are in place with ventilation extraction when pouring.
- Strengthen the industrial hygiene programme with more emphasis on industrial hygiene led exposure control rather than biomonitoring.
- There should be more emphasis on reducing arsenic exposure pathways and less reliance on PPE.
- Continue to implement job rotations, but at lower arsenic cut-off value.
- Improve safe work practices with an overall goal of moving the smelter towards good international practice.

Also refer to air quality mitigation measures in Section 7.4 and the Consolidated ESMP in Appendix K.

Emergency situations

None identified.

7.7.4 Issue: Impacts associated with other Environmental health Areas

The results of the Health Impact Assessment (Appendix I) associated with other Environmental Health Areas
(EHAs) are summarised in the table below. The project related mitigation measures are provided in the Consolidated ESMP in Appendix K.

**Tabulated summary of the assessment of the other Environmental Health Areas (as per the HIA)**

<table>
<thead>
<tr>
<th>Environmental Health Area</th>
<th>Consequence</th>
<th>Likelihood</th>
<th>Overall Risk Matrix Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>EHA #1: Housing and Respiratory Issues</td>
<td>High</td>
<td>Possible</td>
<td>High</td>
</tr>
<tr>
<td>EHA #2: Vector-Related Diseases</td>
<td>High</td>
<td>Unlikely</td>
<td>Minor</td>
</tr>
<tr>
<td>EHA #3: Sexually Transmitted Infections</td>
<td>Moderate</td>
<td>Likely</td>
<td>High</td>
</tr>
<tr>
<td>EHA #4: Soil, Water, Sanitation and Waste Related Diseases</td>
<td>Moderate</td>
<td>Likely</td>
<td>High</td>
</tr>
<tr>
<td>EHA #5: Food and Nutrition Related Issues</td>
<td>Moderate</td>
<td>Possible</td>
<td>High</td>
</tr>
<tr>
<td>EHA #6: Injury burden (intentional and unintentional)</td>
<td>Moderate</td>
<td>Likely</td>
<td>Moderate</td>
</tr>
<tr>
<td>EHA #7: Exposure to Potentially Hazardous Materials (Arsenic)</td>
<td>Moderate</td>
<td>Possible</td>
<td>Moderate</td>
</tr>
<tr>
<td>EHA #7: Exposure to Potentially Hazardous Materials (SO₂)</td>
<td>Minor</td>
<td>Certain</td>
<td>Low</td>
</tr>
<tr>
<td>EHA #8: Social Determinants of Health</td>
<td>Low</td>
<td>Likely</td>
<td>Moderate</td>
</tr>
<tr>
<td>EHA #9: Cultural Health Practices</td>
<td>Insignificant</td>
<td>Unlikely</td>
<td>Minor</td>
</tr>
<tr>
<td>EHA #10: Health Services Infrastructure/Capacity - Programme Management Delivery System</td>
<td>Low</td>
<td>Possible</td>
<td>Low</td>
</tr>
<tr>
<td>EHA #11: Non-Communicable Diseases</td>
<td>Moderate</td>
<td>Certain</td>
<td>High</td>
</tr>
<tr>
<td>EHA #12: Zoonotic Diseases</td>
<td>Low</td>
<td>Rare</td>
<td>Minor</td>
</tr>
</tbody>
</table>

**7.8 NO-GO OPTION**

Potential impacts relating to the no-go option of not implementing the proposed expansion project would largely relate to socio-economic aspects.

The no-go option would maintain the status quo in terms of operational expenditure, CSR investment and foreign exchange benefits, at best. At worst, the continued financial viability of the plant and the benefits associated with current operations may be put at risk. The proposed expansion is one of the later phases of an overall optimisation and expansion project which to date has required substantial investment. Recovering the costs of this investment would be significantly more challenging should the proposed expansion not go ahead.

When considering the current operational expenditure, CSR investment and foreign exchange benefits related to the Tsumeb smelter operations, the benefits are rated as of medium positive significance. Should the expansion not be fully realised, it is expected that the current socio-economic benefits would continue to be felt on a local, regional and national scale, with the significance of these benefits remaining at medium positive. The opportunity to increase the current significance of benefits to high positive would, however, not be realised.

With regards to other environmental impacts, the no-go option should not lead to any significant changes or increases from the status quo. This, however, assumes that a long term solution for the disposal of hazardous waste is implemented, that general waste and effluent management for current operations are addressed in
8 KEY ASSUMPTIONS, UNCERTAINTIES AND LIMITATIONS

Assumptions, uncertainties and limitations relating to each of the environmental aspects are presented in detail in the various specialist studies (Appendices D to I) and will not be repeated in this report. Some general assumptions are described below.

8.1 ENVIRONMENTAL ASSESSMENT LIMIT

The ESIA does not cover an assessment of the alternative solutions for hazardous waste disposal or the addition of a waste incinerator for general waste. These aspects are mentioned in the ESIA, but no final decisions have been made on the appropriate solutions. Once a decision is made in this regard, the impacts will be addressed in a separate EIA.

The assessment of occupational health impacts do not as a rule form part of an ESIA process as occupational health is not dealt with in terms of environmental legislation. As concerns were, however, raised by unions and other I&APs during the scoping phase, occupational health concerns were also addressed as part of the community health assessment. As the ESIA focuses on third party impacts, the assessment of the potential increase in cancer risk to employees within the smelter was only included for information purposes in the impact assessment section of this EIR. In assessing health risks to employees from the proposed expansion project, the SLR impact significance rating scale was used. It must, however, be noted that the SLR assessment methodology and significance rating scale have been developed for third party environmental impacts and do not normally apply to occupational health issues.

8.2 PREDICTIVE MODELS IN GENERAL

All predictive models are only as accurate as the input data provided to the modellers. If any of the input data is found to be inaccurate or is not applicable because of project design changes that occur over time, then the model predictions will be less accurate.

It must be noted that air emissions modelling largely focussed on the latest data from 2016 after substantial capital investments in 2015. These investments included, amongst others, the commissioning of the sulphuric acid plant and addition of new converters and hoods to manage SO₂ and other fugitive emissions. These improvements resulted in a significant reduction in pollutant emissions from the smelter operations, with early positive monitoring results recorded. Some teething problems were still experienced in 2016, with exceedances of air emission standards still recorded off-site. It would’ve been preferable to base modelling exercises on a longer monitoring time period with the new project components (i.e. sulphuric acid plant and converter hoods) functioning optimally. The current ESIA timeframe, however, did not allow for longer
monitoring periods.

9 ENVIRONMENTAL IMPACT STATEMENT AND CONCLUSIONS

Based on the findings of this ESIA, it is not expected that the proposed increased throughput capacity of the DPMT smelter would have a significant contribution to current negative operational impacts. With the implementation of the proposed mitigation measures and further optimising of the already implemented engineering solutions for the management of air emissions, it is expected that cumulative negative impacts related to smelter operations would be reduced to acceptably lower levels.

A tabulated summary of the potential impacts is presented in Table 9-1 below. As can be seen from the table below, the impacts associated with the project vary from high positive to high negative without mitigation.

DPMT shall implement the management and mitigation measures as set out in the ESMP (Appendix K).

The key areas of concern centred on air quality, community health and groundwater. Key findings in this regard are set out below:

Air Quality:

- Continuous improvement in ambient air quality has been recorded for all measured parameters since 2012;
- With the implementation of the recommended mitigation measures for utilisation of the sulphuric acid plant and management of fugitive emissions, the proposed expansion project should not lead to any significant increases in emissions experienced within Tsumeb;

Community Health:

- Since the installation of the Sulphuric Acid Plant, residential areas in Tsumeb rarely experience exceedances of the World Health Organisation (WHO) daily limits for SO₂. Short-term exceedances of the hourly limits are, however, still being experienced in the northern parts of the town which can cause temporary mild upper respiratory symptoms of cough and throat irritation.
- For the expansion project, exceedances of the hourly criteria for SO₂ might still be experienced in the northernmost parts of Tsumeb during upset plant conditions, leading to temporary respiratory irritation.
- Elevated urine arsenic levels recorded for residents closest to the smelter site were found not to be attributable to arsenic in air from smelter operations, and were more likely as a result of behavioural exposures linked to soil from historic sources, hand-to-mouth and eating wild harvested plants.

Groundwater:

- Groundwater quality on and beyond the site boundary is related to historic impacts of mining and
processing activities on the site prior to the establishment of DPMT’s current smelter operations.

- It is not expected that the proposed expansion project would lead to any measurable cumulative contribution to current groundwater quality impacts.
- A conservative update of the current groundwater model indicated that contaminated groundwater may be moving in a north-easterly direction to outside of the smelter boundary, but due to the geological formations present providing a groundwater barrier, it is not expected that contaminated groundwater would reach the irrigation farms to the north of the smelter complex.

With regards to the potential benefits of the proposed expansion project, the positive cumulative impacts related to socio-economic aspects (i.e. direct construction and operational project expenditure, indirect business opportunities, CSR contributions and macro-economic benefits) were all rated as of high significance after mitigation.

It must be noted that there are currently significant contamination levels on the smelter property and surrounds due to historic mining and smelter operations and legacy waste stockpiles. Although it is acknowledged that the current DPMT smelter operations, since DPMT purchased the facility in 2010, have contributed to and continue to contribute to the overall contamination load, the majority of the measured contamination levels and related impacts (i.e. groundwater and to some extent community health) are attributable to historic operations. The ongoing Contaminated Land Assessment will aim to quantify the historic and current contributions. DPMT will continue to support the Tsumeb Municipality in finding ways to address legacy impacts outside of the smelter boundary. It is, however, suggested that MET instruct the owner of the old mine infrastructure and land surrounding Ondundu to become involved in addressing these matters.

The following key aspects with regards to current and future operations are to be addressed as a matter of priority by DPMT:

- Ensure that the sulphuric acid plant and other recent engineering interventions (e.g. hoods) are operating at optimal design levels in order to control SO₂ and other fugitive dust emissions;
- Improve waste management practices through the establishment of a formalised general landfill site within the smelter footprint;
- A final solution for the disposal of hazardous waste well in advance of the onsite hazardous waste disposal site reaching its full design capacity. The following alternatives should be further considered and a final decision made as soon as reasonably possible:
  - Disposal to a potential future regional site in Namibia;
  - Transport of waste to a suitable hazardous waste site in South Africa;
  - Vitrification of flue dust which would render arsenic wastes non-hazardous and saleable; or
  - A combination of the above options.
• Completion of the contaminated land assessment and further detailed investigations into arsenic exposure pathways in order to inform priority actions to be taken with regards to remediation; and
• Completion of studies into the options for groundwater treatment.

**TABLE 9-1: SUMMARY OF POTENTIAL IMPACTS ASSOCIATED WITH THE PROPOSED UPGRADE AND OPTIMISATION PROJECT**

<table>
<thead>
<tr>
<th>Section</th>
<th>Potential impact</th>
<th>Significance of the impact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(the ratings are negative unless otherwise specified)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unmitigated</td>
</tr>
<tr>
<td>Surface water</td>
<td>Changes in surface water runoff</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>Surface water pollution</td>
<td>M</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Groundwater quantity</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Groundwater quality</td>
<td>H</td>
</tr>
<tr>
<td>Air quality</td>
<td>Cumulative air pollution impacts</td>
<td>M</td>
</tr>
<tr>
<td>Noise</td>
<td>Cumulative noise pollution impacts</td>
<td>L</td>
</tr>
<tr>
<td>Socio-economic impacts</td>
<td>Construction phase project expenditure, including employment and downstream business opportunities</td>
<td>L-M'</td>
</tr>
<tr>
<td></td>
<td>Employment phase project expenditure, mainly related to indirect employment opportunities</td>
<td>L-M'</td>
</tr>
<tr>
<td></td>
<td>Increased Corporate Social Responsibility expenditure</td>
<td>L-M'</td>
</tr>
<tr>
<td></td>
<td>Macro-economic benefits</td>
<td>M-H'</td>
</tr>
<tr>
<td></td>
<td>Impact of construction workers on local communities</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Impacts of increased storage and transport</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Smelter decommissioning and closure</td>
<td>M</td>
</tr>
<tr>
<td>Community health impacts</td>
<td>Community health impacts related to SO₂ and PM₁₀ exposure</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Community health impacts of arsenic exposures to Tsumeb communities</td>
<td>L-M</td>
</tr>
<tr>
<td></td>
<td>Health impacts of arsenic exposures to DPMT employees</td>
<td>H</td>
</tr>
</tbody>
</table>
10 REFERENCES


Airshed. 2017. Air Quality Impact Study for the proposed Expansion Project DPM Tsumeb Smelter, January 2017


GCS Water and Environmental Consultants 2016: Tsumeb Smelter Groundwater Model Update, March 2016, Report 1


Dundee Precious Metals - Tsumeb Smelter


SLR. 2014b. Scoping Report (including impact assessment) for the proposed 11kV power Line for Dundee precious Metals.


SLR. 2016a. Groundwater and Surface Water Study for Dundee Smelter Expansion Project EIA.


Synergistics. 2013. General Waste Landfill Site


AFRICAN OFFICES

South Africa

CAPE TOWN
T: +27 21 461 1118

FOURWAYS
T: +27 11 467 0945

SOMERSET WEST
T: +27 21 851 3348

Namibia

WINDHOEK
T: +264 61 231 287