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# ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

## APP: 005046


# FOR THE PROPOSED MULTI-METAL RECYCLING (MMR) PROJECT, SINOMINE TSUMEB SMELTER, TSUMEB

**Sinomine Tsumeb Smelter (Pty) Ltd**

14 February 2025

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| DOCUMENT INFORMATION | | |
|---|---|---|
| **Title** | Environmental and Social Impact Assessment (ESIA) for the proposed **Multi-Metal Recycling (MMR)** Project at Sinomine Tsumeb Smelter, Oshikoto Region | |
| **ECC Application number** | **APP- 005046** | |
| **Listed Activities (EIA Regulations, GN: 30 of 2012)** | **Activity 1. Energy Generation, Transmission and Storage Activities**<br>1.1 The construction of facilities for – (b) the transmission and supply of electricity<br>**Activity 2. Waste Management, Treatment, Handling and Disposal**<br>2.1 The construction of facilities for waste sites, treatment of waste and disposal of waste<br><br>**Activity 4: Forestry Activities**<br>4. The clearance of forest areas, deforestation, afforestation, timber harvesting or any other related activity that requires authorization in terms of Forest Act, No. 12 of 2001, or any other law<br><br>**Activity 8: Water Resource Development**<br>8.1 The abstraction of groundwater or surface water for industrial or commercial purposes<br>8.2 The abstraction of groundwater at a volume exceeding the threshold authorized in terms of a law relating to water resources<br>8.6 Construction of industrial and domestic wastewater treatment plants and related pipeline systems.<br><br>**Activity 9: Hazardous Substance Treatment, Handling and Storage**<br>9.1 The manufacturing, storage, handling or processing of hazardous substance defined in the Hazardous Substances Ordinance, 1974<br><br>**Activity 10. Infrastructure**<br><br>10.1 The construction of the contractor camp (temporary accommodation facility for about 150 workers close to the Smelter) | |
| **Location** | Sinomine Tsumeb Smelter, Smelter Road, Tsumeb | |
| **Proponent** | Sinomine Tsumeb Smelter (Pty) Ltd<br>Client Representative – Mr. Abraham Kanime<br>Office: 067 – 223 4127<br>E-mail: abraham.kanime@sinomine.na | |
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| **Reviewer**:<br>Jonas Heita |  | 14 February 2025 |
| **Copy Right:** *"This document has been developed for the intended purpose* | | |

**Disclaimer:**

The information presented herein (i.e project description, input materials, reagents, products, residue, waste and associated material safety data sheets – MSDS), has been provided by the proponent and accepted in good faith, as accurate and valid.

The assessment, interpretation and analysis has been carried out by the Tortoise Environmental Consultants (TEC), based on common Environmental and Social Impact Assessment (ESIA) assessment tools, referenced and listed literature, and internationally acceptable best practices.

# NON-TECHNICAL EXECUTIVE SUMMARY

## Brief description of proposed project

The proposed Multi Metal Recycling project is part of the new value-addition and processing and is not part of the already approved smelter expansion project. The Tsumeb Smelter was purchased from Dundee Precious Metals by Sinomine Group in September 2024 and, is now owned and operated as Sinomine Tsumeb Smelter (Pty) Ltd.

The Multi-Metal Recycling project production facilities will be constructed within the footprint of the current smelter site. These will be comprised of a feed preparation area, coal storage and coal pulverization equipment, rotary kiln and fuming furnaces for fuming the slag, a blast furnace for smelting the lead residue to produce crude lead, the off gas cooling and cleaning equipment (waste heat boilers, electrostatic precipitators and baghouses, $SO_2$ scrubber, a hydrometallurgical plant for leaching and refining the zinc oxide fumes to produce zinc, germanium and gallium metal.

The estimated lifespan of the proposed project is about 15 years based on the current zinc slag stock onsite, it is a best practice that some of the mitigation measures for closure and rehabilitation be incorporated into designs of the plant e.g. long-term permanent structures.

## ESIA Aim

The aim of the Environmental and Social Impact Assessment (ESIA) is to assess impacts (both positive and negative), identify and recommend mitigation measures to reduce negative impacts and maximise positive impacts, through the adoption of best environmental practices and application of the precautionary principle.

## Rationale of the proposed project

The proposed project aims to diversify the copper smelting business in Tsumeb and generate the additional but urgently required revenue for the continuity and sustainability (survival) of Tsumeb Smelter as a business operation.

Apart from commercial benefits, the proposed project has great potential to address existing environmental issues and aims to remove the current source of localised groundwater contamination which have been observed for long time. Therefore, in this manner the project can be regarded as a green project initiative to address groundwater and air quality pollution risks.

## Supplementary information from the ESIA and Specialist Studies for the Smelter Expansion (DPMT/SLR, 2019 and DPMT/TEC, 2021)

The ESIA is complemented by data and information from the ESIA for the Smelter expansion and associated Specialist reports (DPMT/SLR, 2019 and DPMT/TEC, 2021), as well as the ongoing and long-term monitoring data, such as Groundwater and Air pollution monitoring (STS, 2025). Thus, additional specialist assessment may only be required if new information gaps are identified.

**Receiving environment (baseline conditions)**

The general landscape of the Tsumeb Smelter site is a mountainous, hills and rocky terrain. The area is classified as the Karstveld vegetation type, and it is characterised by large open spaces of grasslands dotted with Acacia trees and falls under the Acacia tree and shrub Savanna sub-biome, which is one of the largest biomes in Namibia.

Tsumeb falls within the Etosha Basin Hydrogeological Region, which is an inland drainage system where runoff flows into the Etosha Pan. The average groundwater levels in Tsumeb are approximately 60m below ground level, with limited seasonal fluctuations in the levels. Groundwater occurs in the Tsumeb Dolomitic Aquifer, which provides water to the town of Tsumeb, nearby farms and the ecosystems.

The geology of the Tsumeb area is characterized by dolomites of the Otavi Group (composed entirely of shallow marine deposits), which is a subgroup of the Damara Supergroup and Gariep Complex1. The smelter is located on the dolomites of the Huttenburg Formation. These dolomites house the Tsumeb deposits which contain an extraordinary diversity of ores.

**EIA process and public consultation undertaken**

The EIA process is underpinned by public and stakeholder consultations. Comments made during the public participation process should be properly captured and addressed in the EIA Scoping report and EMP respectively.

Section 21 (c) stipulates that ECC applications should be advertised once a week for two consecutive weeks in two newspapers that are widely circulated in Namibia. As a result, a total of four (4) adverts were placed in the Namibian and New Era Newspapers.

Table: Newspaper Adverts

| Newspaper | Advert | Date Advertised | Evidence |
|---|---|---|---|
| The Namibian | 1st Advert | 05 December 2024 | A1 – CRR |
| | 2nd Advert | 11 December 2024 | A1 – CRR |
| New Era | 1st Advert | 05 December 2024 | A1 – CRR |
| | 2nd Advert | 11 December 2024 | A1 – CRR |

Two (2) rounds of stakeholder engagement and public consultation meetings were held as follows:

| Round | Period | Number of Meetings held | Total number of People | Appendix |
|---|---|---|---|---|
| 1st Round | 11 – 13 Dec2024 | 4 Meetings | < 50 | A1 – CRR |
| 2nd Round | 15 – 17 Jan 2025 | 3 Meetings | < 350 | A1 – CRR |

*1 Jones & Wagner, Assessment of the Contamination Risks to the Groundwater and Soils at the Tsumeb Smelter, JW48/11/C391, Revision 0, April 2011*

**Project Key impacts**

- **Socio-Economic Impacts**

Namibia Statistics Agency (NSA, 2025), the official unemployment rate in 2024 is estimated at 37% of the labour force, and the majority (47%) of the unemployed is the youth (including graduates from Universities and Vocational Training Centres). However, economists from independent institutions dispute the Government or NSA's estimate of 37%, arguing that NSA has changed the "Unemployment Definition" and that only about 46.2 of the working-age population is employed and the true unemployment stands at 54.8%.

The success of the proposed projects, the Alkali Metal Salts (AMS) and the Multi Metal Recycling Projects (MMR) will have significant socio-economic impacts, including but not limited to:

a) Sustaining the current Sinomine Tsumeb Smelter (STS) work force, as well as employees (663) for contractors and sub-contractors (769), totalling **1,432 people**.

b) Creating new employment opportunities (both during construction and operation of the two projects).

c) Sustaining and enhancing the local economy of Tsumeb through buying power of STS staff (STS staff income sustain the housing properties (purchase or rent), supermarkets, street vendors, schools, house maids, gardeners, entertainment, car wash, etc).

d) Sustaining and enhancing the local economy for the town of Tsumeb, through supply chains (procurement of goods and services from local suppliers).

e) Sustaining transportation revenues for the railway (Trans-Namib) and other transport companies (both import of raw material from Walvis Bay to Tsumeb and export of products from Tsumeb to Walvis Bay).

f) Sustaining revenues for port services and other service providers in Walvis Bay (during both import of raw material and export of products).

- **Socio-Economic Impacts – Rating**

| Impact | Baseline | Mitigation | Without Mitigation | With Mitigation |
|---|---|---|---|---|
| Sustaining the current STS work force, and contractor employees | At present, STS has 663 permanent employees and 769 contractors' employees, totalling 1,432 people, who are directly / in-directly dependent on STS for their monthly income | Policy to retain employees, upskill current workforce to meet requirements of new plant for smooth integration | Medium | High |
| New employment opportunities (both during construction and operation of the project) | The number of new employment opportunities has not been fully quantified. However, new employment opportunities will be created during both the construction and operational phases | Create new employment opportunities, both short and long-term, during Construction and Operation of project | Low | High |
| Sustain current buying power for STS staff to support small and medium business enterprises | The 1,432 people, who (directly / in-directly) receive a monthly income from STS, spend most of their money in Tsumeb and provide a significant buying power (e.g house rent, food, schools, domestic workers) and thereby sustaining the local economy | Retain employees and employ more employees from local to help continue support the local business | Medium | High |
| Support to the Local Economy and Supply through local procurement | STS annual budget for in-land expenditure is NAD 1.5 billion, of which about 48% is spend on Previously Disadvantaged Namibians (NAD 720 million) and 17% spend on Tsumeb based companies (NAD 255 million), annually. | Procure goods from local wholesales | Medium | High |
| Community Investments through Corporate Social Responsibility | STS provides an annual budget for the community trust/community investment, crucial for community development and youth support initiatives | Maintain support to the Sinomine Tsumeb Community Trust and other Community Investment Initiatives | Medium | High |
| Maintain support to local and national transportation services | STS annual budget for in-land expenditure is NAD 1.5 billion, of which about 52% (NAD 780 million) is spend on service providers like Transnamib, annually. | Sustain the use of Transnamib and other service providers for material transport between Walvis Bay and Tsumeb | Medium | High |

- **Waste**

| Waste ID | Waste Classification | Potential Impacts (Negative) | Key Mitigation | Without Mitigation | With Mitigation |
|---|---|---|---|---|---|
| Slag from Fuming and Rotary Kiln | Low risk waste | Water Contamination and soil degradation through Leaching | Granulated slag is used as a cement replacement and can also be used as a sand substitute | Low | Negligible |
| Slag from Lead Blast Furnance | Medium risk waste | Water Contamination and soil degradation through Leaching, Exposure may cause respiratory, skin and eye irritation | Do not empty in drains, Store product in lined facility, and Consider reprocessing to recover residual metals | Medium | Low |
| Calcium Sulphate / Gypsum or Gas desulphurization residue | low risk. Main environmental risk is total dissolves solids (TDS) and sulphate when leaching | Exposure may cause respiratory, skin and eye irritation, reduced Plant growth due to acidification | Waste compound $CaSO_4$ must be stored in a lined disposal facility, dry place well ventilated | Low | Negligible |
| Iron Arsenic (FeAs) sludge residue and defluorination and heavy metals removal residues | Very high-risk wastes. Expected leachability of heavy metals and Fluorine is > LCT1 or LCT2 | Water Contamination, Soil degradation through Leaching, and Exposure may cause respiratory, skin and eye irritation | Waste residue must be stored in a well-designed triple lined facility | High/Severe | Low |
| Calcium Magnesium | Low risk (main concern is TDS and sulphate) | Exposure may cause respiratory, skin and eye irritation | Storage in a lined facility if re-processing is not feasible, Calcium and magnesium are essential nutrients for plants | Low | Negligible |

| Waste ID | Waste Classification | Potential Impacts (Negative) | Key Mitigation | Without Mitigation | With Mitigation |
|---|---|---|---|---|---|
| Dust (Smelting Dust) ZnO product | Very high risk (but not a waste – this is a product) | Exposure to heavy metals from smelting dust may lead to various health problems including respiratory illnesses, reproductive issues Allergic reactions | Store the product in sealed containment to prevent emissions, Dust collection system and recycling | High | |
| Industrial Wastewater | Industrial wastewater | • Surface and ground water contamination<br>• Leachate<br>• Harmful if ingested | Storage in appropriate pollution control dam, evaporate excess wastewater, with salts finally deposited in a HWDF[2] (either when pond fill up or at closure) | High | Low |
| Domestic Wastewater (Sewage) | Domestic Wastewater (Sewage) | • Surface and ground water contamination<br>• Harmful if ingested | Read in sewage treatment plant before directing into reed dam. Further explore option for reuse of treated effluent e.g. Use for site garden and landscape | High | Low |

[2] *HWDF – Hazardous Waste Disposal Facility*

## Monitoring

The general approach to health, safety and environmental monitoring for the proposed project is that the existing monitoring programs require review to determine the need and extend of updates of these program. This is to ensure the current monitoring programs are comprehensive and adequate to cover for the new potential parameters or aspects of concerns associated the proposed alkali metal salt project.

## Conclusion and Recommendation

The assessment concludes that proposed Multi-Metal Recycling presents potential environmental, health and safety risks. Some of the impacts are rated as High in terms of significance before mitigation, however all the identified impacts can be mitigated to low rating and or negligible rating which are acceptable standards.

Further, for each of the waste streams and handling of both input (raw material) and output materials (products), the assessment identified corresponding mitigation measures, which if comprehensively implemented, will reduce the project risks to acceptable standards.

On the direct environmental positive impact, it cannot be emphasised enough that the proposed project aims to reprocess the old/historical waste heaps which are source of the current (though localised) groundwater contamination onsite including air quality dust related emissions.

On condition that all identified impacts and recommended mitigations measures are implemented and monitored, an Environmental Clearance Certificate (ECC) is recommended.

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## ABBREVIATIONS

| | |
|---|---|
| DEA | Department of Environmental Affairs |
| DSR | Draft Scoping Report |
| CCFN | Community Conservation Fund of Namibia |
| EA | Environmental Assessment |
| EAP | Environmental Assessment Practitioner |
| ECC | Environmental Clearance Certificate |
| ECO | Environmental Compliance Officer |
| EIA | Environmental Impact Assessment |
| EIF | Environmental Investment Fund |
| EMA | Environmental Management Act (No. 7 of 2007) |
| EMP | Environmental Management Plan |
| ESR | Environmental Scoping Report |
| I&APs | Interested and Affected Parties |
| MEFT | Ministry of Environment, Forestry and Tourism |
| SM | Site Manager |
| TEC | Tortoise Environmental Consultants |
| MMR | Multi-Metals Recycling |

# 1. INTRODUCTION

## 1.1 Introduction – Sinomine Tsumeb Smelter

The proposed Multi Metal Recycling project is part of the new value-addition and processing and is not part of the already approved smelter expansion project. The Tsumeb Smelter was purchased from Dundee Precious Metals by Sinomine Group in September 2024 and, is now owned and operated as Sinomine Tsumeb Smelter (Pty) Ltd.

The smelter is located about 2 km outside the town of Tsumeb, approximately 430 km north of Windhoek. Sinomine Tsumeb Smelter is a subsidiary of SINOMINE Resource GroupCo which is the world's largest producer and supplier of cesium and rubidium products, and the leading producer and supplier of battery-grade lithium fluoride in China.

The smelter was originally constructed in the early 1960's to process concentrates from the Tsumeb copper mine and other mines in the country. However, since the closure of the Tsumeb Copper mine in 2008, complex copper concentrate has been imported / sourced from outside Namibia. Tsumeb smelter is one of the few smelters in the world that can treat complex copper concentrates with high arsenic content. The smelter treats complex copper concentrates to produce blister copper (98.5%) as well as sulphuric acid that is sold to uranium and copper mining enterprises in Namibia.

To date, the Tsumeb Smelter complex had undergone several transformation and upgrades some of which are listed activities, hence the smelter was issued various Environmental Clearance Certificates over the years and is now currently operating under one Consolidated Environmental Clearance Certificate that covers its operations, related activities as well as the phased ongoing Smelter Expansion Project valid until 2026.

## 1.2 Project description

The proposed Multi-Metal Recycling Plant is part of the new business venture which is not part of the already approved smelter expansion project. The proposed Multi-Metal Recycling Plant aims to reprocess the historic stockpile of Zinc Slag (as main raw material) and produce final products such as zinc ingots, lead ingots, zone refined germanium ingots and high-purity gallium. The by-products include copper slag and Gypsum residues (flue gas desulphurization residue) that can be sold. The wastes are a cleaned slag from the furnaces, an iron-arsenic residue and a defluorination and heavy metal removal residue.

Although the proposed Multi-Metal Recycling Plant is to be operated and managed independently of the smelter, the required utilities such as water and electricity are planned to be sourced from the current supply at the smelter.

The main process for treating zinc slag and producing zinc ingots, germanium ingots, high-purity gallium and crude lead in this project includes zinc slag pyrometallurgical volatilization; lead slag pyrometallurgical smelting; zinc oxide fume hydrometallurgical treatment; germanium and gallium extraction and refining, among others.

Zinc slag undergoes pyrometallurgical volatilization to produce zinc oxide fume enriched with valuable metals such as zinc, germanium, lead and gallium. The zinc oxide fume is then processed through leaching, purification, and electrolysis to yield cathode zinc, which is sent to the zinc foundry where it is melted, purified, and cast into zinc ingots.

The acidic leach residue from zinc oxide leaching contains Pb, Ge, Ga and is further leached with sulfuric acid. The leach residue from this leaching step is a solid Pb residue which is further treated by smelting in a blast furnace to produce crude lead.

The leach solution undergoes iron precipitation (cementation) to remove copper. The solution after copper removal is the Ge/Ga concentrate which first goes to Ga-In refining and after Indium and arsenic removal goes to the Ga and the Ge refining stages to produce gallium metal and zone-refine germanium.

The above processes can be summarized as below:

**Inputs**:

- zinc slag (generated by historical copper-lead smelting)

**Outputs:**

- Zinc ingot,
- Germanium ingot,
- Gallium metal and
- Lead ingot

**Waste products:**

- Slag from Rotary kiln
- Slag from fuming furnace
- Lead Blast furnace slag
- Gypsum from offgas desulphurization
- FeAs cement
- Gypsum from effluent treatment (heavy metals removal)

### 1.3 Project rationale and motivation

The proposed project aims to diversify the copper smelting business in Tsumeb and generate the additional but urgently required revenue for the continuity and sustainability (survival) of Tsumeb Smelter as a business operation. Apart from commercial benefits, the proposed project has a great potential to address existing environmental issues in particular it aims to remove the current source of localised groundwater contamination which have been observed for long time.
Therefore, in this manner the project can be regarded as a green project initiative to address groundwater and air quality pollution risks.

Further, this effort will contribute to overall site long-term environmental improvement program and supplement other similar initiatives which are already implemented such as the installation of sulphuric acid plant which has addressed the issue of sulphur dioxide emissions.

## 1.4 Environmental Management Act provision

The proposed project triggers a number of Listed Activities as set out in the Environmental Management Act, 2007 (Act No. 7 of 2007) (herein referred to as the EMA) and the EMA Regulations pertainining to List of activities that may not be undertaken without Environmental Clearance Certificate, 2012 (No. 29 of 2012.

Further, Listed Activities that may not be undertaken without an Environmental Clearance Certificate (ECC), are to be subjected to a process of environmental impact assessment as also provided for and outlined in EMA Regulations on Environmental Impact Assessment (No.30 of 2012) (herein referred to as EIA Regulations). The EIA entails the development of the ESIA Scoping Report and Environmental and Social Management Plan (ESMP) which should be submitted to the MET as part of the application for the ECC.

## 1.5 ESIA – Framework

An Environmental and Social Impact Assessment (ESIA) is a tool to manage negative environmental impacts that may arise from the proposed development and guides the project design to be more environmentally friendly.

The aim of the EIA is to reduce negative impacts (effects) and maximise positive impacts, through the adoption of best environmental practices and application of the precautionary principle.

# 2. ESIA Process

## 2.1 ESIA Process Flow

The Environmental and Social Impact Assessment (ESIA) is a systematic process of identifying, predicting, evaluating and mitigating the potential environmental and social effects that may arise from the activities of a proposed project.

For the proposed Multi-Metal Recycling project at Sinomine Tsumeb Smelter, the EIA presents the findings of the assessment for potential impacts that may arise from the construction and operation of the proposed Multi-Metal Recycling plant and recommends remedial measures that should be implemented to mitigate the effects of the proposed activity on the environment (Figure 1.1).

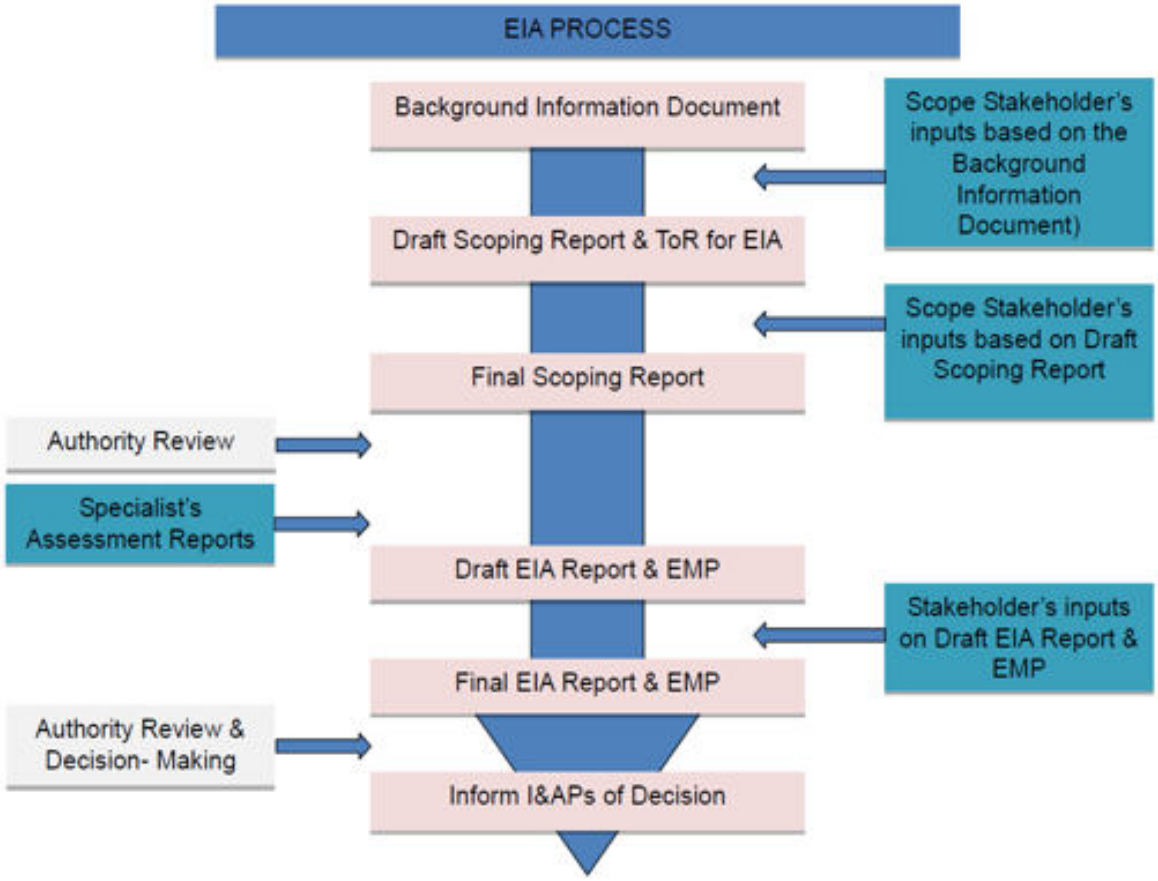


*Figure 2.1: EIA Flow diagram*

## 2.2 Identification and Mitigation of Impacts

The backbone of the EIA report entails identification of impacts (whether real or perceived) and provides recommendations on suitable mitigation measures to ensure compliance with the principles of environmental management; and highlight risks and measures to ensure an environmentally friendly development.

## 2.3 Purpose of the ESIA Scoping Exercise

The purpose of this EIA scoping exercise is to:

a) Provide description of the proposed activity
b) Describe the affected environment (proposed area)
c) Identify potential environmental impacts / aspects of concern
d) Describe the methodology followed to assess the potential impacts
e) Capture, document and address concerns raised by stakeholders in the Comments and Response Report (CRR)
f) Mitigate negative impacts that may arise from the proposed project

## 2.4 Public Participation Process (PPP)

The EIA process is underpinned by public and stakeholder consultations. Comments made during the public participation should be properly captured and addressed in the EIA Scoping report and EMP respectively.

Consultation with the public forms an integral component of the EIA process. The Public Participation Process (PPP) allows Interested and Affected Parties (I&APs) to raise issues and concerns related to the proposed project which they feel should be considered in the EIA process and development of the project. The environmental assessment identifies feasible mitigation measures that can be implemented to address the identified issues of concern.

The following process is required:

- Newspaper adverts
- Site notices
- Stakeholder Engagement and Public meetings

Interested and Affected Parties (I&APs) that may be consulted upon during the PPP may include, but not limited to communities, national, regional and local authorities, environmental groups, business community and civic associations.

Public consultation is a requirement by law (EMA No 7 of 2007) to be incorporated into an EIA process, hence it is a fundamental part of the EIA. Public consultation ensures robust decision-making by involving Interested and Affected Parties (I&APs).

The Public Participation Process (PPP) has therefore been structured to provide I&APs an opportunity to gain more information on the proposed project and for them to provide inputs through the review of documents/reports, and to flag any issue of concern during the PPP process.

### 2.4.1 Authority Consultation

A series of consultative meetings were convened with authorities (MEFT, MAWFT, Tsumeb Constituency Office, Tsumeb Municipality and key stakeholders (i.e. adjacent landowners, farmers/Farmers Association, general Tsumeb community)) to present the proposed project and solicit their input ***(Appendix 1 – CRR).***

### 2.4.2 Newspaper Adverts

Section 21 (c) stipulates that ECC applications should be advertised once a week for two consecutive weeks in two newspapers that are widely circulated in Namibia. As a result, a total of four (4) adverts were placed in the Namibian and New Era Newspapers ***(Appendix 1 – CRR).***)

Table 2:1: Newspaper Adverts

| Newspaper | Advert | Date Advertised | Evidence |
|---|---|---|---|
| The Namibian | 1st Advert | 05 December 2024 | *Appendix 1 – CRR* |
| | 2nd Advert | 11 December 2024 | *Appendix 2 – CRR* |
| New Era | 1st Advert | 05 December 2024 | *Appendix 3 – CRR* |
| | 2nd Advert | 11 December 2024 | *Appendix 4 – CRR* |

### 2.4.3 Public Meetings

Two (2) rounds of stakeholder engagement and public consultation meetings were held as follows: from and

| Round | Period | Number of Meetings held | Total number of People | Appendix |
|---|---|---|---|---|
| 1st Round | 11 – 13 December 2024 | 4 Meetings | < 50 | A1 – CRR |
| 2nd Round | 15 – 17 January 2025 | 2 Meetings | < 250 | A1 – CRR |

## 2.5 Rehabilitation

The ESIA should not only focus on mitigating impacts during construction and operations, but is should also recommend rehabilitation measures at project decommissioning (when activities cease). Where applicable, rehabilitation measures should be implemented incrementally, throughout the project lifespan. The estimated lifespan of the proposed project is about 15 years based on the current zinc slag stock onsite, it is a best practice that some of the mitigation measures for closure and rehabilitation be incorporated into designs of the plant e.g. long-term permanent structures.

## 2.6 Environmental and Social Management Plan (ESMP)

In-addition to the ESIA, an Environmental and Social Management Plan (ESMP) will be developed. The ESMP is a key document and consists of the set of measures to be taken during implementation and operation to eliminate, offset, or reduce adverse environmental impacts to acceptable levels. Also included in the plan are the actions needed to implement them (Ministry of Environment and Tourism, 2008).

## 2.7 Application for ECC

Upon completion, the EIA Scoping Report and Environmental Management Plan (EMP), will be submitted to MEFT for review and decision, in accordance with Section 8 of the EIA Regulations.

# 3. PROJECT INFORMATION

## 3.1 Project Location

The Tsumeb smelter site is located approximately 5 km northeast of the Tsumeb town, Oshikoto Region, north central Namibia (19°13'24.6''S, 17°43'33.4''E) (see Figure 2). Access to the smelter is via a smelter access road at the junction of the M75 and B1 Roads as well as by rail from Tsumeb TransNamib Yard (good delivery and dispatch only). The proposed Multi-Metal Recycling project will be contained within the current footprint of the smelter.

## 3.2 Background and Context

The Tsumeb smelter is owned and operated by Sinomine Tsumeb Smelter (Pty) Ltd. The Smelter is a subsidiary of SINOMINE Resource GroupCo who acquired 98% of the Smelter in September 2024. Sinomine Resources is the world's largest producer and supplier of cesium and rubidium products, the leading producer and supplier of battery-grade lithium fluoride in China.

The smelter was originally constructed in the early 1960's to process concentrates from the Tsumeb copper mine and other copper mines in the country. However, since the closure of the Tsumeb Copper mine in 1998, copper concentrate has been imported / sourced from outside Namibia. The Tsumeb smelter is one of the few smelters in the world that can treat complex copper concentrates with high arsenic content. The smelter treats complex copper concentrates to produce blister copper (98.5%) as well as sulphuric acid (sold to uranium and copper mines in Namibia). The blister copper is exported to refineries in Europe.

The site is accessed by road from the M75 to the west, and rail, which connects, to the Atlantic port of Walvis Bay.

In terms of utilities, the current smelter operation source water from No.1 Mine Shaft (raw water) and also from municipal water supply (domestic water). Raw water means untreated groundwater abstracted for industrial uses; whereas domestic water is treated water from the Municipality supplied for human use onsite. Lastly, the electricity is supplied directly by NAMPOWER via the 11kv powerline and smelter substation.

The smelter currently employs 663 permanent employees (including fixed term contract and internship employees) and 769 contractors' employees.


*Figure 3.1: Locality map of Sinomine Tsumeb Smelter and MMR Project site*

Table 3:1 presents the existing infrastructures and footprint of the current smelter which serves as the infrastructure baseline which will either impacted or incorporated with the infrastructural needs of the proposed project.

*Table 3:1: Current Smelter site buildings, infrastructure and support services*

| Smelter Process | Waste Treatment & Disposal | Site support |
|---|---|---|
| Smelting furnace (Ausmelt Furnace) | Sewage treatment plant | Administration buildings |
| Ventilation system and CV scrubbers | Effluent treatment plant | Offices |
| | Slag milling and flotation plant | General warehouse |
| Copper plant | Site surface water drainage system | Engineering workshops |
| | Pollution Control Dams | Canteen building (currently used as training or meeting venue) |
| Osmosis plant | Old tailings dam | Roads and rail loop |
| Oxygen plant | New tailings dam | Powerline and substation |
| | Blast furnace slag dump | No. 1 Mine Shaft |
| Sulphuric acid plant | Tar pits | Access roads |
| Evaporation ponds | Old slag mill tailings dump | |
| | Mine tailings dump | |
| | Arsenic calcines dumps | |
| | Hazardous waste disposal site | |
| | General waste disposal site | |

## 3.3 Infrastructure to Accommodate the Multi-Metal Recycling Plant

The Multi-Metal Recycling project production facilities will be constructed within the footprint of the current smelter site. These will be comprised of a feed preparation area, coal storage and coal pulverization equipment, rotary kiln and fuming furnaces for fuming the slag, a blast furnace for smelting the lead residue to produce crude lead, the off gas cooling and cleaning equipment (waste heat boilers, electrostatic precipitators and baghouses, $SO_2$ scrubber, a hydrometallurgical plant for leaching and refining the zinc oxide fumes to produce zinc, germanium and gallium metal.

## 3.4 Multi-Metal Recycling and Processing

### 3.4.1 Process Flow Overview

The main process of the Multi-Metal Recycling plant includes zinc slag smelting and fuming, lead residue smelting, zinc oxide fume hydrometallurgical treatment with zinc electrowinning and ingot casting and germanium and gallium extraction and refining.

Zinc slag undergoes pyrometallurgical volatilization to produce zinc oxide fume enriched with valuable metals such as zinc, germanium, and gallium. The zinc oxide fume is then processed through leaching, purification, and electrolysis to yield cathode zinc, which is sent to the zinc foundry where it is melted, purified, and cast into zinc ingots. The acidic leach residue from zinc oxide is further leached to extract Ge, Ga and then after solid/liquid separation and washing,the remaining lead residue is sent to a blast furnace for smelting to produce crude lead. The acidic leachate of this step is high in Ge and Ga and undergoes processes including copper removal, solvent extraction, purification, and neutralization to produce germanium and gallium concentrates for germanium and gallium refining. The germanium concentrate is refined through grinding, chlorination distillation, fractional distillation, reduction and zone refining to obtain zone-refined germanium ingots. The gallium concentrate is processed through leaching, iron removal, electrolysis, and acid washing to yield metallic gallium.

In the refining process arsenic, cadmium, chlorine and fluorine are removed and separated into residues that will be stored in a triple lined tailings dam.

### 3.4.2 Technological process

The treatment of zinc slag typically employs a high temperature pyrometallurgical volatilization process, which not only achieves to recover valuable metals from the slag but also removes hazardous impurities from the slag to transform the slag to non-hazardous slag.

The process of slag fuming involves mixing the slag with reductants and fluxes and feeding the slag to the furnaces. The furnace is heated with fuel to the optimal

temperature for reduction and volatilization of valuable metals from the slag. Valuable metals such as Zn, Pb, Ge, and Ga in the slag are reduced and volatilized to the furnace offgas. The offgas is then cooled in a waste heat boiler and cleaned in a dust collector to collect the zinc oxide fumes (dust). The boiler generates steam for desulfurization and other applications. The cleaned offgas is treated in a desulfurization system for $SO_2$ removal before being discharged. The zinc oxide fume is processed for metals recovery using hydrometallurgical methods. The residual slag from the furnace is discharged and then quenched in water to produce granulated slag, which is dewatered and then stored in the single lined tailings dam or sold.

The slag fuming process is designed to use both a rotary kiln and a fuming furnace, with the rotary kiln processing capacity ranging from 60 kt/a to 80 kt/and the fuming furnace processing capacity ranging from 120 kt/a to 140 kt/a. This is presented in the process flow diagram below.

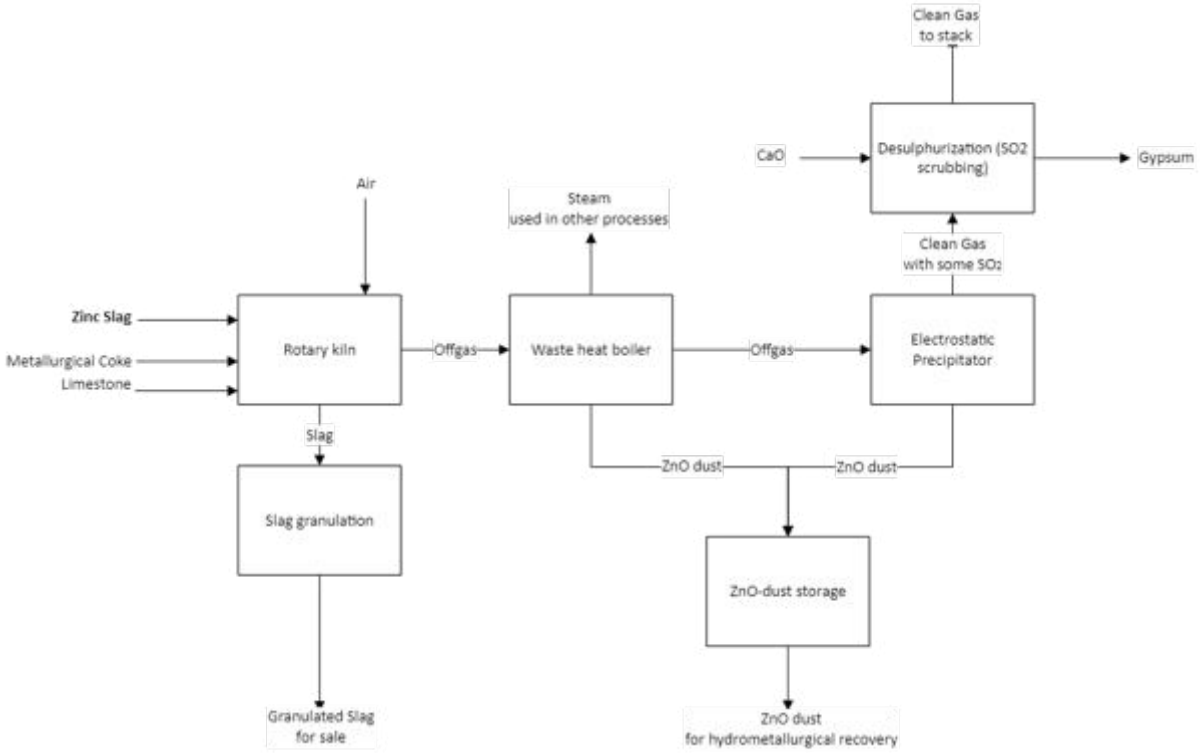


*Figure 3.2: Block flow diagram of the Slag fuming by Rotary kiln process*

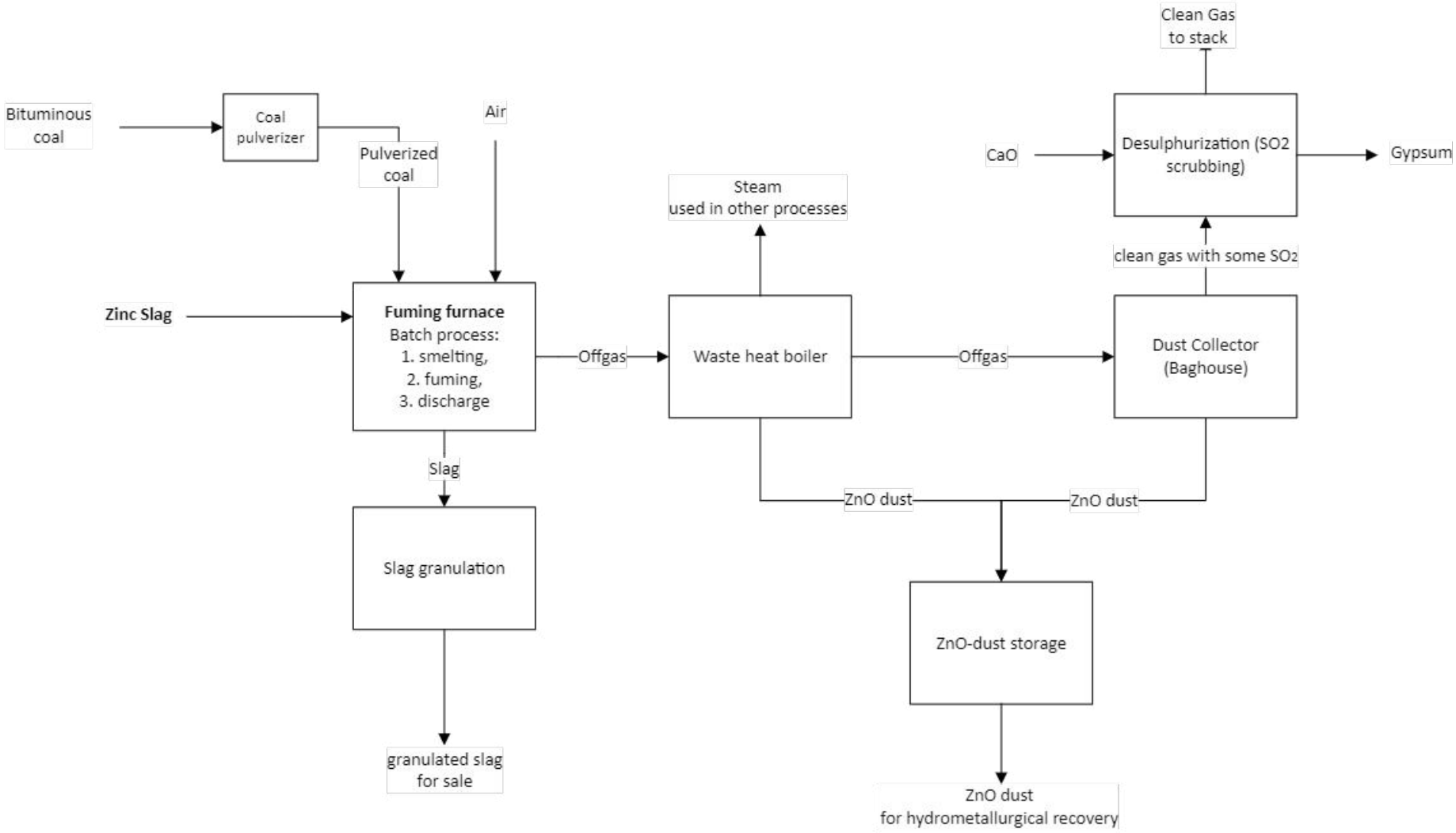


*Figure 3.3: Block Flow Diagram of the Slag fuming furnace process*

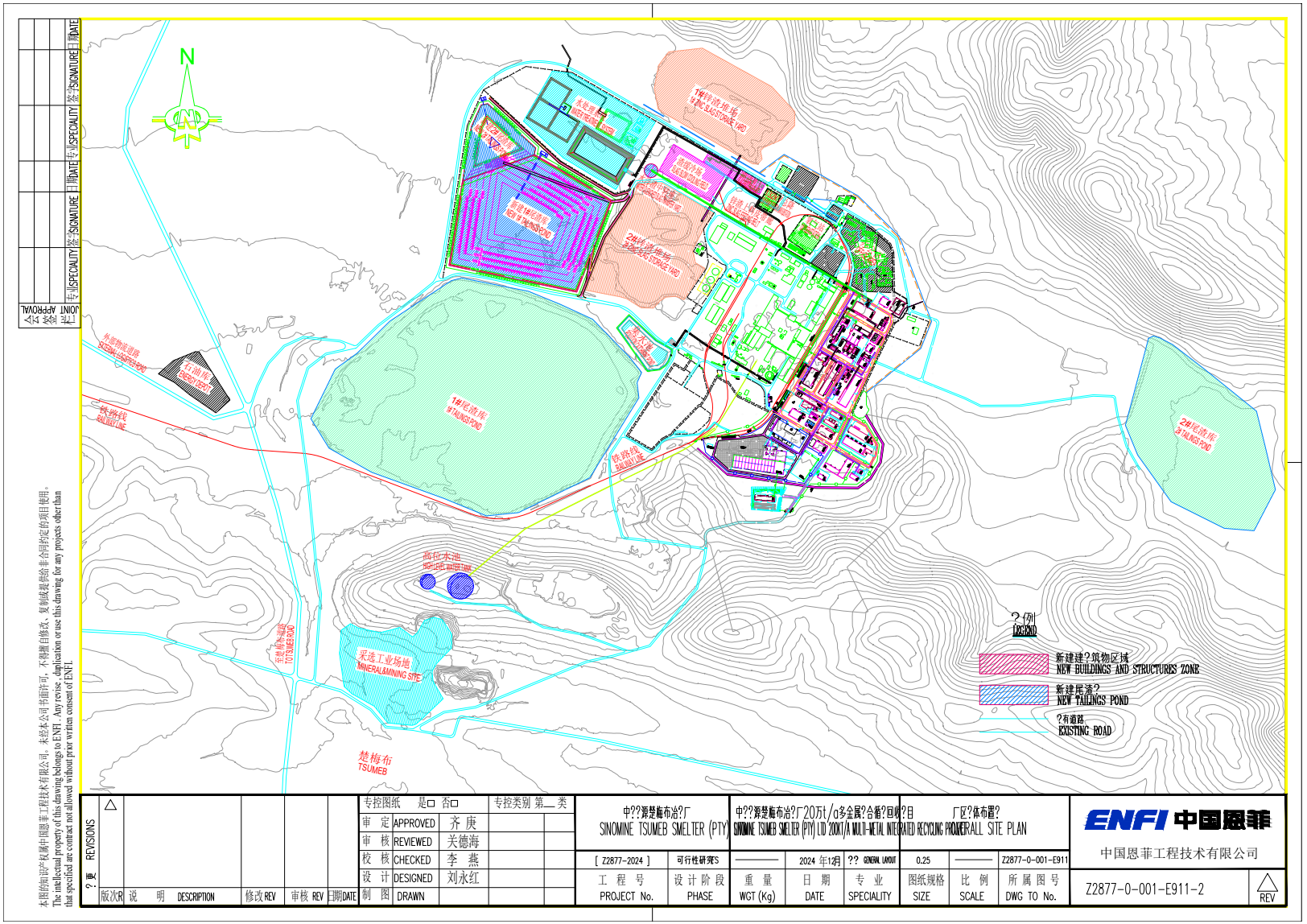


*Figure 3.4: Design for the Tailing Storage Facility, Sinomine Tsumeb Smelter*

## A. Lead Residue Smelting in Blast furnace

This process uses a blast furnace to process the lead residue obtained in the leaching process of the zinc oxide fumes. After drying, the lead residue is sent to the briquetting plant, where it is mixed with flux and coke to produce briquettes. The briquetting system is equipped with a fully automated production line, which includes water addition and mixing, briquetting, curing, and briquette feeding system.

After being weighed, the lead-silver residue is fed onto a conveyor belt and added to a mixer for water addition and fine mixing. The uniformly mixed materials are then transported via a feeding belt to the briquetting press's feeding hopper. After being pressed into briquettes, the materials are sent to a curing rack via a shuttle lift conveyor for curing. After a 7-day curing period, the cured materials are retrieved using a double-sided shuttle lift conveyor and sent to the briquette pushing position, where hydraulic rods push the briquettes into a feeding cart. Coke is added sequentially to the feeding cart via a vibrating feeder. The feeding cart then moves on a rail to the elevator, which lifts it to the height of the blast furnace feeding platform before discharging it into the blast furnace.

The cured materials are charged to the blast furnace via the feeding cart. Oxygen-rich air (with an oxygen concentration of 42%) is injected into the furnace through side-mounted nozzles (Tuyeres). In the furnace, the partial combustion of coke generates CO, which reduces the lead in the materials to metallic lead. The crude lead is released through the siphon lead outlet of the furnace and is sold after being cast into ingots.

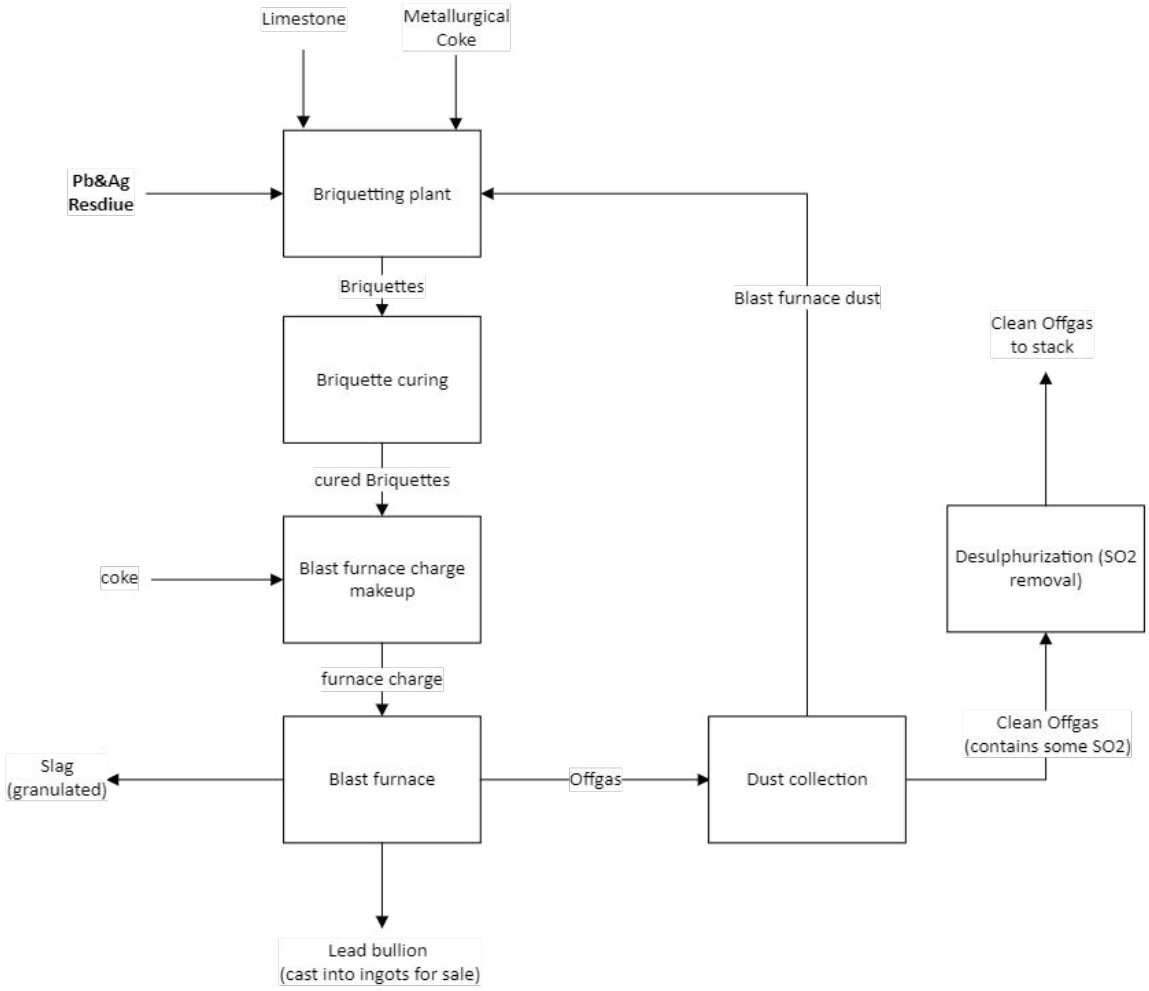

*Figure 3.5: Block Flow Diagram of the Lead Blast furnace Process for the Lead Residue*

## B. Zinc Oxide Fume Hydrometallurgical Treatment

The main processes for treating zinc oxide fume include neutral leaching of zinc oxide, low-acid leaching, and high-acid leaching; chlorine removal from the leachate, two-stage purification and electrolysis, resulting in the production of cathode zinc, which is then cast into zinc ingots. The low-acid leachate is treated with iron powder to precipitate copper and arsenic before being sent to the germanium-gallium extraction process for the recovery of germanium and gallium.

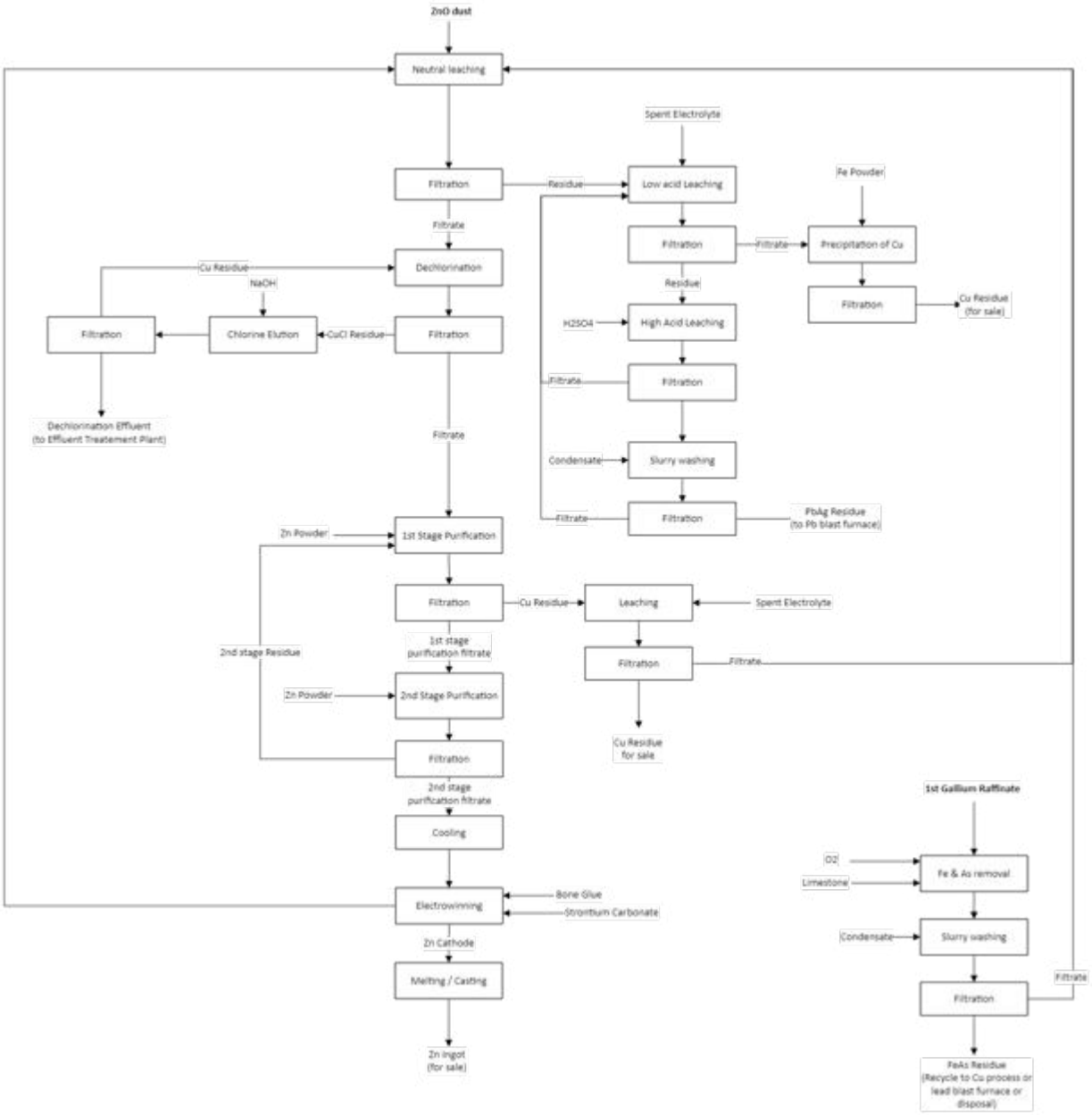


*Figure 3.6: Zinc Oxide Hydrometallurgical treatment block flow diagram*

### 3.4.3 Zinc Oxide Leaching

*(1) Neutral Leaching of Zinc Oxide*

The main objective of the leaching process is to extract metals such as Zn, Cu, Ge and Ga from the zinc oxide fumes while ensuring that metals like Pb remain insoluble and are entirely contained in the leaching residue. Neutral leaching is conducted in a continuous operation. Zinc oxide dust is charged to the zinc oxide leaching plant feed bin, where it enters the leaching tank through a feeding device, along with waste electrolyte and iron-removal liquid, controlling the leaching endpoint pH at 5.0 to 5.2. The neutral leaching slurry is pumped to a medium leaching pressure filter for solid-liquid separation. The filter residue is then pulped and sent to a low-acid leaching tank, while the filtrate from the pressure filter, known as medium leaching liquid, is pumped to the chlorine removal tank.

*(2) Low-Acid Leaching of Zinc Oxide*

Low-acid leaching is also conducted in a continuous operation. The neutral leaching residue is pulped and pumped into the low-acid leaching tank where high-acid leaching filtrate is added, controlling the endpoint acidity at 40 to 60 g/L. The low-acid leaching slurry is pumped to a low-acid leaching pressure filter for filtration. The filter residue is pulped and sent to the high-acid leaching tank, while the filtrate from the pressure filter, known as low-acid leaching filtrate, is pumped to the copper precipitation tank.

*(3) High-Acid Leaching of Zinc Oxide*

High-acid leaching is conducted in a batch operation. The low-acid leaching residue is pulped and pumped into the high-acid leaching tank, where sulfuric acid is added. To ensure the leaching rate of Ge and Ga, the reaction temperature is controlled between 80°C and 90°C, with the endpoint acidity at approximately 120 g/L. The high leaching slurry is pumped to a high-acid leaching pressure filter for filtration. The filtrate is returned to low-acid leaching, and the filter residue is washed and then filtered again using a diaphragm filter of the same specification, with the filter residue being a lead-silver residue sent to the pyrometallurgical lead recovery system (Lead briquetting and blast furnace plant).

*(4) Copper Precipitation from Low-Acid Leaching Filtrate*

Copper precipitation from low-acid leaching liquid uses iron powder for copper removal, conducted in a batch operation. The low-acid leaching filtrate is pumped to the copper precipitation tank, where iron powder is added through a weigh-feeder. After the reaction is complete, the slurry is pumped to the copper precipitation pressure filter, with the filter residue being a copper cement, which is then filtered again using a diaphragm filter of the same specification before being sold. The filtrate is pumped to the Ge and Ga extraction process.

*(5) Iron and Arsenic Removal from First-Stage Ga Extraction Residue*

Iron and arsenic removal from the first-stage Ga extraction residue uses needle-like iron ore for iron removal, conducted in a continuous operation. Limestone is added as a neutralizing agent, and oxygen is introduced as an oxidizing agent to slowly oxidize Fe2+ to Fe3+, allowing iron to precipitate in the form of iron ore. After the reaction, the slurry is pumped to the iron-arsenic residue pressure filter for filtration, with the filtrate returning to neutral leaching and the filter residue being iron-arsenic residue which must be disposed in a triple lined hazardous waste disposal facility or processed in the copper smelter.

### 3.4.4 Purification of the Zn electrolyte

Purification mainly includes chlorine removal and two stages of purification with Zn powder. Chlorine removal, washing, and the two stages of purification with Zn powder are all configured in the zinc oxide leaching plant. The principle of the 2-stage purification by Zn powder is to replace chlorine, copper, cadmium, cobalt and other impurities in the middle supernatant liquid by reducing with Zn powder.

Chlorine removal: The clear liquid after neutral leaching and copper residue slurry are simultaneously added to the chlorine removal tank. After the reaction is complete, the mixture is pumped to the chlorine removal pressure filter for filtration, with the filtrate sent to the first-stage purification tank. The filter residue is pulped and reacted with high-temperature alkaline liquid in the pulping tank, then pumped to the chlorine washing pressure filter. The filtrate is sent to a specialized effluent treatment facility, while the filter residue, which is a copper residue, returns to the chlorine removal process for reuse.

The first-stage purification is conducted in a continuous operation. Chlorine removal filtrate and zinc powder are added for reaction. After the reaction is complete, the slurry is pumped to the first-stage purification pressure filter for filtration. The filtrate is heated in a heat exchanger before being sent to the second-stage purification tank; the filter residue is pulped and pumped to the copper residue leaching tank for leaching. After the reaction is complete, the slurry is pumped to the copper residue leaching pressure filter for filtration, with the filtrate returning to neutral leaching, and the filter residue containing copper, which is then filtered again using a diaphragm filter of the same specification before being sold.

The second-stage purification is conducted in a continuous operation. Heated first-stage purification filtrate, zinc powder, and antimony salt are added for reaction. After the reaction is complete, the slurry is pumped to the second-stage purification pressure filter for filtration. The resulting filter residue is pulped and returned to the first-stage purification tank, while the filtrate is called new liquid, which is cooled and sent to the new liquid storage tank in the electrolysis workshop.

### 3.4.5 Zinc Electrolysis

The new liquid sent from the purification process is at a temperature of approximately 40°C, mixed with waste electrolyte cooled to about 34°C in an air-cooling tower. The

mixing tank controls the mixing ratio of new liquid to waste electrolyte (1:15 to 20) to ensure the electrolysis tank operates at a temperature between 37°C and 42°C. The mixed electrolyte enters each electrolysis tank through the main trough. Lead-silver alloy is used as the anode and rolled pure aluminium plates serve as the cathode. Under the influence of direct current, zinc is deposited on the cathode while oxygen is released at the anode.

The cathode deposition cycle lasts 24 hours. When discharging from the electrolysis tank, the crane removes half of the cathode separators from the electrolysis tank for zinc stripping. The zinc pieces deposited on the cathode plates are manually stripped and then washed and transported back to the original electrolysis tank.

The waste electrolyte flowing out of the electrolysis tank enters the waste electrolyte circulation tank via the waste liquid trough. After cooling in the cooling tower, part of the waste electrolyte is sent to the leaching plant, while most of the waste electrolyte is pumped to the cooling tower for cooling before being mixed with the new liquid sent from the purification workshop, entering the electrolysis tank for electro-deposition.

The electrolysis tank is cleaned approximately every 20 days, using vacuum suction for the cleaning process. The extracted anode mud is vacuumed into a vacuum liquid receiving tank and then placed in an anode mud filtering box for filtration, with the resulting slurry pumped to the leaching plant.

### 3.4.6 Melting and Casting

The cathode zinc pieces produced in the electrolysis plant are transported to the foundry by forklift. The foundry is equipped with an induction furnace and a quantitative casting line for zinc ingots. The furnace temperature is controlled between 440°C and 490°C. After the zinc melts, an appropriate amount of ammonium chloride is added, stirred, and the floating slag is skimmed off after which the purified Zn is cast into ingots. The refined zinc ingots are labelled by an automatic printing device that codes each ingot, followed by robotic stacking and bundling for storage or shipment.

## 3.5 Germanium-Gallium Synergistic Extraction

The Ge and Ga extraction process mainly includes Ge and In extraction, pre-neutralization of the Ga extraction residue, two stages of Ga extraction, Indium back-extraction, and Germanium back-extraction. The liquid after Ge precipitation is evaporated and concentrated to obtain a Ge concentrate; the liquid after the second back-extraction of Ga is evaporated and concentrated, arsenic is removed, and Ga is precipitated to obtain a Ga concentrate.

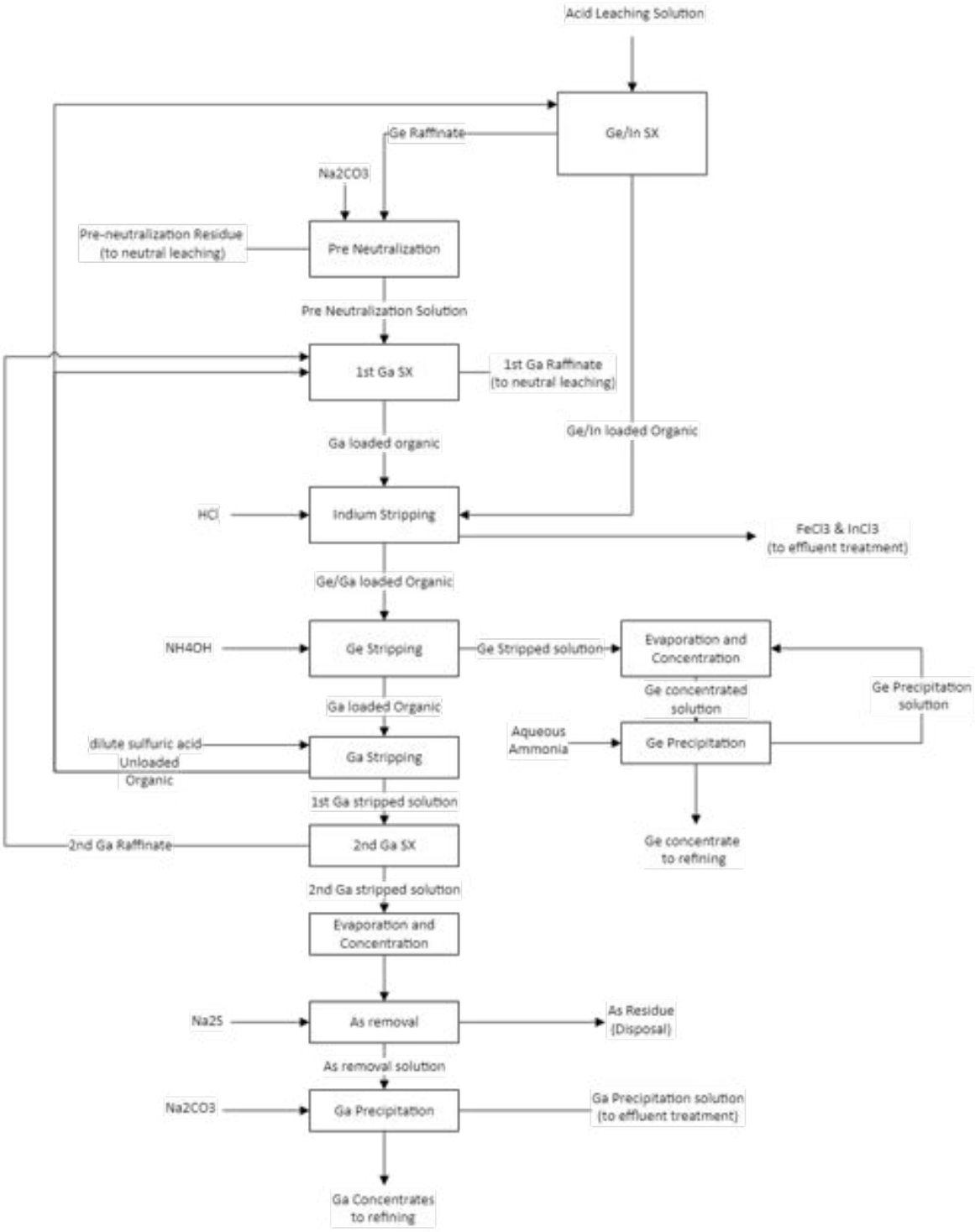


*Figure 3.7: Gallium and Germanium extraction block flow diagram*

### 3.5.1 Germanium– Indium Extraction

The acid leachate obtained from zinc oxide leaching is first subjected to extraction of germanium and indium under high acid conditions using P204+YW100. A mixer clarifier is used for the extraction of germanium and indium and the resulting germanium-rich organic phase is sent to the pre-neutralization process, while the indium-rich organic phase is sent to the indium back-extraction process.

### 3.5.2 Pre-neutralization of germanium-rich Organic Phase

Since the pH required for gallium extraction is higher than that for indium and germanium, the germanium-rich organic phase needs to be pre-neutralized to approximately pH 1.7 before gallium extraction. Sodium carbonate is added as a neutralizing agent during the pre-neutralization process. After neutralization, the slurry is subjected to pressure filtration, and the resulting pre-neutralized liquid is sent to the first gallium extraction, while the pre-neutralization residue is sent to the neutral leaching process.

### 3.5.3 First Gallium Extraction

Chemical extractants P204 (also known as di-(2-ethylhexyl) phosphoric acid) andYW100 (a hydroxamic acid extractant used in combination with P204 to enhance the efficiency and selectivity of the extraction process) are used to extract gallium from the germanium-rich organic phase, and the resulting gallium-rich organic phase is sent to indium back-extraction, while the first gallium extraction residue is sent to the neutral leaching process.

### 3.5.4 Indium Back-Extraction

After combining the indium-rich organic phase and the gallium-rich organic phase, hydrochloric acid (6N) is used for the back-extraction of indium and iron. The resulting gallium-rich organic phase is sent to germanium back-extraction, while the liquid after indium back-extraction mainly consists of iron chloride and indium chloride in hydrochloric acid solution. Due to the low indium content, the liquid after indium back-extraction is sent to wastewater treatment.

### 3.5.5 Germanium Back-Extraction

The gallium-rich organic phase is subjected to germanium back-extraction using ammonia water, and the resulting gallium-rich organic phase is sent to gallium back-extraction, while the liquid after germanium back-extraction is sent to the germanium concentrate preparation process.

### 3.5.6 Gallium Back-Extraction

The gallium-rich organic phase undergoes gallium back-extraction using dilute sulfuric acid, and the resulting organic phase is sent to both germanium-indium extraction and first gallium extraction processes. The liquid after the first gallium back-extraction is sent to the second gallium extraction process. Due to the high solubility and significant loss of YW100, a portion of the YW100 extracting agent is supplemented before gallium extraction.

## 15.1 Germanium Concentrate Preparation

The liquid after germanium back-extraction is concentrated and enriched for germanium using single-tank evaporation. Ammonia water is then used as a precipitating agent for germanium precipitation. The slurry after germanium precipitation is subjected to solid-liquid separation using a pressure filter, yielding germanium concentrate, which is sent

to rare metal processing for germanium refining. The liquid after germanium precipitation still contains a small amount of germanium, which is combined with the liquid after germanium back-extraction and sent to the evaporation concentration process.

### 3.5.7 Gallium Concentrate Preparation

The liquid after the second gallium back-extraction is subjected to second gallium extraction using N503 (N503, also known as **N,N-bis(1-methylheptyl)acetamide)** and secondary octanol as extracting agents. The resulting second gallium extraction residue is sent to the first gallium extraction process, while the gallium-rich organic phase is back-extracted using dilute sulfuric acid. The resulting organic phase is returned to the second gallium extraction process, and the liquid after the second gallium back-extraction is sent to the evaporation concentration process.

The liquid after the second gallium back-extraction is concentrated and enriched for gallium using single-tank evaporation. Sodium sulphide is then used for arsenic precipitation and the resulting arsenic residue is returned to the pyrometallurgical process. The liquid after arsenic precipitation is treated with sodium carbonate as a precipitating agent for gallium precipitation. The slurry after gallium precipitation is subjected to solid-liquid separation using a pressure filter, yielding gallium concentrate, which is sent to rare metal processing for gallium refining, while the liquid after gallium precipitation is sent to effluent treatment.

### 3.5.8 Germanium Refining

The process of producing metallic Germanium from the Germanium concentrate received from the gallium-germanium extraction separation process consists of several steps, including the treatment of germanium concentrate (drying, grinding), production of germanium dioxide (chlorination distillation, re-distillation, rectification, hydrolysis), and production of germanium ingots (reduction, zone refining), as illustrated in the germanium refining process flow.

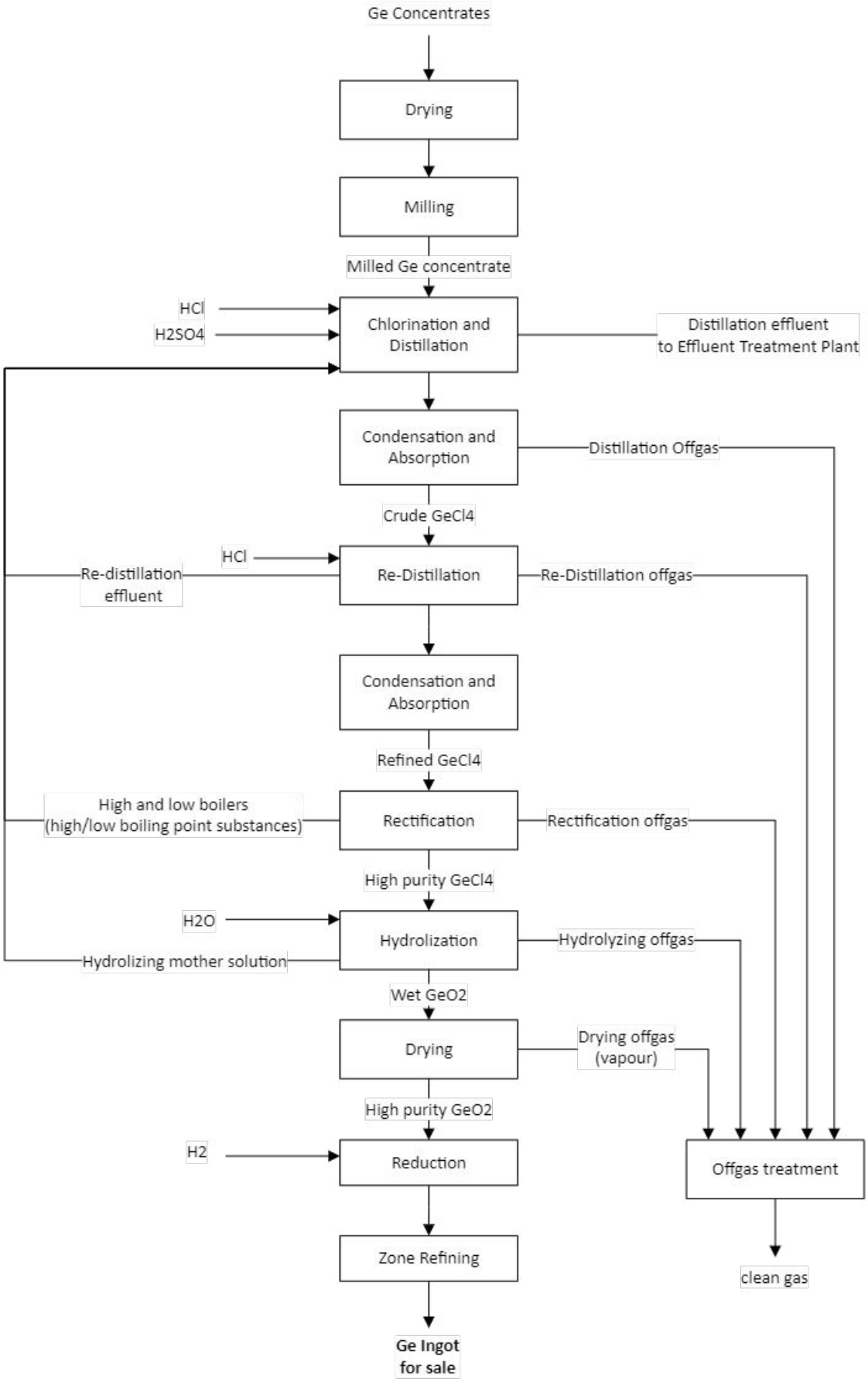


*Figure 3.8: Germanium refining block flow diagram*

### 3.5.9 Germanium Concentrate Treatment

The Germanium concentrate sent from the gallium-germanium extraction and separation process is in the form of a wet residue, which first needs to be dried and have ammonia ($NH_3$) removed. The dried product is sent to a Raymond mill to be ground to 200 mesh, and the qualified germanium concentrate powder is sent to the raw material storage for the germanium dioxide process.

## 15.2 Germanium Dioxide Production

### 3.5.10 Chlorination Distillation

The Germanium concentrate powder is first weighed and then charged to the chlorination distillation kettle. A certain amount of hydrochloric acid and sulfuric acid is added in proportion, and steam is introduced for heating to carry out the reaction. During the chlorination leaching process, most of the Ge is leached from the Ge concentrate, and some other impurity elements are also partially leached out.

As the reaction proceeds, the different boiling points of the chlorination products are utilized, allowing the reaction product germanium tetrachloride ($GeCl_4$) to volatilize from the chlorination distillation kettle, condensing into liquid germanium tetrachloride ($GeCl_4$) in the condensation device, along with a small amount of hydrochloric acid (HCl). Most of the other elements remain in the residual liquid in chloride form. The residual liquid from the chlorination distillation is sent to the effluent treatment plant.

### 3.5.11 Re-Distillation

The germanium tetrachloride ($GeCl_4$) obtained from chlorination distillation is charged into the re-distillation kettle, and hydrochloric acid is added in a certain proportion, using steam for heating. The residual liquid from re-distillation returns to the chlorination distillation process, low boiling point substances are sent for the next re-distillation, and the intermediate boiling point fraction is the refined germanium tetrachloride ($GeCl_4$), which is collected and sent for further purification in the rectification process.

### 3.5.12 Rectification

The germanium tetrachloride ($GeCl_4$) from the re-distillation product is added to the rectification column, which is electrically heated using resistance wire. Low boiling point and intermediate boiling point substances are sequentially collected, while high boiling point substances remain in the kettle, which are discharged after the reaction is complete.

Both high and low boiling point products generated during rectification return to the re-distillation process, with the product being high-purity Germanium tetrachloride ($GeCl_4$) sent to the hydrolysis process.

### 3.5.13 Hydrolysis

In the hydrolysis reaction, pure water and germanium tetrachloride are added for hydrolysis. After the addition is complete, stirring continues for a period to ensure the complete hydrolysis of germanium tetrachloride ($GeCl_4$).

The hydrolysis slurry is sent to a centrifuge for centrifugation, with the solid being high-purity Germanium dioxide ($GeO_2$), which is washed and then dried at 130–140°C. After drying, it is weighed and packaged and after passing inspection, it is stored. The hydrolysis mother liquor and wash liquid return to the chlorination distillation process.

## 15.3 Germanium Ingot Production

The production process of zone-refined Germanium ingots consists of reduction, ingot casting, and zone refining.

### 3.5.14 Reduction

The dried Germanium dioxide is reduced in a reduction furnace at a temperature of 650°C with hydrogen gas to obtain reduced germanium granules.

### 3.5.15 Ingot Casting

The reduced germanium granules are melted and cooled in an ingot casting furnace at a temperature of 1000°C to obtain coarse germanium ingots.

### 3.5.16 Zone Refining

The coarse germanium ingots are purified in a zone refining furnace, with unqualified portions being cut off. The qualified portions are sent for etching treatment to obtain zone-refined germanium ingots, which are then packaged as products for sale. Unqualified zone-refined germanium ingots return to the zone refining process for re-manufacturing.

### 3.5.17 Gallium Refining

The process of producing metallic gallium from the gallium concentrate sent from the gallium-germanium extraction and separation process consists of alkali dissolution, electrolysis, and other processes, as detailed in the gallium refining block flow diagram. The Gallium refining process flow is shown in *Figure **3.9***.

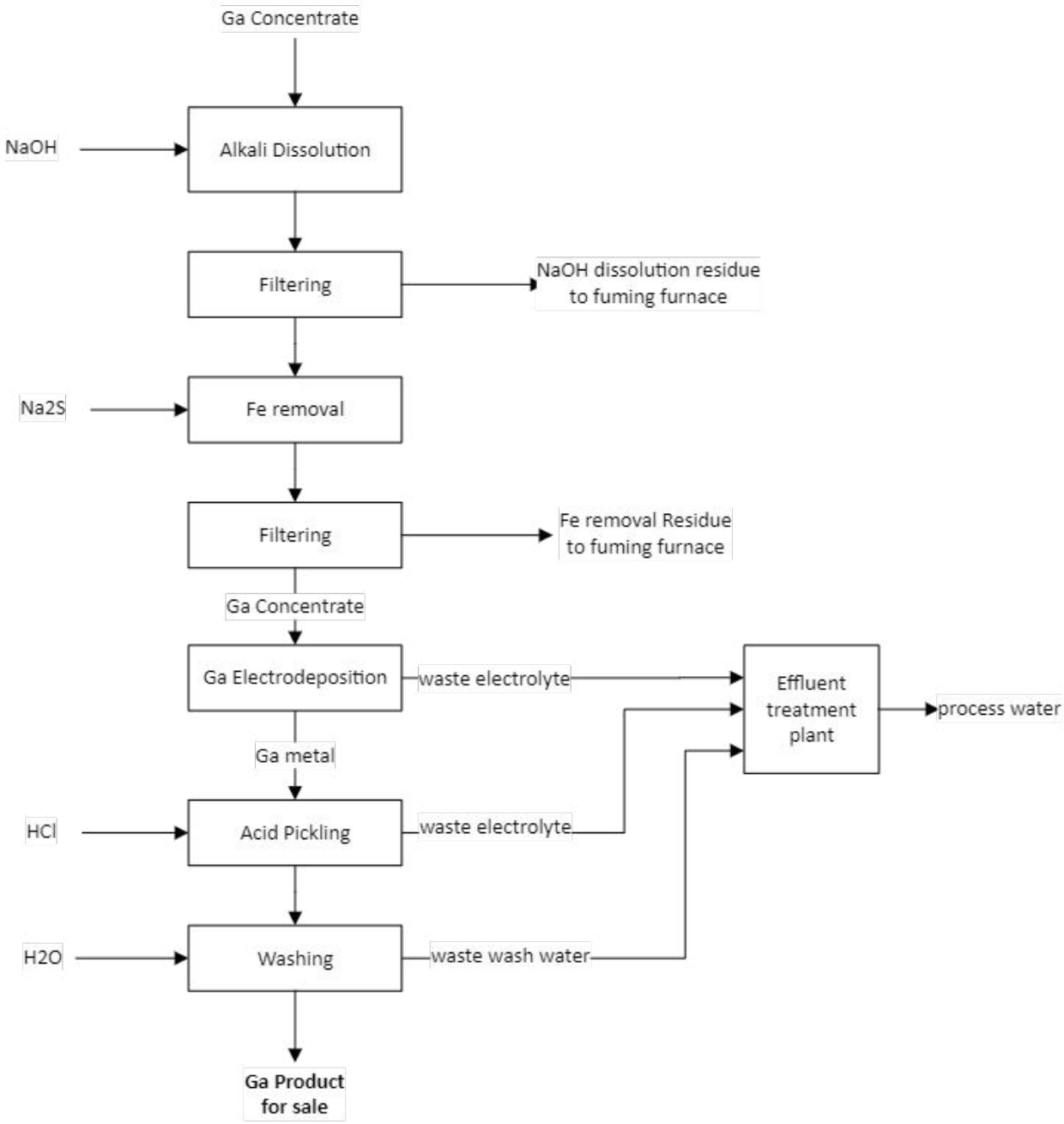


*Figure 3.9: Gallium Refining Block flow diagram*

## 3.6 Alkaline Leaching

Sodium hydroxide and water are added to the gallium concentrate for alkaline leaching with a leaching temperature above 95°C. The leachate is then filtered, and the filtrate is sent for sulfurization to remove impurities.

The sulfurization process uses a Sodium sulfide ($Na_2S$) solution at a concentration of 1.5 to 2.5 g/L, with a temperature above 95°C. The solution after impurity removal is filtered again, and the filtrate is sent for gallium electrolysis.

## 3.7 Electrolysis

The purified solution is fed into the gallium electrolysis cell, using stainless steel plates as anodes and cathodes. The current density is controlled at 1000 A/m², with a cell voltage of 3.8V to 4.5V, and the temperature of the electrolyte is maintained at 40°C to 50°C. After electrolysis, gallium with a purity of 99.99% is obtained.

The obtained gallium is first washed with 1 to 3N reagent-grade hydrochloric acid, with the washing temperature controlled at 70°C. It is then washed with pure water to yield the final product, which is gallium with a purity of 99.99%, which is then bottled and sealed.

## 3.8 Air Pollution

### 3.8.1 Zinc Slag Temporary Storage and Batching Plant

A dust removal system will be installed at the batching and belt transfer points, using a pulse bag filter (F=836m²) with an air volume of 20,850 Nm³/h; after dust removal, the cleaned air will be discharged through a 15m high exhaust stack in compliance with standards.

### 3.8.2 Slag Handling Loading Belt Gallery and Transfer Station

A dust removal system will be installed at the belt transfer point, using a pulse bag filter (F=220m²) with an air volume of 5,650 Nm³/h; for dust removal, after the air is cleaned, it will be discharged through a 15m high exhaust stack in compliance with standards.

### 3.8.3 Rotary Kiln Plant

Suction points will be installed at the loading belt head, top of the silo, feeder head, and receiving points in the loading system of the rotary kiln, forming a dust collection system that uses a pulse bag filter (F=558m²) with an air volume of 17,500 Nm³/h.

### 3.8.4 Smelting Plant

Sealed covers will be installed at various flux silos, belt conveyors, and receiving points from the silo to the feeder in the smelting furnace feed system, forming a dust collection system that uses a pulse bag filter (F=744m²) with an air volume of 21,000 Nm³/h; after dust removal, cleaned air will be discharged through a 15m high exhaust stack in compliance with standards.

### 3.8.5 Zinc Oxide Storage and Conveying

Suction hoods will be installed at the offloading points of the zinc oxide storage, forming a dust removal system that uses a pulse bag filter (F=248m²) with an air volume of 7,000 Nm³/h; after dust removal, cleaned air will be discharged through a 15m high exhaust stack in compliance with standards.

### 3.8.6 Zinc Casting Foundry and Final Product Warehouse

Fume hoods will be installed at the charging and slag discharge points of the induction furnace in the zinc casting foundry, forming a fume and dust removal system that uses a pulse bag filter (F=650m²) with an air volume of 16,500 Nm³/h; after dust removal, cleaned gas will be discharged through a 15m high exhaust stack in compliance with standards.

### 3.8.7 Pulverized Coal Storage and Loading

A dust collection system will be installed at the belt transfer point of the pulverized coal storage, using an explosion-proof pulse bag filter (F=220m²) with an air volume of 5,650 m³/h. After dust removal, cleaned air will be discharged through a 15m high exhaust stack in compliance with standards.

### 3.8.8 Pulverized Coal Preparation Plant

Sealed dust collection hoods will be installed at the discharge head of the silo loading conveyor belt, coal silo, and the discharge point of the pressure-sealed weighing feeder in the pulverized coal plant, forming a dust collection system that uses an explosion-proof pulse bag filter (F=248m²) with an air volume of 7,000 m³/h. After dust removal, cleaned air will be discharged through a 15m high exhaust stack in compliance with standards.

### 3.8.9 Lead Residue Filtration and Batching Plant

A dust removal system will be installed at the batching and belt transfer points, using a pulse bag filter (F=836m²) with an air volume of 20,850 Nm³/h; after dust removal, cleaned air is discharged through a 15m high exhaust stack in compliance with standards.

### 3.8.10 Lead Smelting Plant

Sealed covers will be installed at various flux silos, conveyor belt head, and at the discharge points from the silos to the feeders in the smelting furnace feeding system, forming a dust collection system that uses a pulse bag filter (F=744m²) with an air volume of 21,000 Nm³/h; after dust removal, cleaned air will be discharged through a 15m high exhaust stack in compliance with standards.

The dust removal systems above have an efficiency greater than 99%, and the dust concentration in the cleaned exhaust gas is less than or equal to 50 mg/m³. The exhaust gas will be discharged through exhaust stacks taller than 15m.

## 3.9 Smelting Fume Control

### 3.9.1 Side-Blown Melting Furnace

The offgas (gas and oxide fumes) from the side-blown melting furnace will be cooled by a waste heat boiler for heat recovery, and after dust removal by the electrostatic precipitator, the gas passes the desulfurization system for SO2 removal. The total dust collection efficiency is 99.65%.

The collected dust is packaged using a bulk bagging machine and temporarily stored before being transported to the hydrometallurgical processing plant.

**Gas Cleaning Process:** Side-blown melting furnace fume → Waste Heat Boiler → Electrostatic Precipitator → High-Temperature Fan → Desulfurization.

### 3.9.2 Fuming Furnace Gas Cleaning Process

The offgas from the fuming furnace will be cooled by a waste heat boiler for heat recovery, and after dust collection by the cooling flue and baghouse, it passes the desulfurization system for $SO_2$ absorption. The total dust collection efficiency is 99.9%. The collected dust will be packaged using a bulk bagging machine and temporarily stored before being transported to the hydrometallurgical processing plant.

Fuming furnace off-gas → Waste Heat Boiler → Cooling Flue → High-Temperature Baghouse → Fan → Desulfurization.

### 3.9.3 Rotary Kiln Gas Cleaning Process

The offgas generated by the rotary kiln will be cooled by a waste heat boiler for heat recovery, and after dust collection by an electrostatic precipitator, the gas passes the desulfurization system for sulfur dioxide ($SO_2$) removal by absorption. The dust collection efficiency is 99.7%, and the collected dust will be packaged using a bulk bagging machine and temporarily stored before being transported to the hydrometallurgical processing plant.

Rotary Kiln → Waste Heat Boiler → Electrostatic Precipitator → High-Temperature Fan → Desulfurization.

### 3.9.4 Lead Blast Furnace Off-gas Cleaning Process

The off gas from the lead blast furnace passes the waste heat boiler for heat recovery and after dust collection by the cooling flue and baghouse, sulfur dioxide ($SO_2$) is removed in the desulfurization system. The total dust collection efficiency is 99.9%. The collected dust will be packaged using a bulk bagging machine and temporarily stored before being transported back to the briquetting process to be reintroduced into the blast furnace.

Blast furnace Off-gas → Waste Heat Boiler → Cooling Flue → High-Temperature Baghouse → Fan → Desulfurization.

An acid mist removal system will be set up in the zinc oxide leaching plant, with an exhaust gas volume of 24,600 $m^3/h$, and the discharged exhaust gas meeting emission standards will be released into atmosphere through a 15m high exhaust stack.

### 3.9.5 Smelting Off-gas Desulfurization

The flue gas desulfurization system mainly processes three parts of flue gas, namely the flue gas from the side-blown furnace, fuming furnace, and lead blast furnace.

After dust collection, the desulfurization technology used is the limestone-gypsum method, with a desulfurization efficiency greater than 90%. The sulfur dioxide ($SO_2$) concentration in the tail gas after desulfurization does not exceed 500 mg/m³, and the tail gas will be discharged through a stack.

### 3.10 Wastewater Treatment

Domestic sewage will be treated through a sewage treatment facility according to standards and maybe considered for reuse onsite e.g. landscaping in the plant area. Acidic effluent produced by the hydrometallurgical plant and desulfurization process, is sent to the effluent treatment plant for processing. The treatment of acidic effluent uses the "lime neutralization pretreatment + lime-iron salt deep arsenic removal" process, and the treated water will be sent for use in the copper process slag beneficiation plant (slagmill) or other processes that require process water.

Effluents mainly consist of discharge water from the circulating water system, wastewater from the chemical water treatment station, periodic discharge (blow down) from the waste heat boiler room's cooling water dam and bleed water from the furnace cooling systems and the slag granulation system.Waste water is ultimately sent to the process water treatment plant dam. The clarified water is partially reused for cooling in the discharge cooling dam, for slag granulation and partially pumped to the copper process slag beneficiation plant (slagmill).

The processing plant has one initial rainwater collection dam, where the initial rainwater is partially reused for production after sedimentation and partially used in the copper process slag beneficiation plant (slagmill). Contaminated rainwater will be kept separate from clean rainwater and will be treated to remove contaminants.

### 3.11 Solid Waste Disposal

The Granulated Slag produced by the fuming furnace, rotary kiln, and blast furnace amounts to approximately 229,000 t/a (dry basis), is classified as general solid waste, which can be sold as construction additives or stored in a single lined storage facility. The calcium-magnesium residue produced by the hydrometallurgical plant is approximately 95 t/a (dry basis), is returned to the side-blown melting furnace for recovery of valuable metals. The lead residue produced by the hydrometallurgical plant is approximately 12,000 t/a (dry basis), is sent to the blast furnace for lead recovery.

The arsenic-iron residue produced by the hydrometallurgical plant is approximately 7,000 t/a (dry basis), classified as hazardous waste, and is stored in a Class A (according to South African Standards) hazardous waste landfill facility. Two options which will be considered are to (a) dispose onsite in the existing triple lined facility which is designed for arsenic bearing wastes or (b) taken offsite to a triple lined facility based on quantity and subsequent approval by the regulator.

The neutralization residue produced by the effluent treatment plant is approximately 900 t/a (dry basis), classified as hazardous waste, and is stored in a Class A or triple lined hazardous landfill of a third party or own operation in the desert.

The desulfurization process of the fuming furnace, rotary kiln, and blast furnace produces approximately 9,000 tons per year (dry basis) of gypsum, which will be sent to a single lined waste storage facility.

### 3.12 Noise Control

The main equipment generating high noise levels in this project includes the waste heat boiler steam release pipe, high-temperature ID fan, centrifugal blower, and air compressor, all of which exceed 85 dB(A) in noise level. For these high-noise equipment, in addition to measures such as installing vibration isolation pads and installing soundproofing mechanisms. This high noise equipment are also placed inside buildings to utilize building sound insulation to reduce the impact of equipment noise on the external environment.

# 4. FOOTPRINT

## 4.1 Available Waste Material and Volumes

(229 000 t/a fuming furnace slag and Pb Blast furnace slag, 900 t/a effluent treatment residues, 7000 t/a AsFe residue, 9000 t/a gas desulphurization residue (gypsum)

| Total Material processed Mass per year | Coverage Area | Timeframe | Waste |
|---|---|---|---|
| 200 000 t/a | 28 ha | 15 years | 245 900 t/a |

## 4.2 Transportation and Traffic Management

The mode of transport being considered is the conveyor belts as the first option and also transportation by the onsite haul trucks which is estimated to be 16,500 loads per annum.

It is important to note that the raw material is already on site. Only the reagents and other consumables which be imported.
Further, a total of 10870 t/a of Zinc product will be transported to the port using existing transportation agreement with TransNamib and other service providers.

All 3 processes, from the port to smelter:
Raw material: 350 000 t/a (7000 waggon loads)
Coal & coke: 92000 t/a (2000 waggon loads)
From smelter to port:
Copper + Zink + Cs products + by products: 75 000 t/a (1500 waggon loads)

## 4.3 Surface Area – Footprint

45.9 ha (includes TSF – Tailings storage facility)
Phase 1: 1 ha
Phase 2: 16.9 ha
TSF: 28 ha (a new TSF will be constructed)

## 4.4 Water Requirements

The process is expected to consume 4387 $m^3$/d fresh raw water from the mine shaft. 1413 $m^3$/d of wastewater is produced which is stored in a dam and partially treated for recycle and partially evaporated.

The pumps, pipelines will be upgraded to ensure more pumping capacity.
Sinomine will request for amendment of the water abstraction permit to add the additional expected water consumption.

## 4.5 Energy Requirements

Phase 1: 2MW, Phase 2: additional 23.42 MW, Total Phase 1 & 2: 25.42 MW

Power source is Nampower, annual energy consumption is 128000 MWh and waste heat power recovery of 39000 MWh will be installed.

There is insufficient capacity at the substation for all 3 processes. Nampower will need to install a second 132 kV supply line for the second 40MW (132/11 kV) transformer and ideally another standby system in case one transformer fails. Further upgrades required on Nampower side to deliver the total 53 MW on the 132 kV side need to be confirmed

## 4.6 Environmental and Social Safety

### 4.6.1 Environmental Safety

Dust emissions will be a concern.
The raw slag contains heavy metals.
Dust suppression need to be implemented during loading of the material. This will be by means of moisturizing the material on the surface.

### 4.6.2 Occupational Exposure

The health effects are mainly related to dermal exposure and inhalation with irritant properties. The use of appropriate personal protective equipment and observation of safe handling procedures of chemicals will reduce the likelihood of exposure (uptake of chemical by the recipient).

Material safety monitoring systems for employees will include hygiene monitoring where the workplace air concentrations of the material will be measured. The medical surveillance including the required biological monitoring of employees will be informed by the risk as quantified by the workplace air quality sampling.

In summary, the current occupational health and safety risk management program will extend to this plant factoring the new risk factors.

### 4.6.3 Community Safety and Zone of Influence

Current environmental monitoring programs (air, water, soil and waste) will be reviewed and updated to cover the potential contaminants from this project (arsenic, Lead, Zinc, Cadmium, sulfur dioxide ($SO_2$), dust etc), however with improved technologies (able to recycle some waste) and lined waste facilities for final disposal, impact would be reduced in comparison with current smelter technology.

Additional Hazards:
Organic substances used for solvent extraction,
Various reagents (acidic and alkaline used for the hydrometallurgical process,
Community exposures – the system design is meant to reduce the occurrence of airborne pollutants through the high efficiency bagging system, thus minimal community exposure

The zone of influence will be similar the current copper smelting operation. Key concerns will be related to particulate matter (dust) and $SO_2$).

# 5. LEGAL FRAMEWORK

This chapter outlines the regulatory framework applicable to the proposed project. Table 5.1 provides an overview of applicable policies, plans and strategies and Table 5.2 provides a list of applicable national legislation.

## 5.1 The Namibian constitution

The Namibian constitution is the supreme law of the country and makes provision for environmental protection and sustainable development. Article 95(1) of the Constitution of Namibia states that:- "*The State shall actively promote and maintain the welfare of the people by adopting policies aimed at the maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilization of living natural resources on a sustainable basis for the benefit of all Namibians, both present and future*".

To fulfil the Article 95 of the Constitution, in 2007, the Government for the Republic of Namibia enacted the Environmental Management Act (Act No. 7 of 2007) and subsequently, the EIA Regulations of 2012 (Government notice no: 30 of 2012).

## 5.2 The Environmental Management Act No.7 of 2007

The Environmental Management Act (Act No.7 of 2007) aims to promote the sustainable use of natural resources and provides the framework for the environmental and social impact assessment, demands precaution and mitigation of activities that may have negative impacts on the environment and provision for incidental matters. Furthermore, the act provides a list of activities that may not be undertaken without an environmental clearance certificate. The purpose of the Environmental Management Act is:

a) to ensure that people carefully consider the impact of developmental activities on the environment and in good time
b) to ensure that all interested or affected people have a chance to participate in environmental assessments
c) to ensure that the findings of environmental assessments are considered before any decisions are made about activities which might affect the environment

### 5.2.1 The Environmental Management Plan

In-addition to the EIA scoping exercise, the Environmental Management Act stipulates that for each activity undergoing an EIA process, an Environmental Management Plan (EMP) should be developed.

The EMP outlines mitigation measures against specific steps, stages or processes of the proposed development. Thus, the EMP can be defined as the tool used to prevent / minimize the impacts identified during the EIA process. For accountability, the EMP outlines specific roles and responsibilities for the role-players, and non-compliance is punishable by law.

**Table 5:1: Listed Activities triggered by the proposed Multi-Metal Recycling Project**

| Activity | Specific Activity | Proposed Activity |
|---|---|---|
| **Activity 1.** Energy Generation, Transmission and Storage Activities | *1.1 The construction of facilities for*<br><br>*a) Generation of electricity*<br>*Transmission and supply of electricity* | Increased energy demand for the additional activities for the Project. Ensure that there is agreement to increase energy supply from the energy supplier to the Tsumeb Smelter. |
| **Activity 2.** Waste Management, Treatment, Handling and Disposal Activities | *2.1 The construction of facilities for waste sites, treatment of waste and disposal of waste.* | The proposed project will be generating waste from the processing units. This waste will be handled onsite. |
| Activity 4 Forestry Activities | *4 The clearance of forest areas, deforestation, afforestation, timber harvesting or any other related activity that requires authorization in terms of Forest Act, No. 12 of 2001; or any other law* | Although the will be established within the existing land boundaries of the smelter, there may be a need to clear some vegetation to allow for construction activities and a permit maybe required from Forestry. |
| Activity 6 Tourism Development Activities | *6.0 construction of resorts, lodges, hotels or other tourism and* ***hospitality facilities*** | *construction and operation of contractor camp during the construction of the proposed project* |
| **Activity 8.** Water Resources Developments | *8.2 The abstraction of groundwater at a volume exceeding the threshold authorized in terms of a law relating to water resources* | Increased water demand for the additional activities of the project. Ensure that there is a water abstraction permit to cover for the additional activities of the project. |
| | *8.6 Construction of industrial and domestic wastewater treatment plants and related pipeline systems.* | The project will require extension of pipelines to transfer wastewater from the plant to the wastewater ponds. Wastewater will be treated to reduce energy consumption and reduce overall wastewater volumes |
| **Activity 9.** Hazardous Substance Treatment, Handling and Storage | *9.1 The manufacturing, storage, handling or processing of hazardous substance defined in the Hazardous Substances Ordinance, 1974* | Residues of the project are potentially hazardous substances and appropriate mitigation measures should be adopted and implemented. |

**Table 5:2: Policies, Plans and Strategies**

| Policy / Plan | Relevancy/Summary | Applicability to the Proposed Project |
|---|---|---|
| 5th National Development Plan (NDP) and Vision 2030 | Outlines the country's national development ambitions, in line with the Harambee Prosperity Plan, and Vision 2030. NDP5 incorporates the principles and recommendations contained in the Stockholm Declaration on the Human Environment (1972) and associated Action Plan, as well as Agenda 21 which merged from the Convention on Biological Diversity, Rio De Janeiro (1992). | The proposed project is a development that forms part of the bigger picture of achieving economic progression, social transformation and environmental sustainability. |

**Table 5:3: National Statutes**

| National Statutes | Relevance/Summary | Applicability to the Proposed Project |
|---|---|---|
| Environmental Management Act, 2007 (Act No. 7 of 2007) and associated regulations, including the Environmental Impact Assessment Regulation, 2007 (No. 30 of 2011). | The Act aims to promote sustainable management of the environment and the use of natural resources by establishing principles for decision-making on matters affecting the environment. It sets the principles of environmental management as well as the functions and powers of the Minister. The Act requires certain activities to obtain an environmental clearance certificate before project development. The Act states that an EIA may be undertaken and submitted as part of the environmental clearance certificate application | This EIA report (and EMP) documents the findings of the EIA process undertaken for the proposed project, which will form part of the environmental clearance application.<br><br>The EIA process and associated report have been undertaken in line with the requirements under the Act and associated regulations |

| National Statutes | Relevance/Summary | Applicability to the Proposed Project |
|---|---|---|
| Pollution Control and Waste Management Bill (in preparation and considered as best practice rather than law | The Pollution Control and Waste Mangement Bill, intents to regulate and prevent the discharge of pollutants into the air and water as well as providing for general waste management. Upon gazettement, the Bill will repeal the Atmospheric Pollution Prevention Ordinance (11 of 1976). The Bill also provides for noise, dust or odour control that may be considered a nuisance. Furthermore, the Bill advocates for duty of care with respect to waste management affecting humans and the environment and advocates for a waste management licence for any activity relating to waste or hazardous waste management. | The proposed Multi-Metal Recycling project will be handling material that is classified as hazardous. Precautionary mechanism will be established to prevent spillage and pollution risks emanating from mishandling of material. |
| Water Resources Management Act, 2013 (No. 11 of 2013) | The Act 2013 came in force in August 2023 and provides a framework for managing water resources based on the principles of integrated water resource management. It provides for the management, protection, development, use and conservation of water resource, and for the regulation and monitoring of water services and for incidental matters | The Act sets out obligations in order to avoid water pollution<br>Section 44 stipulates the requirements for a licence to be held for the abstraction and use of water.<br><br>Section 68 makes provisions for water pollution. Section 69 and 72 makes provisions for wastewater treatment plants and stipulates the requirement for a licence to operate wastewater treatment plant and discharge effluent.<br><br>These have been incorporated into the EMP to minimise water pollution. |
| Soil Conservation, (Act 76 of 1969) and Amendment (Act 38 of 1971) | Makes provision for the prevention and control of soil erosion and the protection, improvement and the conservation, improvement and manner of use of the soil and vegetation. | Through vegetation removal there may be the risk of affecting soil quality. Measures shall be taken to avoid this which are set out in the EMP. |

| National Statutes | Relevance/Summary | Applicability to the Proposed Project |
|---|---|---|
| Forest Act 12 of 2001<br>Forest Act Regulations 2015 | To provide for the protection of the environment and the control and management of forest.<br>The Act and Regulations have the following stipulations that may be relevant to the proposed project:<br>- Provision for the protection of various plant species. This includes the proclamation of protected species of plants and the conditions under which these plants can be disturbed, conserved, or cultivated. | There may be some vegetation removal as part of establishing the proposed project.<br>The proponent shall undertake all activities in line with the conditions stipulated in the Permit and a valid permit shall be obtained throughout vegetation clearance activities.<br>It is unlikely that a permit shall be required. |
| National Heritage Act, No. 27 of 2004. | The Act provides for the protection and conservation of places and objects with heritage significance. | There is potential for heritage objects to be found on the development site, therefore the stipulations in the Act have been taken into consideration and are incorporated into the EMP. |
| Public and Environmental Health Act (Act No. 1 of 2015) | The Public Health Act aims to protect the public from nuisance and states that no person shall cause a nuisance or shall suffer to exist on any land or premises owned or occupied by him or of which he is in charge any nuisance or other condition liable to be injurious or dangerous to health. | The proponent should ensure that the workers are provided with protective gear to safeguard their wellbeing. The activities should also be conducted in a manner that does not pose any danger to the general public and that any emissions which could be considered a nuisance should be contained at acceptable levels. |
| Labour Act No. 11 of 2007 | Occupational Health is aimed at the promotion and maintenance of the highest degree of physical, mental and social wellbeing of workers in all occupations. This is done by ensuring that all work-related hazards are prevented and where they occur, managed. | In order to maintain good and healthy standards, at the workplace, cleanliness, adequate sanitary facilities, protection against dangerous substances as well as education and training of both workers and management is necessary. |

| National Statutes | Relevance/Summary | Applicability to the Proposed Project |
|---|---|---|
| Regional Councils Act, 1992 (Act No. 22 of 1992) | The Regional Councils Act legislates the establishment of Regional Councils that are responsible for the planning and coordination of regional policies and development. The main objective of this Act is to initiate, supervise, manage and evaluate regional development. The Regional Council is considered to be an interested and affected party (I&AP) and reserve the right to comment on the project and EMP. | The proposed project need to be assessed in consideration with other development projects in the area or region and in particular with regards to shared resources e.g water, electricity etc to create a balance and prevent competition or deprivation other projects. Project needs to be aligned from a regional development agenda perceptive |

### 5.3 Precautionary Approach Principle

This principle is worldwide accepted when there is a lack of sufficient knowledge and information about proposed development possible threats to the environment. Hence if the anticipated impacts are greater, then precautionary approach is applied.

### 5.4 Polluter Pays Principle

This principle ensures that proponent takes responsibility of their actions. Hence in cases of pollution, the proponent bears the full responsibility and cost to clean up the environment.

# 6. THE RECEIVING ENVIRONMENT

The environmental baseline for the proposed project has been collected through a desktop study as well as a site assessment.

## 6.1 Regional Baseline

The general landscape of the Tsumeb Smelter site is a mountainous, hills and rocky terrain. The area is classified as the Karstveld vegetation type, and it is characterised by large open spaces of grasslands dotted with Acacia trees and falls under the Acacia tree and shrub Savanna sub-biome, which is one of the largest biomes in Namibia.

### 6.1.1 Climate

The average annual temperature of the area is between 20 – 22°C, with an average maximum of 32 - 34°C and minimum of 4 - 6°. The hottest month usually being December and coolest month being July, with an average of 1 to 5 frost days per year.

Between 500 to 550 mm of rainfall falls on the Tsumeb area annually (Median value, usually during the months of October to April, with January and February as the wettest months. The rainfall is significantly more than most areas of Namibia, which is due to moist air being forced upward by the hills in that area. The average evaporation rates for the area are between 2,100 – 2,240 mm per year[3].

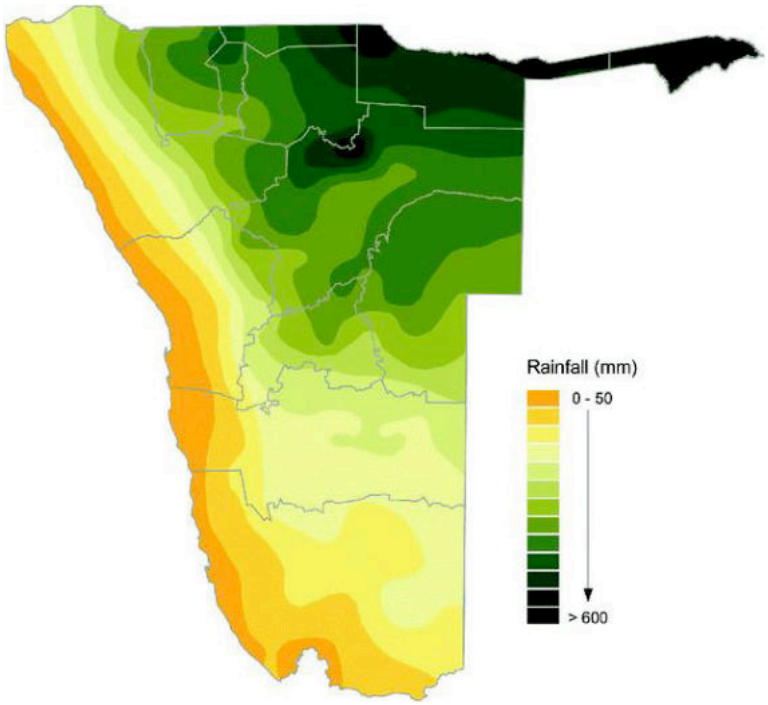


*Figure 6.1: Namibia rainfall pattern*

[3] *Assessment of the Contamination Risks to the Groundwater and Soils at the Tsumeb Smelter, Report. 2011*

### 6.1.2 Geo-hydrology

Tsumeb falls within the Etosha Basin Hydrogeological Region, which is an inland drainage system where runoff flows into the Etosha Pan. The average groundwater levels in Tsumeb are approximately 60m below ground level, with little seasonal fluctuations in the levels.

Groundwater occurs in the Tsumeb Dolomitic Aquifer, which naturally flows in a northly direction to the Owambo basin, although dewatering from the mine has caused a reversal in the groundwater flow over a portion of the site[6]. This groundwater system provides water to the town, nearby farms and the ecosystems.

### 6.1.3 Sustainability of Tsumeb Aquifer

The current abstraction by the smelter is approximately 1,3 $Mm^3$ per annum and the other users such as municipality and neighbouring farmers abstract water more than 3,5 $Mm^3$ per annum. The literature further suggests that Tsumeb aquifer has a potential sustainable yield of up to 18 $Mm^3$ per annum (SLR, 2019). Considering the proposed additional water requirement by this project and if these historic projections are still valid, Tsumeb Aquifer has enough water to sustain the abstraction of additional water in excess of 1,277,500 $m^3$ per annum.

These projections can be updated from time to time to incorporate the new data on the current and future actual abstraction rates for both the smelter and other users, as well as climatic conditions such as rainfall, recharge rates, evaporation among others.

### 6.1.4 Surface Hydrology

There is little surface run-off from the Karstveld landscape, and no major rives drain it. The closest major ephemeral river is the Owambo river approximately 55km to the north of the site.

The surrounding hills around the smelter site result in surface runoff (during the rainy season) flowing into the catchment area that covers much of the site. Clean runoff from surrounding hills is directed around the smelter, preventing contact with any contaminants on site. A drainage line, called the Jordan River is located on the western boundary, receives surface runoff from the site's catchment area, as well as the catchment area of Tsumeb. The river flows in a south-northerly direction, where it drains into the ground. The river is classified as a natural ephemeral river but receives surface water from the central business area in Tsumeb all year round[4].

The assessment undertaken by SLR as part of Tsumeb smelter expansion in 2019 recommended a surface water monitoring programme to be undertaken in the Jordan River. It is recommended that five sampling sites be established along the river to the west of the smelter complex as indicated in figure 6. Two additional sampling sites can

[4] DPMT Consolidated ESMP for the proposed expansion of the Tsumeb Smelter by SLR, 2019

be located where the main drainage line enters the Jordan River to enable monitoring of water discharged from the smelter site [5]

[5] DPMT Consolidated ESMP for the proposed expansion of the Tsumeb Smelter by SLR, 2019

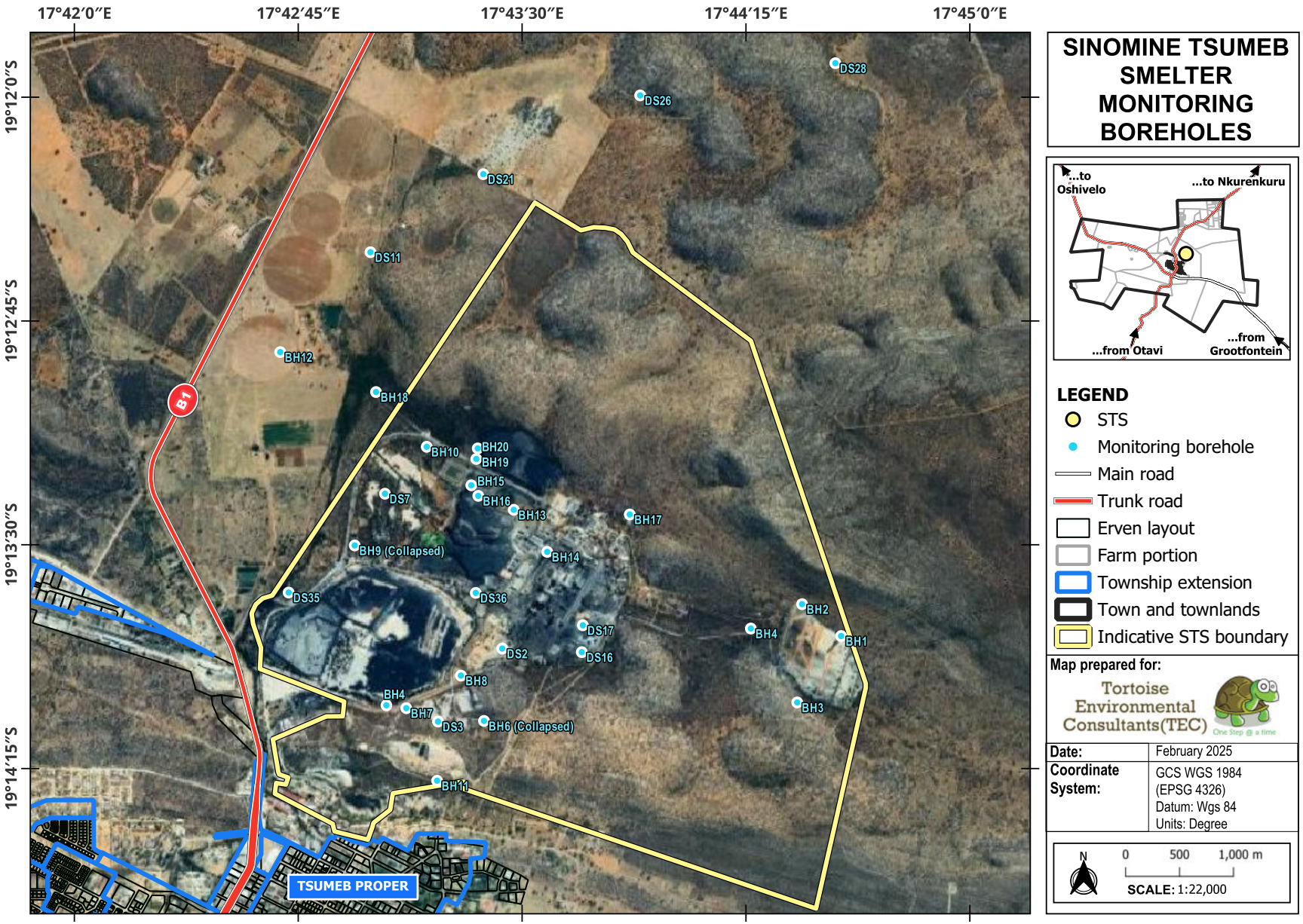


*Figure 6.2: Location of Boreholes for Groundwater monitoring (TEC,2025)*

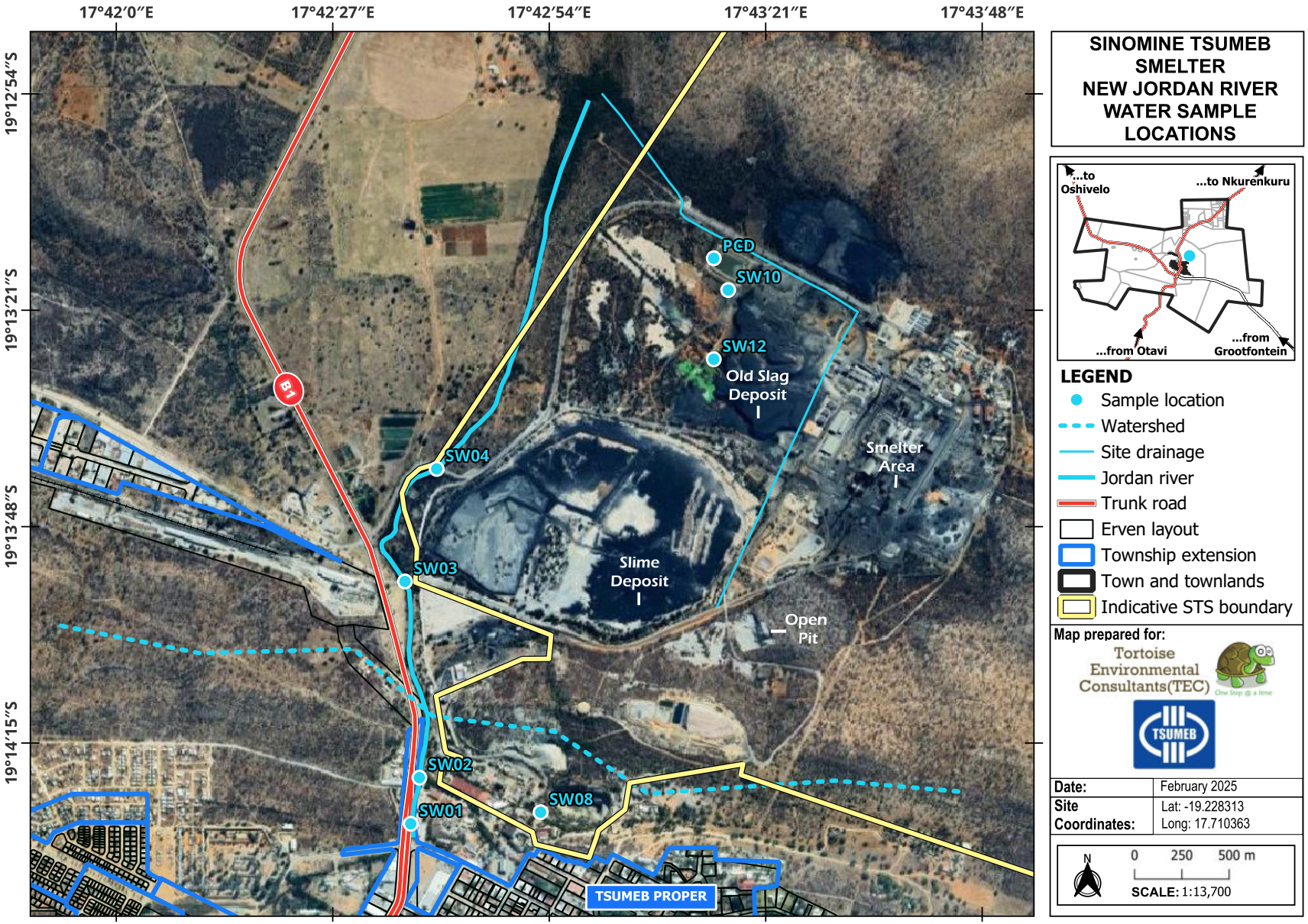


*Figure 6.3: Location of surface water sampling points along the Jordan River (TEC,2025)*

### 6.1.5 Geology

The geology of the Tsumeb area is characterized by dolomites of the Otavi Group (composed entirely of shallow marine deposits), which is a subgroup of the Damara Supergroup and Gariep Complex[6]. The smelter is located on the dolomites of the Huttenburg Formation. These dolomites house the Tsumeb deposits which contain an extraordinary diversity of ores.

The Tsumeb area is considered as being in a high soil fertility zone, however high fertility soil may not cover the whole of the area and varies in quality from very fertile red loam through black turf to chalky clay and loam. Tsumeb is located at the end of a seam of soil which is dominant in Chromic Luvisols soil; soils with bright colours which has good water-holding capacity and is well drained. Luvisols typically comprise an accumulation of clay that has settled some depth below the surface[7].

Several studies of soils quality have been undertaken for soils within and surrounding the smelter site; the most recent ones taking place in 2010[6] and between 2014 and 2016. The 2010 results conclude that arsenic was found to be the most significant contaminant in the soils samples because of atmospheric deposition from the smelter. Preliminary results from the 2014/2016 study indicate that there is a moderate to severe contamination by hazardous metals on site, off-site in the northern section of Tsumeb, along the Jordon River riparian zone and smelter deposition zone towards Witvlei Farm. The contaminants of concern are sulphur, arsenic, copper, chromium, cadmium, lead, antimony, vanadium and zinc.

## 6.2 Biodiversity

The study area is located within the Dolomite Karstveld vegetation type, which is classified as woodland. The Dolomite Karstveld vegetation type is fairly represented in the protected area network of Namibia as it extends into the Etosha National Park. Generally, the area around Tsumeb provides suitable habitat for species of conservation concern such as the damara dik-dik, Namibian dwarf python, leopard tortoise and possibly endemic birds such as Carp's black tit and Ruppel's parrot[8]. Although the habitat is suitable, the sighting of wildlife around the mine is not common and species such as kudu, steenbok, ground squirrels are observed occasionally.

The vegetation structure around the smelter comprises of a diverse plant community and can be described as a savannah thicket. The site is dominated by tall tree species such as *Terminalia prunoides, Sclerocarya birrea, Berchimia discolor, Spyrostachys africanum, Combretum apiculatum, Commiphora glaucescens* and *Kirkia acuminata*. The tree canopy is supported by a shrub layer, which comprises of species such as *Grewia bicolor, Croton gratissimus, Rhigozum brevispinosum* and *Catophractes alexandri* [9].

## 6.3 Socio-Economic Profile

6 Jones & Wagner, Assessment of the Contamination Risks to the Groundwater and Soils at the Tsumeb Smelter, JW48/11/C391, Revision 0, April 2011
7 SLR. 2016. Dundee Smelter Expansion. Ground and Surface Water Specialist input to EIA.
8 TEC. 2022. Social and Environmental Impact Assessment for Dundee Smelter Expansion.
9 Mendelsohn et. Al. 2000. A profile of north-central Namibia. Directorate of Environmental Affairs: Ministry of Environment and Tourism. Gamsberg Macmillan Publishers. Windhoek, Namibia

The Oshikoto Region is one of Namibia's thirteen regions. The capital of the region is Omuthiya Town. The region borders Ohangwena in the north, Kavango in the east, Otjozondjupa in the southeast, Kunene in the southwest, and Oshana in the west and consists of ten constituencies, namely: Eengondi, Guinas, Okankolo, Olukonda, Omuntele, Omuthiyagwiipundi, Onayena, Oniipa, Onyaanya, and Tsumeb. The main economic activities are farming and mining. Tourism also plays an important role.

Key sectors in terms of employment in the Oshikoto region are agriculture (49%), followed by administration and support services (7%), education (6%), activities of private households (6%) and manufacturing (3%). In 2012, unemployment within the Oshikoto Region was estimated at 26.4 % and in Tsumeb at 36 %[10].

### 6.3.1 Population

The population of the Oshikoto Region increased from 181 973 in 2011 to 257 302 in 2023. Of this total, males make up 49.5% of the population in the region (NSA, 2023)[11].

Population 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 DPM Tsumeb 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).

### 6.3.2 Migration to Tsumeb

The migration of people from rural to urban areas is generally a trend being experienced across the country. In this regard, a 2015 Country Profile report by the International Organization for Migration (IOM) indicated that the urban population of Namibia grew by a staggering 49.7% between 2001 and 2011, with this trend continuing. Urbanization is noted as an important phenomenon in Namibia with major implications in terms of access to land and health, and development challenges[12].

The town of Tsumeb has experienced a fair share of migration which resulted in establishment of Kuvukiland in 2009, an informal settlement on the outskirts of town. The establishment of Kuvukiland as an informal settlement presented (and to some extent still presents) the opportunity of cheap land to settle on irrespective of a particular migrant's perception of the employment potential of general Tsumeb area.

#### 6.3.2.1 Endombo hostel

The Endombo hostel was built in the 1950s by the Tsumeb Corporation Ltd (TCL) to accommodate mine contract workers. The hostel is comprised of more than 300 units, each with a capacity to house up to eight people. At the time of construction, Endombo could accommodate up to 7,000 people.[13]

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[10] *Namibia Statistics Agency. 2023. National Population Census Data. Windhoek, Namibia*
[11] *Namibia Statistics Agency. 2023. National Population Census Data. Windhoek, Namibia*
[12] *TEC. 2022. Social and Environmental Impact Assessment for Dundee Smelter Expansion.*
[13] *Based on personal communication on 3 June 2022 in Tsumeb with Mr Andre Neethling (former Ongopolo Mine Managing Director) and Mr Dangi Linekela Sheetekela (former Tsumeb Major)*

TCL/Goldfields was responsible for the livelihoods of people in the hostel and therefore supplied the hostel with food, wood and other essential goods. In 1994, TCL/Goldfields introduced a housing subsidy system for all its employees and the occupants of the hostel at the time were given an opportunity to buy units. The hostel was then closed and TCL/Ongopolo was liquidated in 1998. TCL/Ongopolo sold most of its properties including the farms under its ownership. Similarly, the hostel was sold to new owners in 2000, which then leased the units to new occupants[14].

#### 6.3.2.2 Ondundu

The Ondundu residential area consists of approximately 40 houses, which were initially built to house TCL/Goldfields farm workers. These farm workers were employed as part of TCL's commercial agricultural activities, which at the time included a dairy, piggery, livestock farming, crop cultivation and harvesting of forestry products.

In 1994 TCL/Goldfields sold the farms but, kept the Ondundu settlement and the Mine. Disputes arose between the community of Ondundu and TCL/Goldfields and it was handed over to Tsumeb Municipal Council (TMC) in 2008[15]. The TMC connected the houses to the electricity network and installed community water meters, however no title deeds have been issued to date.

#### 6.3.2.3 Kuvukiland informal settlement

The Kuvukiland informal residential area emerged after the properties of the mine were sold in 1994, attributed to population growth, demand for residential plots (housing) and unwillingness of the residents to pay rent (mostly mine workers who residing in Soweto and Endombo). The town council decided to avail the land to the people between 2008-2010. Since 2010. However, to date the land has not been serviced and there are constant disputes between the council and residents of Kuvukiland. The town council does have plans to install services in Kuvukiland[16].

[14] *TEC. 2022. Social and Environmental Impact Assessment for Dundee Smelter Expansion.*
[15] *TEC. 2022. Social and Environmental Impact Assessment for Dundee Smelter Expansion.*
[16] TEC. 2022. Social and Environmental Impact Assessment for Dundee Smelter Expansion.

# 7. IMPACT ASSESSMENT METHODOLOGY

## 7.1 ESIA Methodology

The ESIA methodology has been adopted and is guided by the Namibian Draft Procedures and Guidance for EIA and EMP (Republic of Namibia, 2008), international and national best practice. The method of each step in the ESIA process is described in the next sections.

### 7.1.1 Screening

As per the Draft Procedures and Guideline for Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP), the first stage of the ESIA process is the determination if the project proposal falls within and triggers a Listed Activity (Ministry of Environment and Tourism, 2008).

The proposed project triggers several Listed Activities as per Section 1.3 and therefore an ECC is required.

### 7.1.2 Alternatives Considered

As stipulated in the Environmental Management Act (EMA) and EIA regulations, alternatives should be considered during the project design, to determine if an alternative site (different locality) or alternative project (different project) would yield better socio-economic benefits.

No alternative sites have been identified or considered for this project. However alternatives options being considered is with regards to specific aspects of the project such as option to reuse or retreating some of the wastewater or waste back into the process as part mitigating full dependency on abstracted water or need for disposal.

### 7.1.3 Scope of Assessment

The Scoping Process is a fundamental stage in the EIA process. Through a high-level assessment, the likely effects and severity of effects because of the development and operations of a proposed project can be identified. Any likely significant effects are taken forward for further assessment (detailed EIA). This stage is important in the EIA process to enable the assessment to be concise and focus on key issues that are central to efficient decision making.

If no likely significant effects are anticipated, a detailed EIA is not undertaken and a Scoping Report detailing the high-level assessment is submitted as part of the ECC application.

As there was uncertainty around the potential effects and their severity, a scoping process was undertaken for the proposed development. The Draft Procedures and Guideline for Environmental Impact Assessment (EIA) and Environmental

Management Plan (EMP) (Ministry of Environment and Tourism, 2008) were followed to undertake the scoping stage.

### 7.1.4 Detailed Impact Assessment

Through scoping, potential significant effects were identified. These potential effects are then considered further to determine the level of significance and identify additional mitigation required to avoid, reduce, or compensate for the effect.

### 7.1.5 Impact Significance

The level of significance is identified through the assessment process in order to understand the potential severity of the effect and identify appropriate mitigation. The impact significance after mitigation is also considered during the decision-making.

The significance of an impact is determined by considering and measuring the temporal and spatial scales and magnitude of the project and the specific activities associated with the project.

## 7.2 Impact Assessment Criteria

For each impact, the **EXTENT**, **MAGNITUDE** and **DURATION** are outlined.

These criteria are used to ascertain the **SIGNIFICANCE** of the impact, firstly in the case of no mitigation and then with the most effective mitigation measure/s in place.

The mitigation recommends plausible and pragmatic measures. To ensure this assessment is consistent and comparable with other environmental assessments undertaken for the smelter site, similar criteria ratings have been applied for sensitivity, magnitude of change and significance of effect.

**Table 7:1 Assessment criteria for the evaluation of impacts**

| CRITERIA | CATEGORY | DESCRIPTION |
|---|---|---|
| **Sensitivity or importance/value of receptor** | **High** | Of value, importance or rarity on a national scale, and with very limited potential for substitution; and/or<br>Very sensitive to change or has little capacity to accommodate a change. |
| | **Medium** | Of value, importance or rarity on a regional scale, and with limited potential for substitution; and/or<br>Moderate sensitivity to change, or moderate capacity to accommodate a change |
| | **Low** | Of value, importance or rarity on a local scale; and/or<br>Not particularly sensitive to change or has considerable capacity to accommodate a change. |
| | **National** | Beyond a 20km radius of the site |
| | **Regional** | Within a 20 km radius of the site |

| CRITERIA | CATEGORY | DESCRIPTION |
|---|---|---|
| **Extent or spatial influence of impact** | **Local** | Within a 2 km radius of the centre of the site |
| | **Site specific** | On site or within the boundaries of the property |
| | **Zero** | |
| **Magnitude of impact (at the indicated spatial scale)** | **High** | Natural and/ or social functions and/ or processes are *severely* altered |
| | **Medium** | Natural and/ or social functions and/ or processes are *notably* altered |
| | **Low** | Natural and/ or social functions and/ or processes are *slightly* altered |
| | **Very Low** | Natural and/ or social functions and/ or processes are *negligibly* altered |
| | **Zero** | Natural and/ or social functions and/ or processes remain *unaltered* |
| **Duration of impact** | **Zero** | Zero time |
| | **Short Term** | Up to 18 months |
| | **Medium Term** | 0-5 years (after operation) |
| | **Long Term** | 5- 10 years (after operation) |
| | **Permanent** | More than 10 years (after operation) |
| **Probability** | **Definite** | Estimated greater than 95 % chance of the impact occurring. |
| | **Very likely** | Estimated 50 to 95% chance of the impact occurring |
| | **Fairly likely** | Estimated 5 to 50 % chance of the impact occurring. |
| | **Unlikely** | Estimated less than 5 % chance of the impact occurring. |
| | **Zero** | Definitely no chance of occurrence |
| **Confidence** | **Certain** | Wealth of information on and sound understanding of the environmental factors potentially influencing the impact. |
| | **Sure** | Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact. |
| | **Unsure** | Limited useful information on and understanding of the environmental factors potentially influencing this impact. |
| **Reversibility** | **Irreversible** | The activity will lead to an impact that is permanent. |
| | **Reversible** | The impact is reversible, within a period of 10 years. |

### 7.2.1 Impact Severity

Impact severity = impact significance. The impact significance is determined using a risk matrix **(below).** A five-by-five matrix was used where the **impact severity** was categorised and assigned scores from 1 to 5 as follows:

Negligible = 1, Low = 2, Medium = 3, High = 4 and Severe = 5.

Similarly, the **likelihood** was assigned scores as follows:

Improbable = 1, Low Likely = 2, Probable = 3, High Probability = 4, Definite = 5.

The impact rating was determined by **multiplying** the **impact severity** and **likelihood**.

**Table 7:2 Impact Severity and Risk Assessment matrix[17]**

| LIKELIHOOD | | | | | | |
|---|---|---|---|---|---|---|
| | **5 Definite** | 5 Low | 10 Medium | 15 High | 20 Severe | 25 Severe |
| | **4 High Probability** | 4 Low | 8 Medium | 12 High | 16 High | 20 Severe |
| | **3 Probable** | 3 Low | 6 Medium | 9 Medium | 12 High | 15 High |
| | **2 Low** | 2 Low | 4 Low | 6 Medium | 8 Medium | 10 Medium |
| | **1 Improbable** | 1 Negligible | 2 Low | 3 Low | 4 Low | 5 Low |
| | | **1 Negligible** | **2 Minor** | **3 Medium** | **4 High** | **5 Severe** |
| | | **IMPACT SEVERITY / CONSEQUENCE** | | | | |
| | | Negligible | Low | Medium | High | Severe |

### 7.2.2 Impact Significance

The significance of an impact is identified determined by qualifying the potential severity of the effect, before and after mitigation. The impact significance after mitigation should be considered during the decision-making process.

The significance of an impact is determined by assessing the magnitude of scale (both temporal and spatial.

Significance is not defined in the Namibian EIA Regulations, however the Draft Procedure and Guidance for EIA and EMP states that the significance of a predicted

[17] Risk Management Guideline for the BC Public Sector (Province of British Columbia Risk Management Branch and Government Security Office 2012)

impact depends upon its context and intensity and qualified into the following categories, as guided by literature:

- **High**: effects associated with features or resources of national importance and, if lost, cannot be replaced, and thus likely to be key decision-making factors.
- **Medium**: effects associated with the features or resources of regional importance, but which are unlikely to be key decision-making factors.
- **Low**: effects considered to be local importance, but unlikely to be critical to decision-making factors.

Impact significance is determined by multiplying the potential severity of the effect, and qualitative assessment of the receptor sensitivity and magnitude of change. If effects garner a severity score, they are considered to be significant.

For significant impacts, supplementary assessments / Specialist studies may be required to further enhance understanding on the consequences (e.g through modelling or other assessment techniques) and identification of appropriate mitigation measures to reduce the effect.

### 7.2.3 Cumulative Impacts

The Environmental Assessment Policy in Namibia requires cumulative environmental impacts to be considered in all environmental assessment processes.

Cumulative impacts can arise when a single resource or receptor is affected by more than one impact or activity of the proposed project. For example, the view of a local resident's property could be altered through the construction phase of the proposed development and noise levels could increase due to excavation activities. In isolation, the impacts may be insignificant, however when combined, the impacts on the local resident may result in a significant impact.

Cumulative impacts may also arise because of the combination of two or more projects on the same receptor. The receptor could be affected by the same activities of these projects resulting in the same impact or by completely different activities resulting in different impacts. An example of this is as follows; dust generated during the construction stage of the proposed project may not cause a significant effect in isolation; however, a sensitive receptor (e.g. local resident) may be significantly impacted when dust from the proposed project is combined with noise generated from other projects.

## 7.3 Mitigation Measures

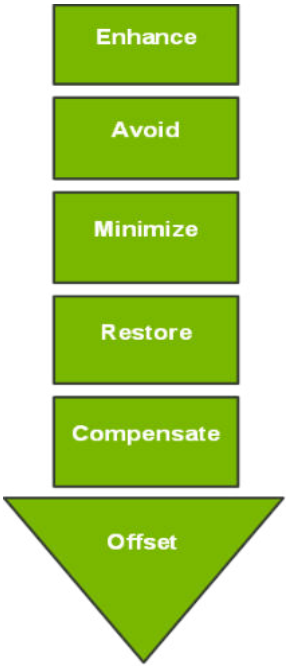
Mitigation comprises a hierarchy of measures ranging from preventative of environmental effects by avoidance, to measures that provide opportunities for environmental enhancement. The mitigation hierarchy is: avoidance; reduction; compensation; remediation; and enhancement.

For each impact assessed during the scoping phase and detailed assessment, mitigation measures are identified to reduce and/ or avoid negative impacts. Implementation of the

recommended mitigation measures forms the foundation of the ESMP, and upon approval, implementation thereof is a binding requirement.

### 7.3.1 Mitigation Hierarchy

Actions to mitigate a potential impact can be done in as systematic manner as guided by what is referred to as Mitigation Hierarchy.




From the onset, the positive impacts of the proposed project should be **enhanced**, however, where an impact in is inevitable, the following sequence should be followed.

**Impact avoidance:** This step is most effective when applied at an early stage of project conceptualization and planning. It can be achieved by:

- Not undertaking certain projects or elements that could result in adverse impacts
- Avoiding areas that are environmentally sensitive; and
- Putting in place preventative measures to stop adverse impacts from occurring.

**Impact minimisation:** This step is usually taken during impact identification and prediction to limit or reduce the degree, extent, magnitude, or duration of adverse impacts. It can be achieved by:

- Scaling down or relocating the proposal
- Redesigning elements of the project; and
- Taking supplementary measures to manage the impacts

**Impact compensation:** This step is usually applied to remedy unavoidable residual adverse impacts. It can be achieved by:

- Rehabilitation of the affected site or environment
- Restoration of the affected site or environment to its previous state or better

### 7.3.2 Uncertainty, limitations and assumptions

- The proposed project will be the first of its kind in Namibia, most of the background information is obtained from literature review

- There is uncertainty around site specific impacts as there are no similar examples that can be benchmarked in Namibia.

## 7.4 Waste Characterization

- Correct waste characterization ensures correct handling procedures, and disposal measures
- Correct handling and disposal of hazardous and toxic waste ensures protection of the staff, community and the environment at large (air, water, soil, plants, etc).
- Mishandling of hazardous or toxic waste can lead to serious staff exposure, the community and the environmental pollution (air, water, soil, vegetation, etc)

### 7.4.1 Namibian Waste Management Policy and Guidelines

- Atmospheric Pollution Prevention Ordinance (11 of 1976)
- Local Authorities Waste Management Regulations (1992)
- Pollution Control and Waste Management Policy (2003)
- Pollution Control and Waste Management Bill (Pending)
- Polluter Pays Principle

*In the absence of the specific Namibian waste classification and disposal standards, a risk-based approach founded on leachability testing by the Australian Standard Leach Procedure (ASLP) shall be adopted for characterizing the waste products and determining the required means of disposal. The approach is outlined in below chapters.*

### 7.4.2 Waste Material Characterisation

- Australian Standard Leaching Procedure (ASLP) will be utilised in material characterisation. The procedure demands that for co-disposal of non-putrescible wastes, leach test must be conducted for each waste at a high and low pH (note: details are defined in the procedure). The results from the leaching (max leached concentration) will be used to assess the potential of the waste to leach hazardous elements (including ions).
- **LCT0**: This is the baseline leachable concentration threshold. It represents the lowest acceptable level of leachable contaminants in a waste material. If the concentration of contaminants is below this threshold, the waste is considered to have minimal environmental impact.
- **LCT1**: This is a higher leachable concentration threshold. Waste materials with contaminant levels between LCT0 and LCT1 require more stringent management and disposal practices to mitigate potential environmental risks
- **LCT2**: This threshold represents a higher level of leachable contaminants compared to LCT1. Waste materials with contaminant levels between LCT1 and LCT2 require even more stringent management and disposal practices to mitigate potential environmental risks
- **LCT3**: This is the highest leachable concentration threshold. Waste materials with contaminant levels between LCT2 and LCT3 are considered to have significant environmental impact and require the most stringent management and disposal measures
- These thresholds help classify waste materials and determine the appropriate disposal methods to ensure environmental safety

## 7.5 Criteria for determining long-term waste storage requirements

a. The waste storage facility requirement (design) is to be determined according to the leachability of chemical constituent with maximum leaching potential as follows: Design of the facilities will be aligned with international standard and are distinguished by the number of liners in below categorization, while the actual designs consider a more complex design to ensure full mitigation of the risks of environmental contamination.

   i. Waste that leaches < LCT0 can be stored without a liner (LCT0 is equivalent to the Namibian acceptable drinking water quality)
   ii. Waste that leaches > LCT0 and < LCT1 can be stored in a single lined facility (equivalent to the South African class C waste facility design). LCT1 is equal to LCT0 multiplied by a dilution attenuation factor of 50 to express the likely dilution that will occur if such a waste leaches to the groundwater.
   iii. Waste that leaches > LCT1 and < LCT2 shall be stored in a double lined facility (equivalent to the South African class B waste facility). LCT2 is 2 times LCT1, whereby the higher leachable concentration is mitigated by an additional liner compared to a single lined facility
   iv. Waste that leaches > LCT2 and < LCT3 shall be stored in a triple lined facility of high standard (equivalent to the South African class A design waste facility). LCT3 is 4 times LCT2
   v. Waste that leaches > LCT3 shall ideally not be stored without stabilization or shall ideally be reprocessed. If those options are not possible then this waste must be stored in a triple lined facility which is not located in a position where a potential leaching or breakage of the facility would allow contamination of an aquifer. Therefore, this facility needs to be located in an area where no aquifer is close by the facility and ideally where precipitation is very low (i.e. in the desert)

   **Abbreviation and interpretations:**

- LCT0 is defined as the drinking water “acceptable standard” according to the new Namibian Water Resource Management Regulations (GG No.269 of 2023).
- LCT1 is LCT0 multiplied by a dilution attenuation factor (DAF) of 50
- LCT2 is 2 x LCT1
- LCT3 is 4 x LCT2
- The factors applied represents a conservative assessment of the decrease in risk achieved by the increase in environmental protection provided by more comprehensive liner designs in higher classes of landfill and landfill operating requirements.

b. Further, the waste that would be required to be stored or disposed into a triple liner landfill facility in a area without the risk of contaminating an aquifer will be transported to the alternative hazardous waste disposal facility located in a drier area where the risk of groundwater exposure is very minimal. The available options are third party facility with national regulated disposal tariffs and or own operated and managed facility to be established in Erongo Region.

c. For waste that would pose a low risk and require only a single lined facility which is equivalent to a South African Class C landfill facility, the approach to be adopted is to establish this onsite on the already disturbed area (e.g. current evaporation ponds).

## 7.6 Difference between Hazardous and Toxic Waste

Hazardous and Toxic refers to waste with properties that make it dangerous or capable of having a harmful effect on human health or the environment."

The two terms *"Hazardous and toxic"* are often used as synonyms. However, in reference to industrial waste, the terms may not always be interchangeable. Correct assessment is necessary before labelling something as "hazardous or toxic." (EPA).

- Hazardous waste is waste that has physical, chemical, or biological characteristics such that it requires special handling and disposal procedures to avoid negative health effects, adverse environmental effects or both (Joint UNEP/OCHA Environment Unit, 2011).
- Toxic waste refers to hazardous waste containing substances that are in such concentrations that pose a significant risk to human or environmental health.

Toxicity is a characteristic of hazardous waste.

### 7.6.1 Characteristic of Hazardous Waste

***Corrosivity***

- *Corrosive materials include substances that are strong acids or bases*
- *Anything with a pH less than 2 or greater than 12.5 falls under this category*
- *Corrosive materials pose an extreme threat to human safety*
- *These products can destroy human tissue and other durable materials*
- *Waste with corrosive properties with should be handled with extreme care*

***Reactivity***

- *Reactive products are highly unstable*
- *They are volatile even under controlled conditions, and can react to various external stimulation*
- *Some reactive materials emit toxic gases, while others are explosion hazards*
- *Waste that reacts to water, high heat, or pressure, you should apply caution during the labelling, storage, and disposal process*

***Ignitability***

- *Material that catches fire easily (fire is a huge danger risk human life (particularly workers), can cause extreme damage to infrastructure and the environment at large)*
- *Material can be tested to determine level of ignitability (e.g. closed cup and solid ignitability tests are some of the methods used)*

***Toxicity***

- *Toxicity is the main property that defines hazardous waste.*

- *It refers to the properties that are harmful to people due to exposure (whether by inhalation or ingestion or skin absorption) and can cause illness or death.*
- *Something that contains materials that can poison the environment (soil, water, plants, animals).*

***Examples of Hazardous Waste***

- Old batteries
- Most paints, paint thinners, and solvents
- Expired cleaning agents
- Pesticides
- Motor oil
- Gas tanks
- Bleach
- Brake fluid
- Hand sanitizer

### 7.6.2 Characteristics of Toxic Waste

- "Toxicity" is a characteristic of hazardous waste.
- However, that doesn't mean that all hazardous waste is toxic.
- Toxic materials don't encompass all kinds of hazardous waste.
- Toxic materials pose threat to public safety and ecosystems, through ingestion, breathing or absorption,

**Examples of Toxic Waste**

- Toxic substances identify three primary materials that have toxic properties, polychlorinated biphenyls (PCBs), hydraulic equipment and dielectric fluid
- Asbestos – unlike most hazardous materials, asbestos is a naturally-occurring mineral, common in buildings with old insulation
- Lead-based paint, which is common in old buildings, which contribute to neurological problems and can also lead to cancer.

### 7.6.3 Chemical or Mineral Leachability – Key definitions

**Soluble** – ability of a substance to dissolve in water.
**Dissolve** – the process through which a solid melts and becomes part of a liquid, thereby forming a solution.

**Percolation** – gradual movement of a liquid through a porous surface or substance
**Porous** – a rock or other material having spaces or holes through which liquid or air may pass

**Leaching** – process when a soluble chemical or mineral drain away from soil, ash, or similar material by the action of percolating liquid, especially in rainwater.

The Australian Leaching Procedure (ASLP, 1997) has been adopted for the project to test for leachability of wastes. Leaching thresholds that will be applied is presented in section 7.4.3.

### 7.7 Material characterization will be done by ASLP (Australian Standard Leaching Procedure)

a. This procedure demands that for co-disposal of non-putrescible wastes, that each waste must be leached at a high and low pH (details are defined in the procedure).
b. The results from the leaching (max leached concentration) will be used to assess the potential of the waste to leach hazardous elements (including ions)

#### 7.7.1 Classification of the waste to determine storage facility

--- Waste storage will be determined according to the leachability

i. Waste that leaches < LCT0 can be stored without a liner (no risk waste)
ii. Waste that leaches > LCT0 and < LCT1 can be stored in a single lined facility (equivalent to the South African class C waste facility design) (low risk waste)
iii. Waste that leaches > LCT1 but < LCT2 shall be stored in a double lined facility (equivalent to the South African class B waste facility design) (medium risk waste)
iv. Waste that leaches > LCT2 but < LCT3 shall be stored in a triple lined facility (equivalent to the South African class A waste facility design) (high risk waste)
v. Waste that leaches > LCT3 but < LCT3 shall be stored in a triple lined facility (equivalent to the South African class C waste facility design) which is not installed close to an aquifer (high-risk waste – should be stored in areas with low groundwater contamination risk e.g in the desert)[18]

--- LCT0 is defined as the Namibian drinking water "acceptable standard"
--- LCT1 is LCT0 multiplied by a dilution attenuation factor (DAF) of 50 (this means if leaching occurs, the groundwater will dilute the leachate 50 times)
--- LCT2 equals 2 times LCT1
--- LCT3 equals 4 times LCT2
--- The factors applied represents a conservative assessment of the decrease in risk achieved by the increase in environmental protection provided by more comprehensive liner designs.

**7.7.2 Waste that leaches > LCT3 needs to be stored in a triple lined facility** which is not close to an aquifer (e.g in the desert)

**7.7.3 Where pH of a leachate is above or below the required limit (pH 10 and pH 6 respectively)**, a risk assessment shall be performed to identify if the underlying rock/soil can buffer such pH or if the waste requires pH buffers to be included during disposal.

[18] *Low groundwater contamination risk means: Low groundwater availability = low aquifer capacity and Low rainfall = low leaching potential*

### 7.7.4 Leachability Limits

| ASLP leachability | Leachability limits LCT0 is Namibian drinking water "acceptable standard", LCT 1 is 50x LCT0 - dilution attenuation factor of 50) | | | | | |
|---|---|---|---|---|---|---|
| *metal ions* | | | **LCT0** | **LCT1** | **LCT2** | **LCT3** |
| | | ideal Drinking water | acceptable drinking water | 50x LCT0 (dilution attenuation) | 2x LCT1 | 4x LCT2 |
| Conductivity @ 25ºC | mS/m | 80 | 300 | 15000 | 30000 | 120000 |
| Final pH | - | 6-8.5 | 6-9 | 5-11 | | |
| Oxidative Redox Potential | mV | | | | | |
| Al | mg/l | 0.025 | 0.1 | 5 | 10 | 40 |
| As | mg/l | 0.01 | 0.05 | 2.5 | 5 | 20 |
| B | mg/l | 0.3 | 0.5 | 25 | 50 | 200 |
| Ba | mg/l | 0.5 | 2 | 100 | 200 | 800 |
| Be | mg/l | 0.002 | 0.005 | 0.25 | 0.5 | 2 |
| Bi | mg/l | 0.25 | 0.5 | 25 | 50 | 200 |
| Br | mg/l | 0.5 | 1 | 50 | 100 | 400 |
| Ca | mg/l | 80 | 150 | 7500 | 15000 | 60000 |
| Cd | mg/l | 0.005 | 0.01 | 0.5 | 1 | 4 |
| Ce | mg/l | 1 | 2 | 100 | 200 | 800 |
| Co | mg/l | 0.25 | 0.5 | 25 | 50 | 200 |
| $Cr_{Total}$ | mg/l | 0.05 | 0.1 | 5 | 10 | 40 |
| Cr(VI) | mg/l | | 0.05 | 2.5 | 5 | 20 |
| Cs | mg/l | 1 | 2 | 100 | 200 | 800 |
| Cu | mg/l | 0.5 | 2 | 100 | 200 | 800 |
| Fe | mg/l | 0.2 | 0.3 | 15 | 30 | 120 |
| Hg | mg/l | 0.001 | 0.002 | 0.1 | 0.2 | 0.8 |
| K | mg/l | 25 | 100 | 5000 | 10000 | 40000 |
| Mg | mg/l | 30 | 70 | 3500 | 7000 | 28000 |
| Mn | mg/l | 0.05 | 0.1 | 5 | 10 | 40 |
| Na | mg/l | 100 | 300 | 15000 | 30000 | 120000 |
| Ni | mg/l | 0.05 | 0.15 | 7.5 | 15 | 60 |
| Pb | mg/l | 0.01 | 0.05 | 2.5 | 5 | 20 |
| Sb | mg/l | 0.005 | 0.05 | 2.5 | 5 | 20 |
| Se | mg/l | 0.01 | 0.05 | 2.5 | 5 | 20 |
| Sn | mg/l | 0.1 | 0.2 | 10 | 20 | 80 |
| Ti | mg/l | 0.1 | 0.3 | 15 | 30 | 120 |
| Tl | mg/l | 0.005 | 0.01 | 0.5 | 1 | 4 |
| U | mg/l | 0.003 | 0.015 | 0.75 | 1.5 | 6 |
| V | mg/l | 0.1 | 0.5 | 25 | 50 | 200 |
| Zn | mg/l | 1 | 5 | 250 | 500 | 2000 |
| *Inorganic anions* | | | | | | |
| TDS | mg/l | 1000 | 2000 | 12500 | 25000 | 100000 |
| Chloride | mg/l | 100 | 300 | 15000 | 30000 | 120000 |
| Sulphate | mg/l | 100 | 300 | 12500 | 25000 | 100000 |
| $NO_3$ as N | mg/l | 6 | 11 | 550 | 1100 | 4400 |
| F | mg/l | 0.7 | 1.5 | 75 | 150 | 600 |
| CN- | mg/l | 0.02 | 0.05 | 3.5 | 7 | 28 |
| Radon | Bq/l | 200 | 1000 | 50000 | 100000 | 400000 |

## 7.8 Groundwater Pollution Risk

**Aquifer** – means a subsurface layer or layers of rock with sufficient porosity and permeability to allow a significant flow of groundwater.

**Groundwater** – water that exists underground in saturated zones beneath the land surface.

**Groundwater Pollution risk** – when the underlying rock is impermeable, an aquifer acts as a groundwater reservoir, which can be tapped / pumped for domestic, agricultural or industrial use. A serious environmental problem arises when the aquifer is contaminated by the seepage of sewage or toxins from waste dumps.

***Low groundwater contamination risk*** *means:*
*Low groundwater availability due to low aquifer capacity (poor geological strata to hold water), and*
*Low rainfall (low leaching potential) and/or*
*Low leachability of contaminants of concern*

# 8. IMPACT ASSESSMENT – SOCIO-ECONOMIC

## 8.1 Socio-Economic Impacts

Namibia has one of the highest unemployment rates in the world. According to the Namibia Statistics Agency (NSA, 2025), the official unemployment rate in 2024 is estimated at 37% of the labour force, and the majority (47%) of the unemployed is the youth (including graduates from Universities and Vocational Training Centres).

However, economists from independent institutions dispute the Government or NSA's estimate of 37%, arguing that NSA has changed the "Unemployment Definition" and that the unemployment rate in Namibia is much higher. In a Newspaper Article dated 01 February 2025, Tannan Groenewald from Cirrus Capital data and analytics, argues that if the broad definition of unemployment historically used is applied, only about 46.2 of the working-age population is employed and the true unemployment stands at 54.8%.

The success of the proposed projects, the Alkali Metal Salts (AMS) and the Multi Metal Recycling Projects (MMR) will have significant socio-economic impacts, including but not limited to:

a) Sustaining the current Sinomine Tsumeb Smelter (STS) work force, as well as employees for contractors and sub-contractors

b) Creating new employment opportunities (both during construction and operation of the two projects)

c) Sustaining and enhancing the local economy for the town of Tsumeb, through supply chains (procurement of goods and services from local suppliers)

d) Sustaining and enhancing the local economy of Tsumeb through buying power of STS staff (STS staff income sustain the housing properties (purchase or rent), supermarkets, street vendors, schools, house maids, gardeners, entertainment, car wash, etc).

e) Sustaining transportation revenues for the railway (Trans-Namib) and other transport companies (both import of raw material from Walvis Bay to Tsumeb and export of products from Tsumeb to Walvis Bay)

f) Sustaining revenues for port services and other service providers in Walvis Bay (during both import of raw material and export of products)

### 8.1.1 Sustain Current Employment

| **Impact category** | **Smelter business sustainability and current employment retention** |
|---|---|

| **Specific potential positive impacts** | **Key mitigation measures to maintain or improve +ve impacts** |
|---|---|
| • Prolong the smelter operation life through diversification of business revenue streams<br>• Retain current employment<br>• Increase confidence for job security among the work force (employees)<br>• Increase workforce productivity which results in improved production | • Integrate the proposed project and revenue streams with the current operations to improve the smelter operations and sustainability<br>• Develop policy with target objective to retain employees<br>• Integrate current workforce into the future workforce requirements of the new smelter (i.e. current smelter and proposed AMS plant)<br>• And or upskill the current workforce on a transitional period to meet the operation skill requirement of the new project |

| **Rating: before mitigation** | | | | | | | **Rating: After Mitigation** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Impact type** | **Extent** | **Magnitude** | **Duration** | **Probability** | **Confidence** | **Significance** | **Impact type** | **Extent** | **Magnitude** | **Duration** | **Probability** | **Confidence** | **Significance** |
| **+Ve** | **Local** | **Medium** | **Medium-term** | **Very likely** | **Sure** | **Medium** | **+Ve** | **Local** | **Medium** | **Long-term** | **Definite** | **Certain** | **High** |

**Monitoring**

| **Monitoring Aspects** | **Frequency** | **Responsibility** | **How** |
|---|---|---|---|
| • Strategic Plan covering development focus on both current and new project<br>• % of employment retention after project commencement<br>• % of workforce completed special upskill program and understudy program | Annually | Human Resource Department:<br><br>Workers Union | Employment records and database |

### 8.1.2 Create New Employment Opportunities

| **Impact category** | **New Employment Opportunities to be created by the proposed project** |
|---|---|

| **Specific potential positive impacts** | **Key mitigation measures to maintain or improve +ve impacts** |
|---|---|
| • Reduce unemployment among the community<br>• Improved standard of living in Tsumeb<br>• Improved food security<br>• Reduce crime | • Create new employment opportunities, both short and long-term, during Construction and Operation of the Project<br>• Create specific employment opportunities following a structured hierarchy: locals, regional, national and international<br>• Strive through recruitment policy to reserve a quantitative proportion of general work job opportunities to locals during the lifecycle of the project |

| **Rating: before mitigation** | | | | | | | **Rating: After Mitigation** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Impact type** | **Extent** | **Magnitude** | **Duration** | **Probability** | **Confidence** | **Significance** | **Impact type** | **Extent** | **Magnitude** | **Duration** | **Probability** | **Confidence** | **Significance** |
| **+Ve** | **Local** | **Medium** | **Medium-term** | **Very likely** | **Sure** | **Low** | **+Ve** | **Local** | **Medium** | **Long-term** | **Definite** | **Certain** | **Medium** |

**Monitoring**

| **Monitoring Aspects** | **Frequency** | **Responsibility** | **How** |
|---|---|---|---|
| • Number of new employment opportunities created<br>• Ensure local residents of Tsumeb have access to the new employment opportunities | Annually | Human Resource Department:<br><br>Workers Union | Employment records and database |

### 8.1.3 Sustain Current Buying Power of STS staff

| **Impact category** | **Sustain current buying power of STS employees and Contractors to sustain the local Economy for Tsumeb** |
|---|---|

| **Specific potential positive impacts** | **Key mitigation measures to maintain or improve +ve impacts** |
|---|---|
| • Sustain and enhance the local economy of Tsumeb through the buying power of STS staff (STS staff income sustain the housing properties (purchase or rent), supermarkets, street vendors, schools, domestic workers, entertainment, car wash, etc) | • Maintain the sustainability of smelter operation<br>• Maintain jobs for the existing workforce<br>• Sustain income and buying power to support the local economy |

| **Rating: before mitigation** | | | | | | | **Rating: After Mitigation** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Impact type** | **Extent** | **Magnitude** | **Duration** | **Probability** | **Confidence** | **Significance** | **Impact type** | **Extent** | **Magnitude** | **Duration** | **Probability** | **Confidence** | **Significance** |
| **+Ve** | **Local** | **Medium** | **Medium-term** | **Very likely** | **Sure** | **Medium** | **+Ve** | **Local** | **Medium** | **Long-term** | **Definite** | **Certain** | **High** |

**Monitoring**

| **Monitoring Aspects** | **Frequency** | **Responsibility** | **How** |
|---|---|---|---|
| • Number of current employments saved and retained<br>• Monthly income and buying power, thereby sustaining the town of Tsumeb and areas of staff origin (regions / villages) | Annually | Human Resource Department:<br><br>Workers Union | Employment records and database |

### 8.1.4 Sustain and Enhance Local Economy through Supply Chains

| **Impact category** | **Sustain and enhance the local economy through Supply Chains** |
|---|---|

| **Specific potential positive impacts** | **Key mitigation measures to maintain or improve +ve impacts** |
|---|---|
| • Transportation of materials from Walvis Bay to Tsumeb and Back (Trans-Namib and Private Transport companies)<br>• Opportunity for the local supply chain for construction material<br>• Opportunity for small and medium enterprises in Tsumeb and beyond<br>• Increase or maintain property value due to increase demand (e.g. rental and purchasing) | • Sustain local economy through supply chains<br>• Continue procurement of materials and services from local supply chains (e.g Cement, steel, security companies, cleaning companies, entertainment, etc)<br>• Enhance other in-direct local economy support e.g buying power of the STS staff and support to housing rental business, supermarkets, street vendors, restaurants, entertainment centres, car wash, schools, housemaids, gardeners, security companies |

| **Rating: before mitigation** | | | | | | | **Rating: After Mitigation** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Impact type** | **Extent** | **Magnitude** | **Duration** | **Probability** | **Confidence** | **Significance** | **Impact type** | **Extent** | **Magnitude** | **Duration** | **Probability** | **Confidence** | **Significance** |
| **+Ve** | **Local** | **Medium** | **Medium-term** | **Very likely** | **Sure** | **Medium** | **+Ve** | **Local** | **Medium** | **Long-term** | **Definite** | **Certain** | **High** |

**Monitoring**

| **Monitoring Aspects** | **Frequency** | **Responsibility** | **How** |
|---|---|---|---|
| • Value of STS direct annual procurement from local supply chains and overall impact on the local economy<br>• In-direct employment and spin-offs across the STS supply chains | Annually | Human Resource Department:<br><br>Workers Union | STS supply chain value and overall local economy support |

### 8.1.5 Community Investments through Corporate Social Responsibility

| **Impact category** | **Community Investments through Corporate Social Responsibility** |
|---|---|

| **Specific potential positive impacts** | **Key mitigation measures to maintain or improve +ve impacts** |
|---|---|
| • Maintain the existing of Sinomine Tsumeb Community Trust and other Community Investment Initiatives aims at the following:<br>• Support to schools (school renovations, construction of classrooms, setting up of computer and science labs, procurement of books, etc)<br>• Support to the health sector (establishment of community health centre and support of government health programs)<br>• Food production (support to agriculture and horticulture projects e.g community gardens) | • Targeted Community Investments and support<br>• Continue with community investment and CSR activities<br>• Explore option to revise the current investment policy and model with a clear exit strategy for self-sustenance goal to reduce long-term dependency |

| **Rating: before mitigation** | | | | | | | **Rating: After Mitigation** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Impact type** | **Extent** | **Magnitude** | **Duration** | **Probability** | **Confidence** | **Significance** | **Impact type** | **Extent** | **Magnitude** | **Duration** | **Probability** | **Confidence** | **Significance** |
| **+Ve** | **Local** | **Medium** | **Medium-term** | **Very likely** | **Sure** | **Medium** | **+Ve** | **Local** | **Medium** | **Long-term** | **Definite** | **Certain** | **High** |

**Monitoring**

| **Monitoring Aspects** | **Frequency** | **Responsibility** | **How** |
|---|---|---|---|
| • Annul Value of STS direct CSR<br>• Overall socio-economic impact of STS CSR on the local economy | Annually | STS – CSR and STS Community Trust Administrator/Trustees | STS CSR Annual Report |

### 8.1.6 Sustain Transportation Companies between Walvis Bay and Tsumeb

| **Impact category** | **Sustain Transportation Ventures between Walvisbay and Tsumeb** |
|---|---|
| **Specific potential positive impacts** | **Key mitigation measures to maintain or improve +ve impacts** |
| • Sustain transportation revenues for the railway (Trans-Namib) and other transport companies (both import of raw material from Walvis Bay to Tsumeb and export of products from Tsumeb to Walvis Bay) | • Sustain transportation services and supply chains between Walvis and and Tsumeb (both import fo materials and export of products)<br>• Support local transportation companies |

| **Rating: before mitigation** | | | | | | | **Rating: After Mitigation** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Impact type** | **Extent** | **Magnitude** | **Duration** | **Probability** | **Confidence** | **Significance** | **Impact type** | **Extent** | **Magnitude** | **Duration** | **Probability** | **Confidence** | **Significance** |
| **+Ve** | **Local** | **Medium** | **Medium-term** | **Very likely** | **Sure** | **Medium** | **+Ve** | **Local** | **Medium** | **Long-term** | **Definite** | **Certain** | **High** |

| **Monitoring** | | | |
|---|---|---|---|
| **Monitoring Aspects** | **Frequency** | **Responsibility** | **How** |
| • Value of STS annual Transportation budget between Walvis Bay and Tsumeb<br>• Job loses (transportation companies) | Annually | STS Procurement and Contract | STS Transport supply chain value |

### 8.1.7 Sustain Port Services and other Supply Chains

| **Impact category** | **Reduced revenue for Port Services and Supply Chains in Walvis Bay** |
|---|---|

| **Specific potential positive impacts** | **Key mitigation measures to maintain or improve +ve impacts** |
|---|---|
| • Sustaining revenues for port services and other service providers in Walvis Bay (during both import of raw material and export of products) | • Sustain services and supply chains at the port in Walvis Bay (additional services required / provided during the importation of raw materials and exportation of products<br>• Support local service providers |

| **Rating: before mitigation** | | | | | | | **Rating: After Mitigation** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Impact type** | **Extent** | **Magnitude** | **Duration** | **Probability** | **Confidence** | **Significance** | **Impact type** | **Extent** | **Magnitude** | **Duration** | **Probability** | **Confidence** | **Significance** |
| **+Ve** | **Local** | **Medium** | **Medium-term** | **Very likely** | **Sure** | **Medium** | **+Ve** | **Local** | **Medium** | **Long-term** | **Definite** | **Certain** | **High** |

| **Monitoring** | | | |
|---|---|---|---|
| **Monitoring Aspects** | **Frequency** | **Responsibility** | **How** |
| • Value of STS annual Transportation budget between Walvis Bay and Tsumeb<br>• Job loses (transportation companies) | Annually | STS and Authority (e.g Namport) | STS Transport supply chain value |

## 9. IMPACT ASSESSMENT – PROCESS FLOW AND WASTE STREAMS

This section presents the potential impacts that may arise from the proposed Multi-Metal Recycling plant and associated activities.

A list of potentially significant effects and other likely environmental effects that should be considered during the construction and operation of the proposed project to reduce adverse effects and minimize pollution (considered best practice) are contained in the Environmental and Social Management Plant (ESMP).

### 9.1 Input Materials

| Input | Source (Country, Producer, Market, etc) | Type (Solid, Powder, Liquid, Gas etc) | Quantity | MSDS Source and Certificate |
|---|---|---|---|---|
| Zinc slag | Onsite waste from previous mining operations at the Tsumeb Smelter | Solid | 200 000 dmt/a | Attached (STS) |
| Water | Water abstraction from underground water through the old Tsumeb mine shaft (No. 1 Mine Shaft). | Liquid | 1,277,500 $m^3$ p/a | N/A |
| Energy | Nampower Supply through 11kv Powerline and Smelter Substation | Electricity (Current) | 25.4 MW (173,053 MWh/a) | N/A |

## 9.2 Reagents

| Input | Source (Country, Company, etc) | Type (Solid, Powder, Liquid, Gas etc) | Quantity p/a | MSDS Source and Certificate a) Producer b) Authority (country of origin) c) Independent Laboratory |
|---|---|---|---|---|
| Coke (for rotary kiln) | South Africa | Solid | 33,060 t/a | STS |
| Limestone (rotary kiln) | Namibia | Solid | 3683 t/a | Product certificate |
| Coal | South Africa | Solid | 61,388 t/a | Product certificate |
| Lime | South Africa | Solid | 500 t/a | Product certificate |
| Iron powder | South Africa / China | Solid | 3,926 t/a | Product certificate |
| Ammonium Chloride | South Africa | Solid | 13 t/a | Product certificate |
| Zinc powder | China | Solid | 323 t/a | Product certificate |
| Flocculant #3 | China | Solid | 22 t/a | Product certificate |
| Copper sulphate | China | Solid | 605 t/a | Product certificate |
| Sodium Hydroxide | South Africa | Solid | 11 t/a | Product certificate |
| Activated Carbon | South Africa | Solid | 27 t/a | Product certificate |
| Concentrated hydrochloric acid | South Africa | Liquid | 4,249 t/a | Product certificate |
| P204 | South Africa / China | Liquid | 260 t/a | Product certificate |

| | | | | |
|---|---|---|---|---|
| YW-100 | South Africa / China | Liquid | 40 t/a | Product certificate |
| N503 | South Africa / China | Liquid | 379 t/a | Product certificate |
| Sec-octyl alcohol | South Africa / China | Liquid | 568 t/a | Product certificate |
| Solvent oil | South Africa / China | Liquid | 2,000 t/a | Product certificate |
| Ammonia water (20%) | South Africa | Liquid | 145 t/a | Product certificate |
| Sodium carbonate | South Africa/Botswana | Solid | 1,445 t/a | Product certificate |
| Strontium carbonate | South Africa | Solid | 39 t/a | Product certificate |
| Bone glue | South Africa | Solid | 2.2 t/a | Product certificate |
| Cathode plate | China | Solid | 39 t/a | Product certificate |
| Anode plate | China | Solid | 67 t/a | Product certificate |
| Hydrofluoric acid (40%) | South Africa | Liquid | 0.4 t/a | Product certificate |
| Nitric acid (40%) | South Africa | Liquid | 3 t/a | Product certificate |
| Caustic soda flakes | South Africa | Liquid | 27 t/a | Product certificate |
| Nitrogen | Self produced | Gas | 1000 $m^3$/a | Product certificate |
| Hydrogen | Self produced | Gas | 196537 $m^3$/a | Product certificate |
| Steam | Self produced | gas | 2786 t/a | Product certificate |

### 9.3 Products

| Output | Type (Solid, Powder, Liquid, Gas) | Quantity (dmt/a) | Storage Facility *Layout and Design* | Uses (Potential uses or opportunities) | Transportation / Shipping Packaging | Destination (Local Market, Export, etc) | MSDS Certificate |
|---|---|---|---|---|---|---|---|
| **Product** | | | | | | | |
| Zinc ingot | Solid | 10,870 | Layout plan | | | Export | Product certificate |
| Germanium ingot | Solid | 32.97 | Layout plan | | | Export | Product certificate |
| Gallium metal | Solid | 10.8 | Layout plan | | | Export | Product certificate |
| Lead ingot | Solid | 3903 | Layout plan | | | Export | Product certificate |
| Coper -Arsenic Residue | Solid | 629 | Layout plan | | | copper smelter | Product certificate |
| Copper slag | Solid | 83 | Layout plan | | | copper smelter | Product certificate |

### 9.4 Residue / Waste

| Residue / Waste | Type (Powder, Liquid, Gas etc) | Waste *Characteristics* | Disposal Facility *Layout and* Conceptual Design[19] | Uses (Potential uses or Opportunities) | Transportation / Shipping Packaging | Destination (Onsite Process, Local Market, Export Country, etc) |
|---|---|---|---|---|---|---|
| **Type** | | | | | | |
| Slag from fuming and rotary kiln | Solid | low risk waste | Single lined tailings dam (class C) Layout plan | Grid blasting material, construction aggregate | Bulk on conveyor belt | Onsite/local market |
| Lead Blast furnace slag | Solid | low risk waste, | Single lined tailings dam (class C) Layout plan | Recycle to zinc fuming furnace | Bulk on conveyor belt | Onsite |
| Gypsum from off-gas desulphurization | Solid | low risk waste | Single lined tailings dam (class C) Layout plan | Cement manufacturing raw material | Bags | Onsite/local market |
| FeAs cement | Solid | High risk waste | Triple lined storage facility (class A) | Recycle in copper process | Bags | Onsite/local hazardous waste site |
| Gypsum from effluent treatment, defluorination and heavy metal removal) | Solid | high risk waste | Triple lined storage facility. (class A) | Recycle in copper process | Bags | Onsite/local hazardous waste site |
| Ca-Mg residue | Solid | low risk waste | Single lined tailings dam (class C) Layout plan | Recycle as flux to fuming furnace or copper process | bags | onsite |

[19] *Disposal facility - Provide full details on separate page, location map (GPS) Coordinates, isolated or mixed with other waste and Conceptual Design*

| **Residue / Waste** | **Type (Powder, Liquid, Gas etc)** | **Waste *Characteristics*** | **Disposal Facility** *Layout and* **Conceptual Design**[19] | **Uses (Potential uses or Opportunities)** | **Transportation / Shipping Packaging** | **Destination (Onsite Process, Local Market, Export Country, etc)** |
|---|---|---|---|---|---|---|
| Dust | Solid | Not a waste | | Recycle to furnaces | | |
| Industrial Wastewater | Liquid | Contaminated, will be stored in lined PCD and re-used after treatment. | Lined pollution control dam, evaporation. Treated for recycle | Recycle as process water after treatment. Dust suppression | | |
| Domestic Wastewater | liquid | Hazardous (biological sewage) | Treated in sewage plant and discharged into reed dam | Greening | pipeline | onsite |

## 9.5 Construction related impacts

### 9.5.1 Removal of protected tree species in the project site

| **Impact source** | Site clearance and excavation with heavy and mobile equipment | **Key Mitigation Measures:**<br>• Adherence to site vegetation clearance checklist/procedure<br>• i.e. avoid removal of protected tree species which do not directly affect the construction<br>• explore option to relocate and replant some plants such as aloe plants |
|---|---|---|
| **Classification** | Vegetation clearance | |
| **Potential Negative Impacts:**<br>• Unselective removal of protected tree species currently on project site | | |

| **Without Mitigation** | | | | | | | **With Mitigation** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** | **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** |
| -ve | Definite | Local | Short-term | Severe | No | Medium | -ve | Definite | Site specific | Short-term | Low | Yes | Low |
| **Qualitative assessment** | | | | | | | **Qualitative assessment** | | | | | | |

| **Monitoring Program** | | | |
|---|---|---|---|
| **Monitoring Aspects** | **Frequency** | **Responsibility** | **How** |
| • Number of trees species removal versus species saved<br>• Number of trees or plant species relocated and successfully replanted | Weekly / Monthly | STS (e.g Environmental Officer)<br>Authority (Environmental Compliance Officer) | Physical observations |

### 9.5.2 Dust emissions from excavation

<table>
<tr><td colspan="2">Impact source</td><td colspan="5">Site clearance and excavation with heavy mobile equipment</td><td colspan="7" rowspan="2">Key Mitigation Measures:<br>• Adherence to site standard/safe operating procedure<br>• Identify and implement appropriate Personal Protective Equipment (PPEs) as a result resort to prevent or reduce exposure to workers<br>• Dust suppression<br>• Speed limit as per existing site policy</td></tr>
<tr><td colspan="2"></td><td colspan="5"></td></tr>
<tr><td colspan="7">Potential Negative Impacts:<br>• Employee exposure to contaminated dust since area is already disturbed site<br>• Dust emission to environment with potential increase background dust emission</td></tr>
<tr><td colspan="7">Without Mitigation</td><td colspan="7">With Mitigation</td></tr>
<tr><td>Impact type</td><td>Probability</td><td>Extent</td><td>Duration</td><td>Severity</td><td>Reversible</td><td>Significance</td><td>Impact type</td><td>Probability</td><td>Extent</td><td>Duration</td><td>Severity</td><td>Reversible</td><td>Significance</td></tr>
<tr><td>-ve</td><td>Definite</td><td>Local</td><td>Short-term</td><td>Severe</td><td>No</td><td>High</td><td>-ve</td><td>Definite</td><td>Site specific</td><td>Short-term</td><td>Low</td><td>Yes</td><td>Low</td></tr>
<tr><td colspan="7">Qualitative assessment</td><td colspan="7">Qualitative assessment</td></tr>
<tr><td colspan="14">Monitoring Program</td></tr>
<tr><td colspan="5">Monitoring Aspects</td><td colspan="2">Frequency</td><td colspan="4">Responsibility</td><td colspan="3">How</td></tr>
<tr><td colspan="5">• Dust fallout and dust chemical analysis</td><td colspan="2">Weekly / Monthly</td><td colspan="4">STS (e.g Environmental Officer)<br>Authority (Environmental Compliance Officer)</td><td colspan="3">Chemical analysis<br>Physical observations</td></tr>
</table>

## 9.6 Waste

### 9.6.1 Slag from Fuming and Rotary Kiln

The Slag from the fuming furnace and rotary kiln is characterized as low risk solid waste, which can be sold as construction additives (road, concrete) and blasting grid or stored in the slag yard on a single lined storage facility. This solid waste is nontoxic and leachability of contaminants of concerns is very low (<LCT1).

#### 9.6.1.1 Impact Description

Slag is a chemical waste that may consists of different element and several compound in a uniform solid phase, such silicon dioxide ($SiO_2$), calcium oxide (CaO), and metallic elements such as aluminium (Al), magnesium (Mg), iron (Fe) in relatively larger proportions. Heavy metals are typically present in very small concentration in such slags, e.g. cadmium (Cd), copper (Cu), lead (Pd), Zinc (Zn) and smaller ratios of arsenic (As) and antimony (Sb). The slag cooling methodology (granulation = quenching in water) allows for such contaminants to be stabilized in a glass form.

Therefore, the slag may have **negative impacts** to health if contamination occurs on the continuous basis such as:

- May cause skin, eye and respiratory irritation
- Harmful if swallowed
- leaching metals into drinking water. These metals include lead, arsenic, cadmium and copper which can affect soil, water, animals, and people.

#### 9.6.1.2 Impact Assessment

**Severity**
The granulated slag is not combustible, an insoluble solid in water, not classifies as hazardous and not carcinogen as well as not toxic to ecosystem. In addition, it does not bioaccumulation. Therefore, the severity rating of GBFS is relatively low, even without mitigation measures.

**Duration**
The duration of impact is immediate to Zero-time in absence of mitigation measures. With the effective mitigation measures the duration of impact is Zero time or none.

**Spatial scale**
The impact of slag is mainly site specific and directly affect the site worker or experimenter at very lower chances in absence of mitigation measures. With effective mitigation measure there will be minimal to no contamination taking place.

**Probability**

The possibility of contamination or impacts of the slag is relatively lowe to indefinite or improbable for both with and without effective mitigation measures. This may be so because the slag is neutral, insoluble and very low reactive.

**Significance**

Granulated fuming furnace furnace slag is solid, very stable with lower reactivity to non-reactive; it is also said to be insoluble, non-hazardous and not bio cumulative in nature, therefore the significance rating of the Multi Metals Recycling project on basis of this slag is None, or Zero for both in presence and absence of the effective mitigation measure. Impact has very low chances of occurring.

#### 9.6.1.3 Description of mitigation measures

- The experimenter or workers must wear protective gear and strictly adhere to the standards on handling chemical waste.
- The slag must be stored in a single lined storage facility (min requirement) unless the testing of the actual product indicates that leaching water is better than teh acceptable drinking water standard of Namibia. The storage facility must be monitored to detect the potential leakage and alert the site-specific workers.
- Avoid moisture and incompatible materials. The slag must be stored in a stable condition to avoid further chemical reactions in the settled storage.
- slag can be stored segregated from other wastes to allow for reclaiming some slag for sale for industrial uses.
- slag may be sold for commercial purposes in area of constructions, cement manufacturing as well concrete production.

### 9.6.1.4 Summary of Impact: Slag from Fuming and Rotary Kiln

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Waste Classification:** | Low risk waste | | | | | | **Key Mitigation Measures:**<br>• Adherence to site standard/safe operating procedure<br>• Provide Personal Protective Equipment (PPEs) for workers<br>• Granulated slag is used as a cement replacement and can also be used as a sand substitute, can improve concrete durability, and reduce the amount of ozone depleting substance and energy needed to create the concrete.<br>• Slag can increase soil pH, which can help mobilize nutrients and improve plant productivity. | | | | | | |
| **Est. Quantity p/a** | 218,000 dmt/a (600 t/day) | | | | | | | | | | | | | |
| **Potential Negative Impacts:**<br>• Water Contamination<br>• Soil degradation through Leaching<br>• Exposure may cause respiratory, skin and eye irritation<br>• Harmful if swallowed | | | | | | | | | | | | | | |
| **Without Mitigation** | | | | | | | **With Mitigation** | | | | | | | |
| **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** | **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** |
| -ve | Definite | Local | Long-term | Medium | No | Low | -ve | Definite | Site specific | Short-term | Low | Yes | Negligible |
| **Qualitative assessment** | | | | | | | **Qualitative assessment** | | | | | | |
| **Monitoring Program** | | | | | | | | | | | | | |
| **Monitoring Aspects** | | | | | **Frequency** | | **Responsibility** | | | | **How** | | |
| • Tailings volume measurement records<br>• Dust fallout and dust chemical analysis<br>• Slag activity, moisture, composition | | | | | Monthly<br>Quarterly | | STS (e.g Environmental Officer)<br>Authority (Environmental Compliance Officer) | | | | Chemical analysis<br>Physical observations | | |

### 9.6.2 Slag from Iron Blast Furnace

Similar to the slag from the fuming furnace and rotary kiln, the lead blast furnace slag is classified as low-risk waste, which can be stored on a single lined storage facility. This solid waste is nontoxic and due to the water quenching the contaminants of concern are stabilize in the slag mostly in a glass.

#### 9.6.2.1 Impact Description

Slag is a chemical waste that may consists of different element and several compound in a uniform solid phase, such silicon dioxide ($SiO_2$), calcium oxide (CaO), and metallic elements such as aluminium (Al), magnesium (Mg), iron (Fe) in relatively large proportions. Heavy metals are typically present in very small concentration in such slags, e.g. cadmium (Cd), copper (Cu), lead (Pb), Zinc (Zn) and smaller ratios of arsenic (As) and antimony (Sb). The slag cooling methodology (granulation = quenching in water) allows for such contaminants to be stabilized in a glass form.

Therefore, the slag may have **negative impacts** to health if exposure happens on a continuous basis. The health effects of exposure to material containing heavy metals are usually dose-dependent such as:

- Skin, eye, and respiratory irritation
- Gastrointestinal effects if swallowed

The leaching of the above-mentioned metals into underground water sources may be possible with potential effects on the soil, animals, and people.

#### 9.6.2.2 Impact Assessment

**Severity**
The granulated slag is not combustible, insoluble solid in water, not classified as hazardous and not carcinogen as well as not toxic to ecosystem. In addition, it does not bioaccumulate. Therefore, the severity rating is relatively low, even without mitigation measures.

**Duration**
Without mitigation, the impact duration would be immediate. With effective mitigation measures the duration of impact is Zero time or none.

**Spatial scale**
The impact of Pb blast furnace slag is mainly site specific and directly affect the site worker or experimenter at very low chances in absence of mitigation measures. With effective mitigation measure there will be minimal to no contamination taking place.

**Probability**

The possibility of contamination or impacts of the Pb blast furnace slag is relatively low to indefinite or improbable for both with and without effective mitigation measures. This may be so because the Pb blast furnace slag is granulated (mostly as glass), insoluble and very low reactive.

**Significance**

Granulated blast furnace slag is solid, very stable with lower reactivity to non-reactive; it is also said to be insoluble, non-hazardous and not bio cumulative in nature, therefore the significance rating of the multi metals recycling project on basis of this slag is None, or Zero for both in presence and absence of the effective mitigation measure. Impact has very low chances of occurring.

#### 9.6.2.3 Description of mitigation measures

- The workers must wear protective gear and strictly adhere to the standards on handling chemical waste.
- The Pb blast furnace slag in granulated form must be stored in a lined waste storage facility. The storage facility must be regularly monitored to detect the potential leakage and alert the site-specific workers.
- The Pb blast furnace slag shall be stored in such a way that later reprocessing of the slag to extract residual Ge and Ga can be achieved.
- The slag may be sold for commercial purposes in area of constructions, cement manufacturing as well concrete production.

### 9.6.2.4 Impact Assessment Summary: Slag from Lead Blast Furnace

| | | |
|---|---|---|
| **Waste Classification:** | Medium risk waste | **Key Mitigation Measures:**<br>• Adherence to site standard/safe operating procedure<br>• Identify and implement appropriate Personal Protective Equipment (PPEs) as a resort to prevent or reduce exposure to workers<br>• Do not empty in drains<br>• Store product in lined facility<br>• Consider reprocessing to recover residual metals |
| **Est. Quantity p/a** | 11000 dmt/a (30 t/day) | |
| **Potential Negative Impacts:**<br>• Water Contamination<br>• Soil degradation through Leaching<br>• Exposure may cause respiratory, skin and eye irritation<br>• Harmful if swallowed | | |

| **Without Mitigation** | | | | | | | **With Mitigation** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** | **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** |
| -ve | Definite | Local | Long-term | Medium | No | Medium | -ve | Definite | Site specific | Short-term | Low | Yes | Low |
| **Qualitative assessment** | | | | | | | **Qualitative assessment** | | | | | | |

| **Monitoring Program** | | | |
|---|---|---|---|
| **Monitoring Aspects** | **Frequency** | **Responsibility** | **How** |
| • Tailings volume measurement records<br>• Groundwater monitoring<br>• Dust fallout and dust chemical analysis<br>• Slag activity, moisture, composition | Monthly<br>Quarterly | STS (e.g Environmental Officer)<br>Authority (Environmental Compliance Officer) | Chemical analysis<br>Physical observations |

### 9.6.3 Calcium Sulphate hydrate (CaSO4) or Gas desulphurization Residue

The Gas desulphurization residue (mainly Anhydrite/Gypsum, $CaSO_4$) is a chemical compound that is produced as a waste product from off gas desulphurizationof the offgas of the three furnace operations. It is a white solid or powder that is poorly insoluble in water and it is classified as non-hazardous.

#### 9.6.3.1 Impact Description

Calcium sulphate $CaSO_4$, is a naturally occurring chemical and has minimal negative impacts.

Calcium sulphate is a relatively harmless chemical, but human exposure, may lead to the following effects:

- **Skin and eye irritation**
  Repeated or prolonged contact with calcium sulphate can irritate the skin and eyes.

- **Respiratory irritation**
  Breathing in calcium sulphate particles can irritate the nose and throat, leading to a sore throat, nosebleeds, and shortness of breath.

- **Gastrointestinal issues**
  Consuming large amounts of calcium sulphate can cause nausea, stomach upset, vomiting, diarrhoea, bloating, and constipation.

- **Allergic reactions**
  In rare cases, calcium sulphate can cause allergic reactions, such as hives, swelling of the face, lips, tongue, and throat, and difficulty breathing.

- **Plant growth**: Calcium sulphate can reduce plant growth by causing nutritional imbalances. This can happen when $K^+$ is replaced by $Na^+$, and $Ca^{2+}$ concentration decreases.

- **Acidification**: If left untreated, sulphate-rich wastewater can acidify water bodies, which can impact aquatic organisms.

#### 9.6.3.2 Impact Assessment

**Severity**
Calcium sulphate ($CaSO_4$) is a relatively harmless chemical waste. Any hazards are due primarily to the physical hardness of the particles. Repeated or prolonged contact can irritate the skin and eyes. Breathing anhydrite particles can irritate the nose and throat, causing a sore throat, nosebleeds and shortness of breath, Therefore, the severity rating of this chemical waste is low without mitigation and with effective mitigation, the severity rating very low to non-occurrence.

**Duration**

Calcium sulphate degrades quickly, usually within weeks or months, and is fully degraded within 3–6 months in humans and animals, without mitigation, thus the duration of the impact is rated Zero time. And with the effective mitigation measures it will no lower occurrence to none, duration can as well be rated as zero time.

**Spatial scale**

The impact of calcium sulphate is direct to the experimenter or workers only. The soil pollution and water pollution the chemical waste is biodegradable with a few months' duration and hence the local pollution through environmental parameters may be very minimal. Therefore, the rating scale of impact is localised both unmitigated and mitigated measures of $CaSO_4$ chemical waste.

**Probability**

Without mitigation, the impact of calcium sulphate is probable through the contact directly by experimenter or workers and perhaps the deposit in soil and water will be relatively improbable because the solid precipitation of calcium sulphate is insoluble in water, hence lower mobility is expected. With effective mitigation measures the impact of $CaSO_4$ chemical waste is improbable.

**Significance**

Since $CaSO_4$ is non-hazardous and biodegradable product, the significance rating is relatively low without mitigation and none or zero significance with mitigation.

#### 9.6.3.3 Mitigation measures

- Develop standard operating procedure as an operational guideline to reduce workers exposure to any potential hazards, which may include identification and enforcement of appropriate Personal Protective Equipment
- The waste compound $CaSO_4$ can be stored in an appropriate facility
- Ensure that the $CaSO_4$ must not enter drains or water courses
- STS should identify, assess and control sources of potential pollution and their impacts on human health and the environment. They should also apply the mitigation hierarchy to control sources of potential pollution.
- This waste product can potentially be used as a gypsum raw material to produce crack filler, dry wall and ceiling boards, and use as raw material for cement manufacturing.

### 9.6.3.4 Impact Assessment Summary: Calcium Sulphate (CaSO4) / Gypsum or Gas desulphurization residue

| | |
|---|---|
| **Waste Classification:** | low risk. Main environmental risk is total dissolves solids (TDS) and sulphate when leaching |
| **Est. Quantity p/a** | |

**Potential Negative Impacts:**

- Exposure may cause respiratory, skin and eye irritation, Gastrointestinal issues and allergic reactions
- Reduced Plant growth due to acidification
- Acute toxicity: LD50 oral (Rat)-50000mg/kg

**Key Mitigation Measures:**

- Appropriate protective gear for workers
- The waste compound $CaSO_4$ must be stored in a lined disposal facility, dry place.
- Isolate from incompatible materials and avoid further chemical reactions in the settled storage.
- $CaSO_4$ is a key ingredient in cement production (opportunity to sell the product)- store it in a way that it can be recovered.
- Prevent dust generation on the storage facility (keep moisture in the material >10%)

| Without Mitigation | | | | | | | With Mitigation | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** | **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** |
| -ve or +ve | Definite | Local | Short-term | low | Yes | Low | -ve or +ve | Definite | Site specific | Short-term | Low | Yes | Negligible |
| **Qualitative assessment** | | | | | | | **Qualitative assessment** | | | | | | |

**Monitoring Program**

| Aspect to Monitor | Frequency | Responsibility | How |
|---|---|---|---|
| • Tailings volume measurement records<br>• Groundwater monitoring<br>• Dust fallout and dust chemical analysis | Weekly | STS (e.g Environmental Officer)<br>Authority (Environmental Compliance Officer) | Chemical analysis<br>Physical observations |

### 9.6.4 FeAs Cement and Effluent treatment and heavy metals removal

#### 9.6.4.1 FeAs Residue and Residue from defluorination and heavy metals removal

The iron-arsenic residue produced by the hydrometallurgical plant amounts to approximately 7,000 t/a (dry basis), characterized as high-risk waste
The neutralized residue from the defluorination and heavy metals removal process produced by the effluent treatment plant amounts to approximately 900 t/a (dry basis), is a hazardous waste.

Both those wastes will be stored in a Class A (according to South African Standards) hazardous waste landfill facility which consist of three liners.

#### 9.6.4.2 Impact of FeAs, Defluorination and heavy metals removal residues

- Arsenic can have many effects on the environment, including inhibition of growth, photosynthesis, and reproduction.
- Arsenic and other heavy metals contamination can also have serious human health risks including:
  - skin lesions
  - skin cancer
  - increased risk of other cancers.
  - cardiac, pulmonary, and artery diseases, diabetes, and neurological
  - developmental, and reproductive disorders
- **water contamination**

  Heavy metals and fluorine, chlorine and sulphates are present in those residues and could contaminate water making the water unsafe for drinking and agriculture. It can also lead to acid mine drainage, which acidifies water bodies near mining sites and harms aquatic ecosystems.
- **Soil damage or contamination**

  The residues can damage soil structure, lead to nutrient loss, and increase soil acidity.
- **Vegetation loss or contamination**

  Arsenic-iron residue can destroy vegetation and make it difficult for trees to grow or vegetation can be contaminated through water absorption and nutrient uptake.
- **Ecosystem damage**
  Heavy metals can be absorbed by plants and enter the food chain, affecting human health.
- **Air pollution**
  Heavy metals that attache to small particles can stay in the air for days and travel long distances.

#### 9.6.4.3 Impact Assessment

**Severity**

The residues may be very hazardous as it contains heavy metals which are carcinogen, thus severely harm, and pose threat to life, health and biodiversity life of living organism, the rating in terms of severity is high. Therefore, strict measure must be put in place to compact the possible contamination and pollution by arsenic-iron residue. Several monitoring tests must be encouraged. With effective mitigation measures the severity of the residues may be lowered.

**Duration**

If contamination occurs, which may be very unlikely, the impact duration of the leach residue to the environment such as water pollution and soil pollution can be irreversible and permanent, because the arsenic-iron residue is an inorganic waste of which are not biodegradable. The human health, some effect of arsenic-iron residue may be curable, but some may cause because long-term health effects, but not permanent health issues or death to multiple cancerous cell affecting several organs in human body. With effective mitigation measures the duration of impact may be very minimal to short-term.

**Spatial scale**

The impact of the residue can be direct to the worker or experimenters for potential exposure to the heavy metal residues, through contamination, inhalations, human negligence of not adhering to protocol established or perhaps the potential leakage in the storagesite of the residues. The contamination of the residues to water course or underground water pollution may be assessed as impact at local level and in terms of air pollution, the arsenic particles may reach at regional contamination. Without mitigation measure impact is regionaland with mitigation measure extend may as well be localised.

**Probability**

The likelihood of impact of this residue to the environment, without mitigation is extreme. But Sinomine, operation have mitigation measure to prevent the contamination or possible pollution by those residues. The waste will be stored in a triple linedhazardous waste stodrage facility (class A - according to RSA standards). Therefore, the possibility of any form of pollution by those residues is very low to improbable rating. However, monitoring tests are encouraged on weekly basis for the safety precaution.

**Significance**

The significance of the multi metals recycling project, with reference to those residues is rated higher without mitigation, because it poses environmental pollution as well as health issue with the local inhabitant due to the hazardous, carcinogenic nature and toxicology of the residues. Hence the operation cannot commence. With effective mitigation and strict adherence to safety standard the possibility of pollution is minimal hence significance of those residues may be rated low; thus, operation can commence.

#### 9.6.4.4 Description of mitigation measures

- The workers must wear protective gear and strictly adhere to the standards on handling chemical waste.
- The residue must be stored in a lined facility (3 liners). The storage facility must be strictly monitored to detect the potential leakage and alert the site-specific workers.
- Avoid incompatible materials.
- Employees or workers must undertake regular medical test, to ensure they are not affected by the residue.
- STS should identify, assess and control sources of potential pollution and their impacts on human health and the environment. They should also apply the mitigation hierarchy to control sources of potential pollution.

### 9.6.4.5 Summary of Impact: Arsenic-Iron (FeAs) sludge residue and defluorination and heavy metals removal residues

| | |
|---|---|
| **Waste Classification:** | Very high-risk wastes. Expected leachability of heavy metals and Fluorine is > LCT1 or LCT2 |
| **Est. Quantity p/a** | 7,000 + 900 dmt/a |

**Potential Negative Impacts:**
- Water Contamination
- Soil degradation through Leaching
- Exposure may cause respiratory, skin and eye irritation
- Harmful if swallowed

**Key Mitigation Measures:**
- Adherence to site standard/safe operating procedure
- Provide appropriate Personal Protective Equipment (PPEs)
- Do not empty in drains
- Waste residue must be stored in a well-designed triple lined facility

| Without Mitigation | | | | | | | With Mitigation | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** | **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** |
| -ve | Definite | Local | Long-term | Severe | No | High/Severe | -ve | Definite | Site specific | Short-term | Low | Yes | Low |
| **Qualitative assessment** | | | | | | | **Qualitative assessment** | | | | | | |

**Monitoring Program**

| Monitoring Aspects | Frequency | Responsibility | How |
|---|---|---|---|
| • Laboratory chemical residue tests<br>• Waste quantification<br>• Groundwater monitoring<br>• Dust fallout and dust chemical analysis | Weekly<br>Monthly | STS (e.g Environmental Officer)<br>Authority (Environmental Compliance Officer) | Chemical analysis<br>Physical observations |

### 9.6.5 Assessment Summary: Ca-Mg Residue

#### 9.6.5.1 Calcium and magnesium (Ca-Mg) Residue

Ca-Mg residue is chemical waste that contains calcium and magnesium, mainly in sulphate form. "Ca-Mg" is a combination of these two elements extracted from mineral sources or produced as chemical waste like in this project. Ca-Mg is often used together in applications like fertilizers or dietary supplements where a balanced ratio of both is needed. Ca-Mg waste is a product of series of different chemical reactions and reaction conditions or process. It is expected that this residue will be recycled to the furnace as a flux, however this could be not feasible, hence the possibility of disposing this waste.

#### 9.6.5.2 Impact of Ca-Mg residue

Ca-Mg waste, containing high levels of calcium and magnesium, can impact the environment primarily by altering soil pH levels due to its alkaline nature, potentially affecting plant growth and nutrient availability, while also influencing water quality depending on the disposal method; high concentrations of Ca and Mg can lead to issues like reduced soil infiltration and altered mineral balance in aquatic ecosystems when improperly managed.

The key negative impact of Ca-Mg waste involves the following:

- **Soil pH increase:** Both calcium and magnesium contribute to alkalinity, raising soil pH when present in significant quantities, which can hinder the uptake of certain nutrients by plants and favor alkaline-tolerant species.
- **Nutrient imbalances:** Excess calcium can lead to a decrease in the availability of other essential nutrients like manganese and zinc in the soil due to antagonistic effects.
- **Soil structure changes:** Depending on the concentration and form of Ca-Mg waste, it can alter soil texture by impacting flocculation and aggregation, potentially affecting water infiltration and drainage.
- **Water quality issues:** When Ca-Mg waste enters water bodies, it can elevate pH and contribute to hardness, impacting aquatic life, particularly sensitive species.
- **Human health:** with a high Ca:Mg ratio being linked to increased risk of various chronic conditions like cardiovascular disease, metabolic syndrome, and certain cancers, while a low ratio may also have negative effects; maintaining a balanced intake of both minerals is key for optimal health.

#### 9.6.5.3 Impact Assessment

**Severity**

Calcium-Magnesium (Ca-Mg) is a relatively non-hazardous biological nutrients in this case referred to as chemical waste. Therefore, the severity rating of this

chemical waste is low without mitigation and with effective mitigation, the severity rating very low to no occurrence.

**Duration**

Calcium-Magnesium (Ca-Mg), as biological nutrients for both plants and animals is biodegradable and therefore the duration of the impact is rated Zero time. And with the effective mitigation measures it will no lower occurrence to none, duration can as well be rated as zero time.

**Spatial scale**

The impact of calcium-magnesium is direct to the workers only. The soil pollution and water pollution the chemical waste is biodegradable with a few months' duration and hence the local pollution through environmental parameters may be very minimal. Therefore, the rating scale of impact is localised both unmitigated and mitigated measures of Ca-Mg chemical waste.

**Probability**

Without mitigation, the impact of Ca-Mg is probable through the contact directly by experimenter or workers and perhaps the deposit in soil and water will be relatively probable. With effective mitigation measures the impact of Ca-Mg chemical waste is improbable.

**Significance**

The significance of the impact of Ca-Mg is very low without mitigation, since this chemical waste is nonhazardous and it also biodegradable with. Ca-Mg is biocompatible and relatively non-toxic. The Ca-Mg waste have no severe harm to prevent the operation to commence with the production in both category without mitigation and with effective mitigation measures. The rating of significance is relatively low without mitigation and none or zero significance with mitigation.

#### 9.6.5.4 Description of mitigation measures

- workers must wear suitable protection gear.
- The waste compound Ca-Mg must be stored in a lined facility with sufficient moisture to prevent dust (moisture > 10%)
- Ensure that Ca-Mg waste must not enter drains or water courses
- Proper waste management: Store the residue in a lined facility
- Soil analysis: Before applying Ca-Mg waste as a soil amendment, analyze soil pH and nutrient levels to determine the appropriate amount needed.
- Regulation compliance: Adhere to local regulations regarding the disposal and management of Ca-Mg waste.
- STS should identify, assess and control sources of potential pollution and their impacts on human health and the environment. They should also apply the mitigation hierarchy to control sources of potential pollution.

### 9.6.5.5 Impact Summary: Calcium-Magenesium (Ca-Mg) waste

| | | |
|---|---|---|
| **Waste Classification:** | Low risk (main concern is TDS and sulphate) | **Key Mitigation Measures:**<br>• Provide Personal Protective Equipment (PPEs)<br>• Isolate from incompatible materials and avoid further chemical reactions in the settled storage.<br>• Storage in a lined facility if re-processing is not feasible.<br>• Calcium and magnesium are essential nutrients for plants |
| **Est. Quantity p/a** | | |
| **Potential Negative Impacts:**<br>• Exposure may cause respiratory, skin and eye irritation,<br>• Can be harmful if swallowed | | |

| Without Mitigation | | | | | | | With Mitigation | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** | **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** |
| -ve or +ve | Definite | Local | Short-term | low | Yes | Low | -ve or +ve | Definite | Site specific | Short-term | Low | Yes | Negligible |
| **Qualitative assessment** | | | | | | | **Qualitative assessment** | | | | | | |

| Monitoring Program | | | |
|---|---|---|---|
| **Aspect to Monitor** | **Frequency** | **Responsibility** | **How** |
| • Waste quantification - measurement records<br>• Groundwater monitoring<br>• Dust fallout and dust chemical analysis | Weekly | STS (e.g Environmental Officer)<br>Authority (Environmental Compliance Officer) | Chemical analysis<br>Physical observations |

### 9.6.6 Dust – ZnO dust product

In the smelting process, "dust" refers to a waste product, often called "smelting dust" or "flue dust", which is a fine particulate matter containing various heavy metals and impurities that are released as a byproduct during the high-temperature smelting process, typically captured in gas cleaning systems; it is considered hazardous due to its potential toxicity and needs careful management.
In the Multi Metals Recycling Process the flue dust is the actual intermediate produce which contains the recovered valuable metals. In the first phase, this dust will be sold as is and in the second phase this dust will be processes onsite in the hydrometallurgical process to recover the metals Zn, Pb, Cu, Ge, Ga from it.

#### 9.6.6.1 Impact Description

The dust composition comprises of various metal and non-metal impurities in solid form, which may comprise of heavy metals such as lead, zinc, arsenic, antimony, cadmium etc. Dust is generated through a combination of mechanical entrainment (small particles getting carried by the gas stream) and chemical reactions during the smelting process where volatile metals vaporize, oxidizeand then condense into dust. The impact of this Dust may severely be influenced by the constituent elements or compounds present in the dust, which is determined by the type of raw material (slag) and smelting process occurred.

**Environmental concerns:** Due to the presence of heavy metals, smelting dust poses a significant environmental concern if not properly handled, potentially contaminating and causing pollution to **air**, **soil**, and **water sources**.

- Air pollution: Fine dust particles from smelting can travel long distances and be inhaled, causing respiratory issues, particularly in communities near smelters.
- Soil contamination: Dust settling on land can contaminate soil with heavy metals like lead, arsenic, and cadmium, impacting plant growth and potentially entering the food chain through crops.
- Water contamination: Dust can leach into waterways, further contaminating water sources and impacting aquatic life.

**Environmental accumulation:** Dust can accumulate in surrounding areas over time, leading to long-term environmental contamination.

**Human health:** Exposure to heavy metals from smelting dust can lead to various health problems including respiratory illnesses, reproductive issues, developmental delays in children, and cancer

#### 9.6.6.2 Impact Assessment

**Severity**
The Dust is fine and dry in nature and thus it can easily be inhaled or contaminate bothair and water. The dust contains fine or tiny particles of heavy metals and other harmful or dangerous contaminants which are hazardous and not biodegradable.

Therefore, the severity rating of the dust is very high, and no production can commence in absence of strict dust monitoring mechanisms in place. With effective mitigation measures the severity may be lowered to non-existant.

**Duration**

The duration of impact due to the smelting dust may be long term to permanent due to the fact that the tiny particles of heavy metals and metallic oxide or metallic sulfides are not biodegradable. With effective mitigation measures the smelting dust may be contained and in such there might be no possible impact due to dust, therefore the duration of impact may be lowered to short time or immediate.

**Spatial scale**

The impact of the smelting dust is highly direct to the worker for potential exposure through air pollution, inhalations, human negligence of not adhering to protocol established or perhaps the potential leakage in the storage vessel or production system. The air pollution may extend to regional level. The contamination of dust to water course or underground water pollution may be assessed as impact at local and regional level. Without effective mitigation measure impact is regional. And with mitigation measure extend may as well be localised.

**Probability**

The likelihood of dust impact, without mitigation is extreme. But Sinomine, operation have mitigation measure to prevent the contamination or possible pollution due to dust. However, monitoring tests are encouraged on weekly basis for the safety precaution.

**Significance**

The significance of this project, with reference to the dust is rated higher without mitigation, because it poses environmental pollution as well as health issue with the local inhabitant due to the hazardous, carcinogenic nature and toxicology of the dust contaminants. Hence the operation cannot commence. With effective mitigation and strict adherence to safety standard the possibility of pollution is minimal hence significance of smelting dust may be rated low, thus operation can commence.

#### 9.6.6.3 Description of mitigation measures

- The workers must wear protective gear and strictly adhere to the standards on handling chemical waste.
- The dust must be stored in a way that dust emissions are prevented.
- Dust collection systems: Implementing efficient dust collection technologies like scrubbers and bag houses to capture dust emissions from smelting operations.
- Recycling and reprocessing: The dust is the actual intermediate product. It has high value and will be treated to prevent any loss.
- 
- The ZnO dust must be packaged in lined containments (bags, or similar with internal liner)

### 9.6.6.4 Assessment Summary: Dust (Smelting Dust) ZnO product

| | |
|---|---|
| **Classification:** | Very high risk (but not a waste – this is a product) |
| **Est. Quantity p/a** | 1,500 dmt/a |

**Potential Negative Impacts:**

- Exposure to heavy metals from smelting dust may lead to various health problems including respiratory illnesses, reproductive issues Allergic reactions
- Dust can accumulate in surrounding areas over time

**Key Mitigation Measures:**

- Wear protective gear and strictly adhere to the standards on handling chemical substances
- Store the product in sealed containment to prevent emissions
- Dust collection system and recycling
- The residue consists of element that can be recycled to obtain chemicals and metallic element for important applications

| Without Mitigation | | | | | | |
|---|---|---|---|---|---|---|
| **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** |
| -ve | Definite | Local | Long-term | High | No | High |
| **Qualitative assessment** | | | | | | |

| With Mitigation | | | | | | |
|---|---|---|---|---|---|---|
| **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** |
| -ve | Definite | Site specific | Short-term | Low | Yes | Low |
| **Qualitative assessment** | | | | | | |

**Monitoring Program**

| Monitoring Aspects / Instruments | Frequency | Responsibility | How |
|---|---|---|---|
| • Air sampling pumps<br>• High volume air sampler<br>• Passive sampler<br>• Chemical speciation analysis | Weekly | STS Environmental Officer<br>Authority (Environmental Compliance Officer) | Chemical analysis<br>Physical observations |

### 9.6.7 Industrial Wastewater

Industrial wastewater is the aqueous discard that results from substances having been dissolved or suspended in water, typically during the use of water in an industrial process or the cleaning, rinsing, acid treatments and cooling activities. Industrial wastewater maybe contaminated with heavy metals like lead, copper, zinc, arsenic and other toxic elements, often exhibiting high acidity levels due to the chemical reactions involved in the smelting or industrial process, making it a significant environmental concern that requires specialized treatment before discharge; key characteristics include high concentrations of dissolved heavy metals, sulphates, carbonates, metal oxides and potentially harmful chemicals depending on the industrial process.

#### 9.6.7.1 Impact Description

Industrial wastewater may contain harmful heavy metals pollutants. These inorganic pollutants are also non-biodegradable. Therefore, the industrial wastewater is dangerous to human. As it possesses threat to human health through several organ damage and possibilities of many cancerous diseases. The soluble industrial water may contaminate the water sources as well as the soil pollutions.

Key impact smelting or industrial wastewater may involve the following:

- **Pollutants:** Primarily contains heavy metals like lead, copper, zinc, cadmium, and arsenic, depending on the mining activities or industrial processes.
- Pollutant possess health risk to human, ecosystem and aquatic marine inhabitants such as fish.
- **Acidity:** Usually, acidic due to the presence of sulphates, which can further exacerbate the toxicity of metals.
- **Sources:** Wastewater from cooling systems, slag quenching, gas cleaning processes, the hydrometallurgical effluent treatment and accidental spills within the smelting facility.
- **Water contamination:** Direct discharge can severely pollute water bodies, impacting aquatic life and potentially affecting drinking water sources.
- **Soil contamination:** Leakage or improper disposal can lead to heavy metal accumulation in soil, impacting plant growth and potentially bioaccumulation.

#### 9.6.7.2 Impact Assessment

**Severity**

The magnitude of impact rating, of the industrial wastewater is very high, as this wastewater contain highly toxic pollutant and hence classified as hazardous substance. With effective mitigation measures, of which the industrial wastewater is contained or treated to re-use purposes the severity will be effectively lowered to non-occurrence.

**Duration**

The pollutant contained in the smelting or industrial wastewater are inorganic toxic substance which are not biodegradable. Therefore, the duration of impact in absence of

mitigation measure is rated long term to permanent. With the effective mitigation measures, industrial wastewater can be effectively contained and treated.

**Spatial scale**

The extent of the impact of industrial wastewater is localised within a 2 km radius of the centre of the site, thus the smelting wastewater can pollute outside the mining boundaries and the surrounding area of STS. With effective mitigation measures the spatial scale rating is site specific, thus contamination can occur on site or within the boundaries of the property.

**Probability**

The possibility of impact by industrial wastewater is definite, which translate the probability is very high, these pollutants are in liquid phase and soluble in water and hence very reactive. With effective mitigation measures the likelihood of impact due to industrial wastewater, will be lowered since the industrial wastewater is effectively regulated and treated for the re-use purposes.

**Significance**

The severity of impact is higher, since the constituent species or contaminants is toxic, some are inorganic which are hazardous and not biodegradable, therefore the significance rating is higher, in absence of effective mitigation measures the project may not allowed to start with the operation. However, with the effective mitigation measures, the significance is rated very low.

#### 9.6.7.3 Description of mitigation measures

- The workers must wear protective gear and strictly adhere to the standards on handling chemical waste. water
- The waste water must be treated to be re-usable or stored in an evaporation pond to evaporate excess water. No discharge of untreated process water is allowed.
- Industrial wastewater can be mitigated by reducing the amount of wastewater produced and treating it to remove pollutants.

- Reducing industrial wastewater production may involve the following:

    - Identify issues: Identify runoff and connection issues
    - Install water-saving devices: Install meters and modify equipment
    - Reuse water: Reuse water at various points in the operation
    - Use waterless processes: Use waterless processes whenever possible

- STS may apply necessary water treatment mechanisms to recycle the industrial wastewater for the re-use purposes.

### 9.6.7.4 Impact Assessment Summary: Industrial Wastewater

| | |
|---|---|
| **Waste Classification:** | Industrial Wastewater/Hazardous wastewater |
| **Est. Quantity p/a** | 1413 $m^3$/d |

**Potential Negative Impacts:**

- Surface and ground water contamination
- Leachate
- Harmful if ingested

**Key Mitigation Measures:**

- Storage in pollution control dam for evaporation as a means of disposal
- Evaporate excess wastewater, with salts finally deposited in a HWDF (either when pond fill up or at closure)
- Cleaning the wastewater to a standard for re-use and then evaporate brine and dispose salts in hazardous disposal facility
- Cleaning the wastewater to effluent discharge quality *(as per the Namibian wastewater discharge standards).*
- *In summary: Wastewater will be reused, remaining portion will be stored in pollution control dam for evaporation, and any excess water will be treated to a discharge limit standard (Namibian wastewater discharge*
- *Deter biodiversity access to wastewater ponds to prevent mortality and loss*

| **Without Mitigation** | | | | | | | **With Mitigation** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** | **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** |
| -ve and +ve | Definite | Local | Long-term | High | No | High | -ve | Definite | Site specific | Short-term | Low | Yes | Low |
| **Qualitative assessment** | | | | | | | **Qualitative assessment** | | | | | | |

**Monitoring Program**

| **Aspect to Monitor** | **Frequency** | **Responsibility** | **How** |
|---|---|---|---|
| • Quantification through Flow meters<br>• Leakage and points sources of pollution<br>• Groundwater monitoring<br>• Biodiversity monitoring | Weekly | STS (e.g Environmental Officer)<br>Authority (Environmental Compliance Officer) | Chemical analysis<br>Physical observations |

### 9.6.8 Domestic Wastewater

Domestic wastewater is wastewater produced by human activities in households. Contains impurities such as suspended solids, colloidal material, dissolved materials, and disease-causing microbes and usually contains relatively small amounts of contaminants. In additions, domestic wastewater can contain contaminants such as fecal matter, bacteria, plastic, cloth fiber, nitrate, phosphate, calcium, sodium, heavy metals and ammonia.

#### 9.6.8.1 Impact Description

The wastewater, when not treated, can significantly impact severely the environment by causing water pollution through the introduction of harmful bacteria, viruses, nutrients, chemicals, and heavy metals, leading to detrimental effects on aquatic life, human health, and ecosystems, including algal blooms, oxygen depletion, and contamination of drinking water sources.

Some of the key impact of industrial wastewater involves the following:

- **Disease transmission:** Industrial wastewater carries pathogens like bacteria and viruses which can cause waterborne diseases like diarrhea, cholera, and hepatitis if ingested by humans or animals.
- **Eutrophication:** High levels of nutrients (nitrogen and phosphorus) in wastewater can stimulate excessive algae growth (algal blooms) which depletes oxygen levels in water bodies, harming fish and other aquatic life.
- **Oxygen depletion:** Decomposition of organic matter in wastewater consumes dissolved oxygen in the water, further impacting aquatic organisms.
- **Habitat destruction:** Sediment and pollutants from wastewater can accumulate in water bodies, altering habitats and disrupting ecosystem balance.
- **Toxicity:** Industrial wastewater can contain toxic chemicals and heavy metals which can directly harm aquatic organisms and accumulate in the food chain.
- **Impact on drinking water sources:** Improper wastewater management can contaminate drinking water sources, posing serious health risks.
- **Aesthetic degradation:** Visible pollution from wastewater discharge can negatively affect recreational water use and tourism.

#### 9.6.8.2 Impact Assessment

**Severity**

The influence of domestic wastewater may be relatively severe to medium in the severity rating in absence of the mitigation measures. With the effective mitigation measures, the severity rating is relatively low to none existence since the domestic waste water is contained and treated for re-use purposes.

**Duration**

The duration of impact can be rated as medium term in absence of mitigation measures. With the effective mitigation measures the duration of impact is greatly minimised to Zero time, since the domestic waste water will be treated and cleaned for the re-use purposes.

**Spatial scale**

The possibility of impact of domestic wastewater's extend is localised with and without mitigation. However, with strict effective mitigation measures the domestic wastewater will be treated and cleaned for the re-use purpose, thus there will be no chances of domestic wastewater occurring.

**Probability**

The likelihood of impact by the domestic wastewater is probable, in absence of the mitigation measures, however under strict monitoring and effective mitigation measures the probability is lowered to improbable.

**Significance**

The impact of domestic wastewater is medium in absence of mitigation measures, since the pollutant in wastewater may contaminate the environment, possibility of waterborne diseases outbreak and degradation of the water quality. With the effective mitigation measures the significance rating is lowered.

#### 9.6.8.3 Description of mitigation measures

- The experimenter or workers must wear protective gears and strictly adhere to the laboratory standards on handling chemical waste.
- Wastewater treatment plants: Implementing effective wastewater treatment processes to remove pollutants before discharge.
- Proper sanitation practices: Promoting hygiene practices like proper sewage disposal to reduce the amount of pollutants entering wastewater systems.
- Industrial waste management: Strict regulations and practices to manage industrial wastewater and minimize toxic discharges.
- Storm water management: Implementing measures to control storm-water runoff which can carry pollutants into waterways.

### 9.6.8.4 Impact Assessment Summary: Domestic Wastewater

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Waste Classification:** | Domestic Wastewater (Sewage)/hazardous wastewater | | | | | | **Key Mitigation Measures:**<br>• Treat in sewage treatment plant before directing into reed dam. Use for site greening<br>• Cleaning the wastewater to effluent discharge quality *(as per the water Namibian wastewater discharge standards).* | | | | | | |
| **Est. Quantity p/a** | 27 375m3/annum (75 m3/day) | | | | | | | | | | | | |
| **Potential Negative Impacts:**<br>• Surface and ground water contamination<br>• Harmful if ingested | | | | | | | | | | | | | |
| **Without Mitigation** | | | | | | | **With Mitigation** | | | | | | |
| **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** | **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** |
| -ve and +ve | Definite | Local | Long-term | Medium | Yes | High | -ve | Definite | Site specific | Short-term | Low | Yes | Low |
| **Qualitative assessment** | | | | | | | **Qualitative assessment** | | | | | | |
| **Monitoring Program** | | | | | | | | | | | | | |
| **Aspect to Monitor** | | | | | | **Frequency** | **Responsibility** | | | | | **How** | |
| • Flow meters<br>• Leakage and points sources of pollution | | | | | | Weekly | STS (e.g Environmental Officer)<br>Authority (Environmental Compliance Officer) | | | | | Chemical analysis<br>Physical observations | |

### 9.6.9 Contractors Camp

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Classification:** | Contractors Temporary Camp<br>Domestic Waste (Solid and Wastewater) | | | | | | **Key Mitigation Measures:**<br>Induction, orientation and awareness of staff on waste management *(importance of toilets, cleanliness, hygiene, maintenance, and impacts of open defecation, engulfing smell, used toilet papers all over the place, food contamination by flies, potential water pollution through leaching of human faecal waste, impact of littering, etc)*<br>Flushing toilets with provision of a containerized septic system, with capacity to handle the volumes, honey sucked and emptied frequently for disposal at the municipal oxidation ponds<br>Engage municipality and obtain permission for wastewater disposal into the Municipal oxidation ponds | | | | | | |
| **Scale** | About 150 contract workers for about 12 Months construction duration | | | | | | | | | | | | | |
| **Potential Negative Impacts:**<br>Lack of ablution facilities – leading to open defecation, environmental pollution (scattered human waste), engulfing smell and leaching of human faecal waste into water bodies<br>Long-drop toilets – not suitable for bigger groups (e.g 150 people) over long period of time (e.g 12 months)<br>Littering – due to lack of waste bins, lack of waste collection and disposal, lack of staff orientation and awareness | | | | | | | | | | | | | | |
| **Without Mitigation** | | | | | | | **With Mitigation** | | | | | | | |
| **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** | **Impact type** | **Probability** | **Extent** | **Duration** | **Severity** | **Reversible** | **Significance** |
| -ve and +ve | Definite | Local | Long-term | Medium | Yes | Medium | -ve | Definite | Site specific | Short-term | Low | Yes | Low |
| **Qualitative assessment** | | | | | | | **Qualitative assessment** | | | | | | |
| **Monitoring Program** | | | | | | | | | | | | | |
| **Monitoring Aspects** | | | | **Frequency** | | | **Responsibility** | | | | **How** | | |
| Ablution facilities (Flushing toilets)<br>Containerised septic tank<br>Wastewater collection schedule and records<br>Waste bins, collection schedule and records | | | | Weekly | | | STS Environmental Officer<br>Authority (Environmental Compliance Officer) | | | | Physical observations<br>Records | | |

# 10. MONITORING ASPECTS

The general approach to health, safety and environmental monitoring for the proposed project is that the existing monitoring programs require review to determine the need and extend of updates of these program. This is to ensure the current monitoring programs are comprehensive and adequate to cover for the new potential parameters or aspects of concerns associated the proposed alkali metal salt project.

The following monitoring programmes will be undertaken:

## 10.1 Occupational Health and Safety Monitoring Program

Occupational exposure monitoring must be conducted for specific exposure risk and at a frequency deemed fit as per expert recommendations based on the occupational exposure and risk profile.
Medical surveillance and any testing of employees shall be based on the risk as shall be recommended by the Occupational Health Specialists using the hygiene monitoring data and occupational health risk assessment methods.

### 10.1.1 Medical Examinations

Routine medical examinations shall be conducted at intervals that are determined by the occupational risk.

### 10.1.2 Biological exposure monitoring

Biological monitoring samples as deemed necessary by the occupational health experts will be collected to assess employee short-term and long-term exposures.

### 10.1.3 Biological effect monitoring

Medical surveillance may include biological monitoring for health effects of occupational exposure to allow for early detection and management of adverse health impacts.

## 10.2 Environmental Monitoring Program

The following environmental monitoring program must continue and be updated to ensure potential contamination from all the wastes can be adequately monitored during the operation of the project and beyond closure

### 10.2.1 Facility monitoring

Periodic leach and characterisation tests be conducted on the residues to continuously keep trend on the waste characterisation and risk of leachability. Waste storage facility will be constructed with a leak detection system. This will be monitoring for any leaks. Should a leak occur, leachate will be analysed and appropriate corrective measures taken.

### 10.2.2 Groundwater monitoring

There is currently a network of 34 monitoring boreholes which are strategically located in and around the smelter boundary. This program should continue with a specific effort to identify specific boreholes which will serve as monitoring boreholes for the waste storage facility and should the review of current monitoring network identify a gap, such gap be closed with the drilling of appropriate number of boreholes. Further, to identify any gap in the parameters of measurement and equally close this gap with incorporation of new required analysis.

### 10.2.3 Air quality monitoring

There is currently a network of 6 ambient air quality monitoring stations which are strategically located in and around the smelter boundary. Further, there are currently 19 dust fallout buckets which are also installed in various places in and around site. This program should continue with a specific effort to identify any gap in the parameters of measurement which should be closed with installation of new instrument and or increasing scope of sample measurement / analysis.

### 10.2.4 Biodiversity monitoring

All programs of biodiversity monitoring should continue with a particular focus on observed shift in observation trends which would be attributed to the existence of waste storage facility and related activities. Current monitoring programs include biodiversity sighting, mortality, road kills, bird powerline interaction, etc.

## 10.3 Other Monitoring Techniques

Periodic leaching and characterisation tests are important because they can assess the risk of a waste releasing contaminants into the environment. The monitoring and regulation of the waste may include the following:

### 10.3.1 Australian Leaching Procedure (ASLP)

A procedure that uses four leaching methods, data management tools, and scenario assessment approaches to evaluate the release of inorganic constituents from solid materials.

### 10.3.2 Laboratory tests

These tests can be used to determine the source term and assess the risk of soil and groundwater contamination.

### 10.3.3 X-ray diffraction analysis (XRD)

This technique can be used to determine the mineralogical composition of samples and can also be used as a quick field measurement for example before a sample can be taken to be subject to XRD.

### 10.3.4 Chemical analysis

This technique can be used to investigate the phase composition of samples.

## 10.4 Elemental analysis techniques

These techniques include inductively coupled plasma atomic emission spectroscopy (ICP-AES), inductively coupled plasma mass spectrometry (ICP-MS), and atomic adsorption spectroscopy (AAS) to determine chemical composition of the wastes.

## 10.5 Industrial Wastewater Monitoring

Industrial wastewater monitoring is the process of collecting and analyzing samples of wastewater to ensure it meets environmental standards and is safe for reuse. The monitoring process may involve the following:

Total Dissolved Solids (TDS)
This method measures the amount of dissolved solids in the water. Often a conductivity is measured online to relate to the TDS.

### 10.5.1 Effluent monitoring

This involves collecting and analyzing samples of liquid and gaseous effluents.

### 10.5.2 Level sensors

These sensors can monitor wastewater levels in sewage treatment plants.

## 10.6 Domestic Wastewater Monitoring

They key monitoring aspect of the domestic wastewater may involve the following:

### 10.6.1 Wastewater flow

A flume and ultrasonic flow meter can be used to measure wastewater flow in a flow manhole.

### 10.6.2 Wastewater level

Submersible pressure transmitters or level sensors can be used to monitor wastewater levels in sewage treatment plants.

### 10.6.3 Fluid pressure

Submersible pressure transmitters or level sensors can be used to monitor fluid pressure at pumps or valves in sewage treatment plants

## 10.7 Total Dissolved Solids (TDS)

This method measures the amount of dissolved solids in the water (usually a conductivity probe relating conductivity to TDS)

### 10.7.1 Effluent monitoring

This involves collecting and analyzing samples of liquid and gaseous effluents.

### 10.7.2 Level sensors

These sensors can monitor wastewater levels in sewage treatment plants.

# 11. CONCLUSION AND RECOMMENDATIONS

The assessment concludes that proposed Multi-Metal Recycling presents potential environmental, health and safety risks. Some of the impacts are rated as High in terms of significance before mitigation, however all the identified impacts can be mitigated to low rating and or negligible rating which are acceptable standards.

Further, for each of the waste streams and handling of both input (raw material) and output materials (products), the assessment identified corresponding mitigation measures, which if comprehensively implemented, will reduce the project risks to acceptable standards.

On the direct environmental positive impact, it cannot be emphasised enough that the proposed project aims to reprocess the old/historical waste heaps which are source of the current (though localised) groundwater contamination onsite including air quality dust related emissions.

On condition that all identified impacts and recommended mitigations measures are implemented and monitored, an Environmental Clearance Certificate (ECC) is recommended.

## 12. REFERENCES

Assessment of the Contamination Risks to the Groundwater and Soils at the Tsumeb Smelter, Report No.: JW181/09/C391, Revision 0, Jones and Wagener, April 2011.

Barnard, P. 1998. Under protected habitats. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.

Based on personal communication on 3 June 2022 in Tsumeb with Mr Andre Neethling (former Ongopolo Mine Managing Director) and Mr Dangi Linekela Sheetekela (former Tsumeb Major).

Butterman C, Brook W and Reese G. 2005. Mineral Commodity Profiles. Cesium. United States Geological Survey, Reston, Virginia.

Curtis, B. & Barnard, P. 1998. Sites and species of biological, economic or archaeological importance. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.

DPMT Consolidated ESMP for the proposed expansion of the Tsumeb Smelter by SLR, 2019

Giess, W. 1971. A preliminary vegetation map of SouthWest Africa. Dinteria 4: 1 – 114.

Jones & Wagner, Assessment of the Contamination Risks to the Groundwater and Soils at the Tsumeb Smelter, JW48/11/C391, Revision 0, April 2011

Mendelsohn et. al. (2000). A Profile of north-central Namibia. Directorate of Environmental Affairs: Ministry of Environment and Tourism of Namibia. Gamsberg Mcmillan Publishers. Windhoek: Namibia.

Mendelshon et. al. (2003). Atlas of Namibia – A Portrait if the Land and its People. The Ministry of Environment and Tourism of Namibia. New Africa Books. Cape Town: South Africa.

Miller, R, McG. (1992) Regional Geology Series – The Stratigraphy of Namibia. Ministry of Mines and Energy Geological Survey of Namibia.

Ministry of Environment and Tourism. (2002) Digital Atlas of Namibia. http://www.uni-koeln.de/sfb389/e/e1/download/atlas_namibia/index_e.htm

Namibia Statistics Agency. 2023. National Population Census Data. Windhoek, Namibia

Namibia. 2008. Draft Procedures and Guidelines for Environmental Impact Assessments (EIA) and Environmental Management Plan (EMP). The Republic of Namibia.

National Heritage Council Namibia. 2013. (www.nhc-nam.org) Official Gazette 1616, No. 325, 1951. Vogt, Official Gazette 1616, No. 325, 1951. Vogt, Andreas, \\\"National Monuments in Namibia\\\", Windhoek 2004, p.7-8. Heinz, R., \\\"Die Saurierfaehrten bei Otjihaenamaparero im Hereroland und das Alter

The National Planning Commission of Namibia. 2011. Namibia 2011 Population and Housing Census Preliminary Results. (www.npc.gov.na)

SLR. 2016. Dundee Smelter Expansion. Ground and Surface Water Specialist input to EIA.

TEC. 2022. Social and Environmental Impact Assessment for Dundee Smelter Expansion.

## 13. APPENDICES

**APPENDIX (1):** Material Safety Data Sheets (MSDS)

**APPENDIX (2):** Stakeholder Engagement Report

**APPENDIX (3):** Groundwater Monitoring Framework

**APPENDIX (4):** Biannual Environmental Performance Report (2024)

**APPENDIX (5):** General Waste Handling Flow Chart (STS)

**APPENDIX (6):** Landfill Management Manual (STS)

**APPENDIX (7):** Design and Proven Capacity to handle Hazardous Waste (STS)

**APPENDIX (8):** Environmental and Social Management Plan (ESMP)

# Material Safety Data Sheet (MSDS)

**Version 1.0 Issue date: 09-12-2024 Revision date: 09-12-2024**

**Product:** **Gas-Desulphurization Residue**

## 1. Identification of the Substance/Mixture and of the company/undertaking

### 1.1. Product identification

**Product Name**: Gas De-sulphurization Residue

**Mineral Composition**: Calcium Sulphate Dihydrate (Gypsum), Water, Calcium Carbonate

| Component | CAS Number | Percentage (%) |
|---|---|---|
| Gypsum ($CaSO_4 \cdot 2H_2O$) | 10101-41-4 | 90-100% |
| Calcium Carbonate ($CaCO_2$) | 471-34-1 | 0-10% |
| Water ($H_2O$) | 7732-18-5 | 10-25% |

### 1.2. Relevant Identified uses of the substance

Cement manufacturing additive, Plaster, drywall board

### 1.3. Details of the supplier of the Safety Data Sheet:

**Supplier (Manufacturer):** Sinomine Tsumeb Smelter

**Address:** Smelter Road, Tsumeb, Namibia

**Contact person:** Emergency response department

**Telephone:** +264 (0) 811228702

**Available outside office hours?: YES ☑ NO ☐**

## 2. Hazards Identification

- **Classification of the substance:**

  This product is non-hazardous

- **Potential Health Effects:**
  - **Inhalation:** May cause respiratory irritation.

- **Skin Contact:** May cause skin irritation.
- **Eye Contact:** May cause eye irritation.
- **Ingestion:** Harmful if swallowed.

## 3. Composition/Information on Ingredients

- **Substance/Mixture:** Mixture
- **Ingredient(s):**

| Component | CAS Number | Percentage (%) |
|---|---|---|
| Gypsum ($CaSO_4 \cdot 2H_2O$) | 10101-41-4 | 90-100% |
| Calcium Carbonate ($CaCO_2$) | 471-34-1 | 0-10% |
| Water ($H_2O$) | 7732-18-5 | 10-25% |

## 4. First Aid Measures

- **Description of first aid measures:**
  - **In case of inhalation:** Provide fresh air.
  - **In case of skin irritation:** Wash off immediately with plenty of water.
  - **In case of eye contact:** Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Call a physician immediately.
  - **In case of ingestion:** Do NOT induce vomiting. Call a physician immediately.

## 5. Firefighting Measures

The substance is not combustible

## 6. Accidental Release Measures

- **Personal Precautions:** Use personal protective equipment. Avoid dust formation.
- **Environmental Precautions:** Prevent further spillage. Do not let product enter drains.
- **Methods for Cleaning Up:** Sweep up and shovel up. Keep in suitable, closed containers for disposal.

## 7. Handling and Storage

- **Handling:** Avoid contact with skin and eyes. Avoid formation of dust.
- **Storage:** Keep container tightly closed.

## 8. Exposure Controls/Personal Protection

- **Engineering Controls:** dust ventilation installation
- **Personal Protective Equipment:**
    - **Respiratory Protection:** Use a dust mask
    - **Hand Protection:** Wear protective gloves.
    - **Eye Protection:** Safety glasses with side-shields.
    - **Skin and Body Protection:** Wear suitable protective clothing.

## 9. Physical and Chemical Properties

- **Appearance:** white solids (powder when dry)
- **Odor:** Odorless
- **pH:** Not applicable
- **Melting Point/Range:** 1100-1200 °C
- **Boiling Point/Range:** Not applicable
- **Flash Point:** Not applicable
- **Flammability:** Not flammable
- **Vapor Pressure:** Not applicable
- **Density:** not available
- **Solubility:** slightly in water

## 10. Stability and Reactivity

- **Stability:** Stable under normal conditions.
- **Conditions to Avoid:** Avoid incompatible materials.
- **Incompatible Materials:** Strong acids.
- **Hazardous Decomposition Products:** None under normal use conditions.

## 11. Toxicological Information

- **Acute Toxicity:** Not available
- **Chronic Toxicity:** Not available
- **Carcinogenicity:** Not classified as a carcinogen by IARC, NTP, or OSHA.

## 12. Ecological Information

**Ecotoxicity**: Non-hazardous to aquatic life.

**Persistence and Degradability**: Not applicable.

**Bioaccumulative Potential**: Not applicable.

**Mobility in Soil**: Not applicable.

## 13. Disposal Considerations

- **Waste Disposal Methods:** Dispose of in accordance with local, regional, and national regulations.

## 14. Transport Information

- **DOT:** Not regulated
- **IATA:** Not regulated
- **IMDG:** Not regulated

## 15. Regulatory Information

**US Federal Regulations**: Not applicable.

**International Regulations**: Not applicable.

## 16. Other Information

- **Prepared By:** SINOMINE TSUMEB SMELTER
- **Revision Date:** 09-12-2024

# Material Safety Data Sheet (MSDS)

**Version 1.0 Issue date: 09-12-2024 Revision date: 09-12-2024**

**Product:** **Granulated Fuming Furnace Slag**

## 1. Identification of the Substance/Mixture and of the company/undertaking

### 1.1. Product identification

**Product Name**: Granulated Fuming Furnace Slag

**Mineral Composition**: Fayalite, Olivine, Glass, Slag- CAS: 65996-69-2

| Element | Value (%) |
|---|---|
| As | 0-0.1 |
| Cd | <0.005 |
| Cu | <0.2 |
| Pb | <0.05 |
| Zn | <0.05 |
| Fe | 10-25 |
| Mg | 5-10 |
| Al | 2-8 |
| $SiO_2$ | 30-60 |
| CaO | 15-40 |
| $H_2O$ | 1-5 |

### 1.2. Relevant Identified uses of the substance

Sand Blasting Grit, Construction additive

### 1.3. Details of the supplier of the Safety Data Sheet:

**Supplier (Manufacturer):** Sinomine Tsumeb Smelter

**Address:** Smelter Road, Tsumeb, Namibia

**Contact person:** Emergency response department

**Telephone:** +264 (0) 811228702

**Available outside office hours?: YES ☑ NO ☐**

## 2. Hazards Identification

- **Classification of the substance:**

  This product is non-hazardous

- **Potential Health Effects:**
  - **Inhalation:** May cause respiratory irritation.
  - **Skin Contact:** May cause skin irritation.
  - **Eye Contact:** May cause eye irritation.
  - **Ingestion:** Harmful if swallowed.

## 3. Composition/Information on Ingredients

- **Substance/Mixture:** Mixture
- **Ingredient(s):** Moisture: 3%

  Slag: CAS 65996-69-2

## 4. First Aid Measures

- **Description of first aid measures:**
  - **In case of inhalation:** Provide fresh air.
  - **In case of skin irritation:** Wash off immediately with plenty of water.
  - **In case of eye contact:** Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Call a physician immediately.
  - **In case of ingestion:** Do NOT induce vomiting. Call a physician immediately.

## 5. Firefighting Measures

The substance is not combustible

## 6. Accidental Release Measures

- **Personal Precautions:** Use personal protective equipment. Avoid dust formation.
- **Environmental Precautions:** Prevent further spillag. Do not let product enter drains.
- **Methods for Cleaning Up:** Sweep up and shovel. Keep in suitable, closed containers for disposal.

## 7. Handling and Storage

- **Handling:** Avoid contact with skin and eyes. Avoid formation of dust.

- **Storage:** Keep container tightly closed.

## 8. Exposure Controls/Personal Protection

- **Engineering Controls:** none
- **Personal Protective Equipment:**
    - **Respiratory Protection:** Use a dust mask
    - **Hand Protection:** Wear protective gloves.
    - **Eye Protection:** Safety glasses with side-shields.
    - **Skin and Body Protection:** Wear suitable protective clothing.

## 9. Physical and Chemical Properties

- **Appearance:** black/grey solid granules (glassy)
- **Odor:** Odorless
- **pH:** Not applicable
- **Melting Point/Range:** 1100-1200 °C
- **Boiling Point/Range:** Not applicable
- **Flash Point:** Not applicable
- **Flammability:** Not flammable
- **Vapor Pressure:** Not applicable
- **Density:** true density: 3.5 kg/l, bulk density 2.0 kg/l
- **Solubility:** insoluble in water

## 10. Stability and Reactivity

- **Stability:** Stable under normal conditions.
- **Conditions to Avoid:** Avoid incompatible materials.
- **Incompatible Materials:** Strong acids.
- **Hazardous Decomposition Products:** None under normal use conditions.

## 11. Toxicological Information

- **Acute Toxicity:** Not available
- **Chronic Toxicity:** Not available

- **Carcinogenicity:** Not classified as a carcinogen by IARC, NTP, or OSHA.

## 12. Ecological Information

- **Ecotoxicity:** Not toxic to the ecosystem
- **Persistence and Degradability:** Not available
- **Bioaccumulative Potential:** does not bioaccumulate
- **Mobility in Soil:** Not mobile
- **Leachability in water:** Leachability of As (arsenic) is 0.13 mg/l in water according to Australian Standard Leach Procedure

## 13. Disposal Considerations

- **Waste Disposal Methods:** Dispose of in accordance with local, regional, and national regulations.

## 14. Transport Information

- **DOT:** Not regulated
- **IATA:** Not regulated
- **IMDG:** Not regulated

## 15. Regulatory Information

No specific national regulations for this substance.

## 16. Other Information

- **Prepared By:** SINOMINE TSUMEB SMELTER
- **Revision Date:** 09-12-2024