

3.1 INTRODUCTION

The purpose of this Chapter is to provide a description of the Project. In doing so the section provides a description of:

- Background to Project;
- Project location;
- Overview of Project;
- Rationale for the Project;
- Proposed Project timeframes; and
- Description of and motivation for mining method.

3.1.1 Background to Project

In 1998, Anglo American (hereafter referred to as Anglo) purchased Goldfield's interest in the Gamsberg Zinc Mine (hereafter referred to as 'the Project') and commenced detailed feasibility studies for the establishment of a large scale open pit mine with a metal production capacity of 300 kilotons per annum (ktpa). Upon completion of the feasibility study in 1999, Anglo commenced with all environmental and other regulatory approval processes in order to establish the mine. An old order mining right was granted in terms of the Mineral Act (No. 50 of 1991). Environmental approval was received in 2000 for the proposed mine, associated infrastructure and waste management facilities in terms of the Environmental Conservation Act (No. 73 of 1989).

Despite receiving the necessary approvals to proceed with the construction and operation of an open pit mine and associated refinery, Anglo did not initiate the full project development for various reasons. Subsequently, Anglo established a small scale underground mining operation which commenced along the northern section of the Gamsberg inselberg in 2003. These underground mining operations are on-going and currently produce a total of 60,000 tpa of ore. The material is concentrated at the existing Black Mountain Mine concentrator; it is then transported to Loop 10 siding (approximately 160 km east of Aggeneys) and railed to the Port of Saldanha, via the Sishen – Saldanha railway line.

The feasibility study undertaken during the initial EIA process in 2000 (SRK Consulting) explored various mining options. The study concluded that the viability of a mine at Gamsberg would be dependent on a zinc metal production of 300,000 tpa for at least 25 years. In order to achieve this zinc metal production, open pit mining was identified to be the only feasible option, as it would have a life span of 33 years, meet the production targets and recover 95% of the ore reserves. The underground mining option confirmed that the production level could only attain 250,000 tpa, with a life span of less than 25 years as only 65% of ore deposits could be recovered. Based on these findings, Anglo pursued the option of open pit mining to achieve project viability.

The proposed construction of the open pit zinc mine and associated refinery was placed on hold until 2007, at which time Anglo commenced a Concept Study to augment the 1999 Feasibility Study. The Concept Study scaled up the proposed metal production from 300 ktpa to 400 ktpa. However, upon completion of this study, the project was placed on hold once again due to insecurity of electricity supply and rising costs of power.

In 2009/2010, Anglo introduced additional project components and initiated a Gap Analysis. The purpose of the Gap Analysis served to identify legislative and technical requirements that were now required, based on the changes in environmental legislation (ie EIA regulations) and project components. Upon completion of the Gap Analysis in 2010, Vedanta Resources plc. acquired BMM as well as the Project area. BMM (now a subsidiary of the Vedanta Resources plc.) intends developing the mine and has initiated the necessary feasibility studies and associated environmental studies. BMM has appointed ERM to undertake the necessary environmental regulatory processes in terms of NEMA, the NWA, and MPRDA (amongst others).

3.1.2 Project Location

The mine is located in the Northern Cape Province of South Africa, between the existing town of Aggeneys and the town of Pofadder, approximately 120 km east of the Springbok, along the N14. The mine and associated plant facilities will be located on the following properties, approximately 14 km east of the town of Aggeneys, along the eastern border of the N14 (refer to *Figure 1.1*):

- Bloemhoek 61 Portion 1;
- Gams 60 Portion 1;
- Aroams 57 RE; and
- Gams 60 Portion 4;

The site is commonly referred to as Gamsberg, and is characterised by an oval shaped inselberg, that extends approximately 220 meters above the surrounding plains.

There is an existing gravel road that runs in a south-easterly direction from the Mine to Loop 10 rail siding, on the Sishen-Saldanha railway line, which is located approximately 160 km south-east of the Mine. It is expected that half of the zinc concentrate produced will be transported via this route to the Port of Saldanha. It is also expected that the remaining proportion of the zinc concentrate will be trucked to the Port of Saldanha directly from the mine along the N14, via N7 and R399.

3.1.3 Overview of Project

BMM intends to establish the mine with resultant waste rock dumps; mine machinery fleet and workshops. A concentrator plant with resultant stockpile areas, tailings facility and supporting infrastructure (ie water supply distribution

network, laboratories, sewage works and an office complex) will be established to process the mined ore. Off-site linear infrastructure in the form of energy and water supply as well as transport routes will be established. Residential housing in support of the project will also be established. All of the above will be the subject of this ESIA application.

The Port of Saldanha is currently used by BMM for exporting its products and it is intended that the Project will also utilise this Port. At this stage, only preliminary design and layout options for the expected expansions or upgrades to accommodate the additional zinc concentrate export have been undertaken. Pending outcomes from further feasibility studies and engagement with the National Ports Authority, the preferred option to accommodate the increase in zinc exports will be confirmed and this will be subject to a separate environmental application process, if required.

3.1.4 *Global Demand*

In order to understand the need and desirability for the project, the driving factors for the establishment of the mine are presented below. The need for the project is presented within the context of the global market and its relation to the South African context. BMM's motivation for the Project is presented, followed by the regional mining context within the Northern Cape.

Zinc is the fourth most common metal in use globally, behind iron, aluminium, and copper, with an annual production of about 12 million tons (www.minerals.usgs.gov). According to the United States Geological Survey, the total global zinc resource is approximately 1,9 billion metric tons. According to the International Lead and Zinc Study Group (ILZSG), 50% of the end use of zinc is galvanising, followed by zinc alloying and the production of brass and bronze. Zinc is also used in the chemical industries as well as household products, but the volumes are minimal compared to the end uses identified above.

The current global mine production of zinc slightly exceeds the current global usage of zinc, as indicated in *Table 3.1* below. The forecasted growth of zinc demand however is projected to increase over the period 2012 – 2025 at a rate of 3.7% per annum (Wood Mackenzie, 2012). The growing global demand for zinc will exceed current global production by approximately 503 Ktpa by the year 2015 (Wood Mackenzie, 2012).

Table 3.1 *Estimated Zinc Mine Production and Metal Usage (Sourced from Wood Mackenzie, 2012)*

World Refined Zinc Supply and Usage 2008 – 2012 (thousand tons) & projection for 2015						
Year	2008	2009	2010	2011	2012	2015
Mine production	11 487	11 174	12 712	12 992	13 457	14 870
Metal Usage	11 198	10 136	11 681	12 584	13 191	15 373

The establishment of the mine is expected to introduce approximately 500,000 tpa of zinc into the global market at its peak production capacity. The zinc concentrate generated from the Project would be exported to Europe and Asia for refining and distribution, until such time a zinc refinery is established in South Africa.

Although the current global supply exceeds the current global usage of zinc (Wood Mackenzie, 2012), the mine intends to meet the growing demand, at the time of commencement of operation (ie 2015). The viability of the Project is closely linked to timing of, and increasing, global demand trends. Leading zinc mines like Century in Australia and Lisheen in Ireland are expected to close during 2014-16 and other large zinc mines like Rampura-Agucha in India would experience a fall in production, thereby generating greater global demand for concentrate produced from the Project.

Regional Mining

Mining is a major gross domestic product (GDP) contributor and provides about 50% of the employment in Northern Cape Province (SRK Consulting, 2010).

Mining in the north western area of the Northern Cape is however declining and is expected to have a significant impact on the region.

BMM has a long term view to exploit additional resources to ensure mining continues in the region. The Swartberg Mine and Broken Hill Mine are no longer mined and the Deeps Mine (in Aggeneys) has a life of mine until 2020. The Deeps Mine will continue to explore potential mining opportunities to expand its life of mine. The Project is a key project to ensure mining continues in the region and will have an expected life of mine of 19 years with future potential for the possible extension of this period.

South Africa has been a net importer of refined zinc resulting in loss of foreign exchange for the nation. While the Project will not reduce the countries dependency on importing refined zinc (as there is no zinc refinery in South Africa), it will create many new job opportunities, stimulate the Northern Cape economy.

Regional contribution to local economy by the existing Black Mountain Mine

BMM's current contribution to the local and regional economy includes:

- Employing in excess of 1,300 persons, operating as the largest private employer in the Namakwa region and it is a stable employer for the last 30 years. 80 % of the employees are local, with 62% from Namakwa, Khai-Ma and Nama Khoi municipal area.
- Residential accommodation is provided by the mine to almost all its employees. Aggeneys currently houses the existing BMM work force of approximately 700 permanent employees and approximately 680 sub contracted staff.
- Basic service provision to the town of Aggeneys is maintained for all residents. Monitoring of resources like water, energy as well as waste and its

recycling takes place continually to enable sustainable management of resources by all the users.

- An indirect result of the Deeps Mine and by the support of BMM, potable water is provided to Pofadder, Pella, Aggeneys and surrounding farmers (a total of approximately 11,200 people).
- The public provincial gravel road of 160 km from the N14 to Loop 10 railroad siding is maintained by BMM.
- Supporting businesses and clubs are directly or indirectly supported by BMM providing additional employment and non-mine skills development and economic benefit to the area.
- In addition to the above, the Black Mountain Social and Labour plan currently implement four projects, affecting approximately 9,000 persons positively with a total spent of approximately R 16.5 million over five years.

It is expected that the proposed Project will continue to add socio-economic value in similar manner in the future.

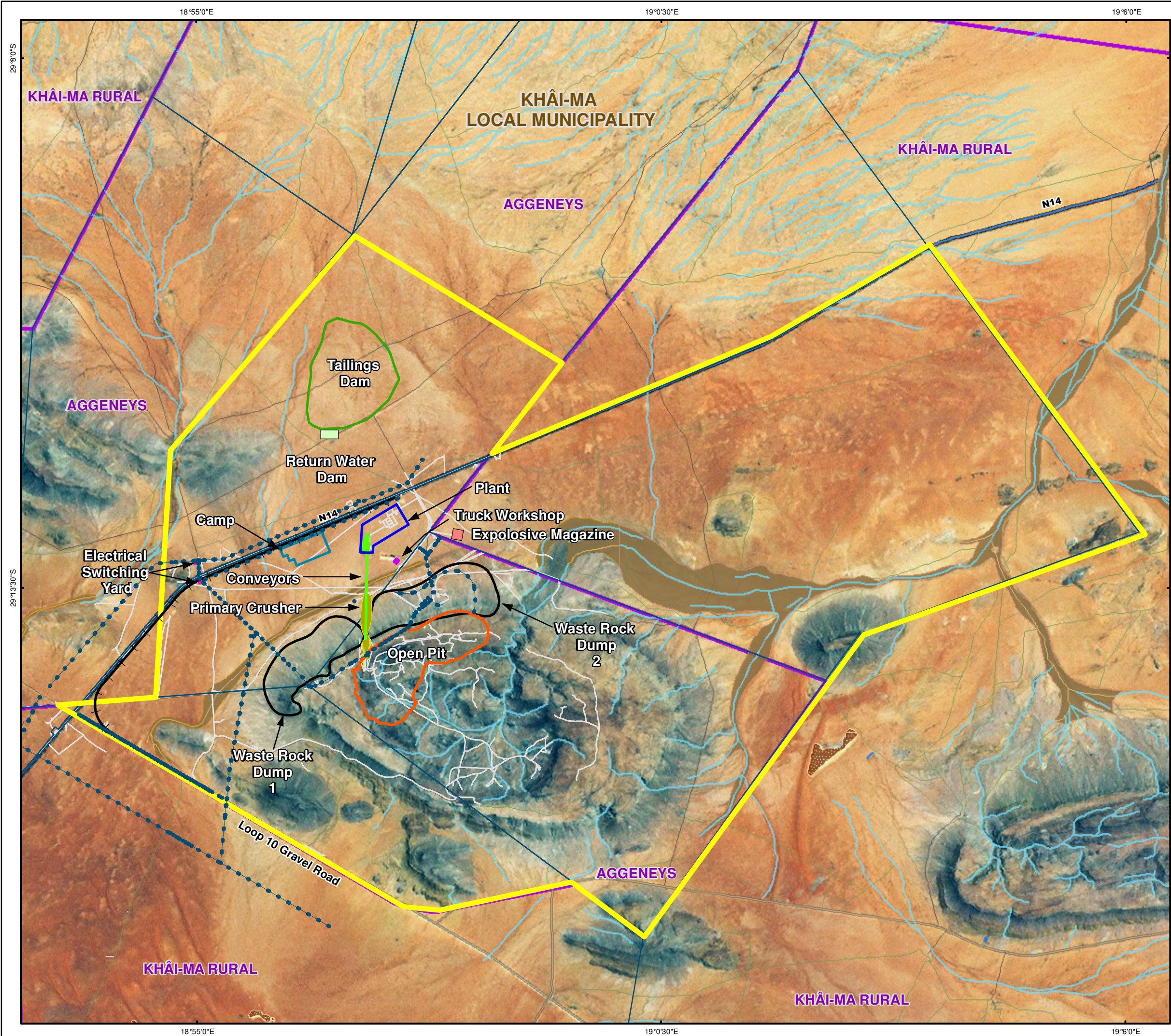
3.1.5 *Proposed Project timeframes*

The project programme, based on the current work schedule, is summarised below:

Table 3.2 *Estimated Project Programme*

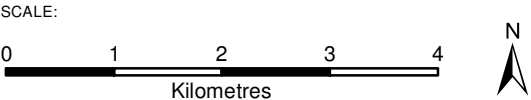
Phase	Commencement	Completion	Duration	Remarks
Planning & Design	First Quarter 2012	First Quarter 2013	12 Months	
Construction	Fourth Quarter 2013	First Quarter 2017	42 Months	First stream of 3.35 Mtpa will come into operation from 1st quarter of 2015
Operation	Second Quarter 2015	2032	19 years	Two additional streams will be added, during the remaining life of mine.
Decommissioning	2033		12 months	Decommissioning phase to be refined during updates of the mine closure plan.

The final layout plan for the Project is presented in *Figure 3.1* below. Please note that the layout planning was subject to a detailed assessment of alternatives, which are contained in *Section 4*.



Legend

- Non-Perennial River
- Dry Water Course Centre Line
- Dry Water Course Floodplain
- Dam
- Dry Pan
- National Route (N14)
- Main Road
- Secondary Road
- Other Road
- Track/Footpath
- Railway
- Electrical cables
- Haul Roads
- Town Boundary
- Cadastral Boundaries
- Open Pit
- Contractors Camp
- Conveyor
- Electrical Switching Yard
- Explosive Magazine
- Plant
- Primary Crusher
- Return Water Dam
- Tailings Dam
- Truck Workshop
- Waste Rock Dump 1
- Waste Rock Dump 2
- Mineral Rights Area



TITLE:

Figure 3.1:
Updated General Layout Plan

CLIENT:

BLACK MOUNTAIN MINING (PTY) LTD

DATE: Apr 2013	CHECKED: MP	PROJECT: 0164903
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 70 000
DRAWING: Updated General Layout Plan.mxd		REV: 0

ERM
Great Westerford Building
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Fax +27 21 686 073

Projection: Transverse Mercator, CM19, Datum : WGS84
Source: Chief Directorate National Geo-Spatial Information, Black Mountain Mining (Pty) LTD
Inset Map: Esri Data & Maps

SIZE:
A3

3.2

CONSTRUCTION PHASE

Key activities that will be undertaken during the construction phase of the Project include the following:

- upgrading/widening of site access routes;
- earth-moving, levelling, grading and excavations;
- site clearance;
- blasting;
- pre-stripping;
- installation of equipment;
- construction of temporary construction camp and associated bulk services;
- construction of all mine infrastructures and facilities; and
- construction of bulk services facilities (ie power infrastructure, waste facilities and water supply system and sewerage treatment plant).

This section focuses on the construction phase of the project and describes the following:

- Job creation during the construction phase;
- Construction camp infrastructure (office, workshop, temporary storage of fuels and wastes);
- Contractor housing camp (temporary staff housing);
- Bulk service requirements for the construction camp and temporary contractor housing camp;
- Non-mineral waste management;
- Storm water management; and
- Concentrator plant.

3.2.1

Job Creation during the Construction Phase

The construction phase of the Project will result in between approximately 3,200 construction phase jobs. *Table 3.3* provides a breakdown of the number and types of jobs expected for different components associated with the construction phase.

Table 3.3 *Estimated Direct Temporary Employment during Construction*

Construction component	Total number of workers needed				Ave duration of each employment contract within over all 36 to 42 month construction period
	Highly skilled	Medium skilled	Low skilled	Total	
Mine & Pre-Stripping	150	375	675	1200	19 months
Concentrator plant	120	300	550	970	
Housing	50	125	225	400	
Infrastructure	80	200	350	630	
Total	400	1000	1800	3200	

3.2.2 Construction Camp Infrastructure (Office, Workshop, Temporary Storage of Fuels and Wastes)

A construction camp will be established during the construction phase of the Project, which will cover a total area of approximately 2 to 4 hectares. It is proposed to locate the construction camp north of the Gamsberg inselberg, south of the N14. The following areas will be needed for the construction camp:

- an office complex;
- workshops;
- housing for contractors;
- servicing areas;
- temporary storage of materials;
- bulk fuel storage (100 m³);
- bulk lubricant storage (20 m³); and
- truck yard and vehicle parking.

It is expected that the following variety of large equipment will be required during the construction phase:

- cranes;
- dump trucks;
- front end loaders;
- shovels;
- concrete batch plant;
- excavators;
- boom placers; and
- road rollers.

3.2.3 Contractor Housing Camp (Temporary Staff Housing)

In order to house the contracted work force, temporary on-site housing will be constructed. The proposed housing will be located adjacent to the south of the plant and cover a total area of approximately 30 hectares (refer to *Figure 3.2* below). A total of approximately 500 units will be erected to house workers from the estimated 5000 jobs that will be created during the 30 month construction period. The proposed housing and construction camp will have bulk water, sewage, electricity and supporting road networks as discussed below.

3.2.4 Bulk Service Requirements for the Construction Camp and Temporary Contractor Housing Camp

Water

The Pella Drift Water Board is the official water service provider for the towns of, *inter alia*, Aggeneys and Pofadder. The Pella Drift's Water Board current infrastructure includes an existing pump-station and water treatment works, located along the Orange River, near the town of Pella. An existing pipeline extends from the water treatment works to the town of Aggeneys.

In response to the growing demand for water in the towns of Pella, Pofadder and Aggeneys, the Pella Drift Water Board is currently in the process of upgrading the water supply infrastructure. The upgrade will include, amongst another:

- Upgrading of existing pump-station to increase abstraction volumes;
- Upgrading of water treatment works to increase treatment capacity;
- Construction of a new steel pipeline extending from the water treatment works to the town of Aggeneys. The pipeline diameter will vary between 500 – 750 mm; and
- Construction of new reservoirs at the treatment works as well as along the pipeline route.

Pella Drift Water Board is currently in the planning and design phase. An environmental legislative requirement for the upgrading of the water infrastructure is still to be determined, based on a finalisation of the project description. Pella Drift Water Board will undertake a Basic Assessment for the water infrastructure upgrades.

Based on the current project timing, the operational phase for the upgraded water infrastructure is expected to commence prior to the construction phase of the Mine. Construction phase water requirements for the Mine will be sourced from the Pella Drift Water Board water pipeline.

According to current estimations, the water requirement for the construction phase is approximately 2,000 m³/day and will be sourced from Pella Drift Water Board, via a 5 km off-take pipeline that is going to be constructed from the Pella Drift Water Board pipeline to the Mine (refer to *Figure 3.2*). The off-take pipe will be 550 to 750 mm in diameter and will be constructed aboveground from the discharge point to the mine, except for the section that crosses the N14. A culvert will be constructed under the N14 in order to facilitate this pipeline crossing. While the impacted footprint during the construction of the pipeline will cover an area of 1000 m², the pipeline itself will cover a total area of 0.5 hectares. Two water storage reservoirs will be located adjacent to the off take pipe. These include a 44ML reservoir located within the existing mining right area, adjacent to the Pella Drift Water Board pipeline and a 25 ML reservoir that is being proposed at the existing tailings dams to the north of the Gamsberg inselberg (*Figure 3.2*). Should the construction of the off take pipeline or the associated reservoirs be delayed, the water requirement will be transport to site via road tankers. A breakdown of the water requirements and associated percentage usages are set out in terms of *Table 3.4* below.

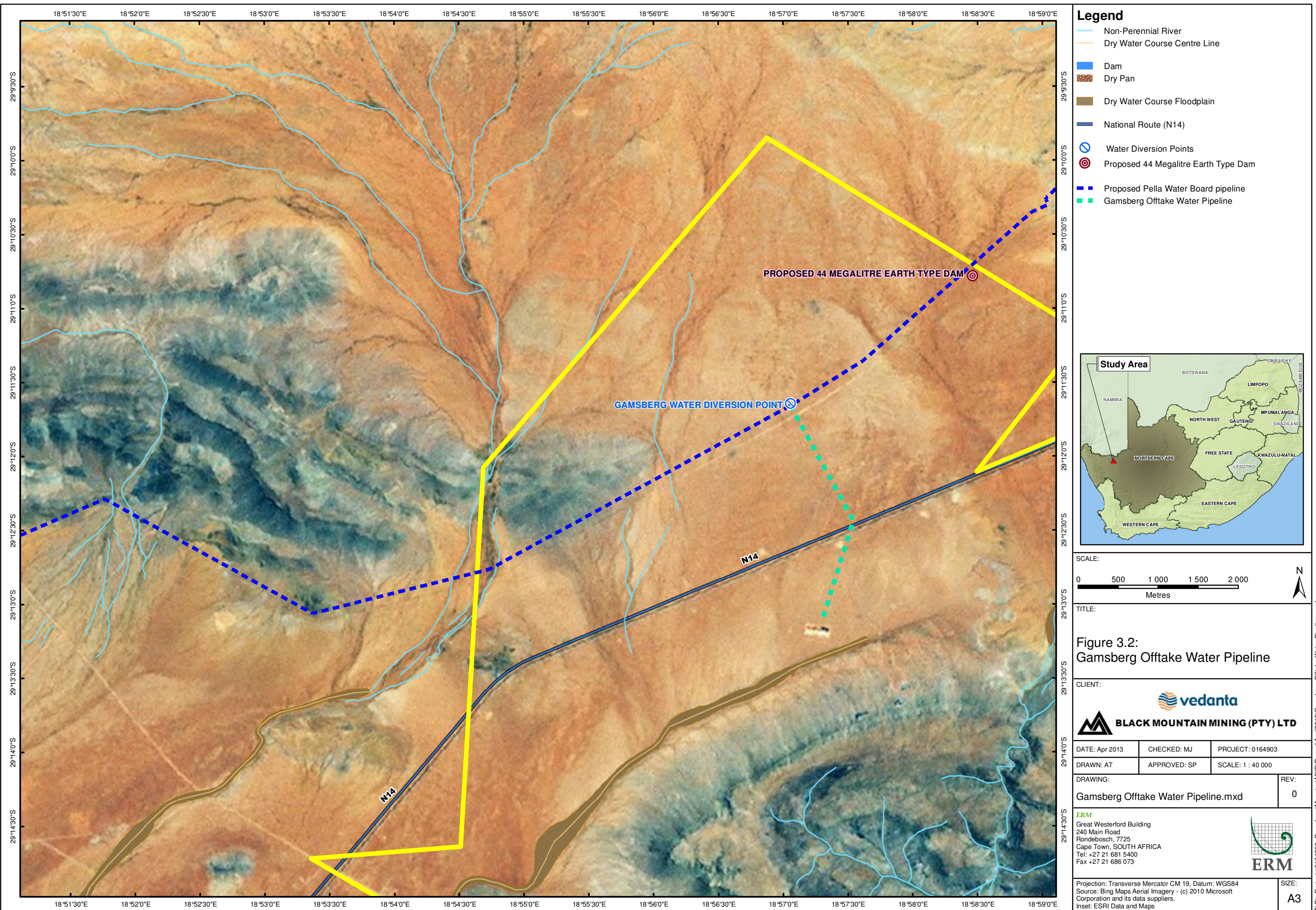


Table 3.4 **Construction Phase Water Usage**

Construction Activity	Water volume requirements (%)
Contractor Camp	25
Temporary Housing	25
Waste Water Treatment Works	15
Open Pit	15
Construction Staff	25
Total	100%

Power

The construction phase is expected to require a temporary 4 MVA supply point on the existing Gamsberg 11kV line using 21 million kilowatts hour per year. The electricity will be supplied to the construction site via a 5km overhead line and 4 x 500kVA miniature substations. One of the substations will be in a fixed position at the construction camp and the other 3 will be movable units on the construction site. One miniature substation has a footprint of about 4 square meters.

Fuel and Lubricants

The expected bulk fuel requirements for all on-site equipment during the construction phase will be approximately 100 m³ per day, without exceeding more than two days of storage at any one time. The fuel will be stored in a bunded area of 50 m² within the construction camp. In addition to this, approximately 20 m³ of lubricants and oils will be stored in the contractor's camp site, for the duration of construction. The lubricant and oil containers will also be stored within a bunded area of approximately 10 m².

Sewage

In order to manage the sewage generated during the construction period, a temporary sewage treatment plant will be constructed to service the construction team. The proposed sewage plant will have a treatment capacity of approximately 600 m³ per day. The proposed treatment works will use a biological treatment method, with 3 maturation ponds and 3 aerators. The temporary treatment plant is expected to treat 600 m³ per day and generate an estimated 480 m³ amount of effluent discharge and 1 500 tons of sludge per day. All treated effluent will be reused in the processing plant and for dust suppression (if effluent quality allows). Upon completion of the construction phase, the sewage treatment plant will probably be decommissioned and closed. All remaining sludge will be investigated for re-use or final disposal. If the sludge is to be disposed of, it will be removed by an authorised waste contractor and taken to Vissershok hazardous landfill site for final disposal.

Access Roads

Access to the inselberg, will be facilitated via an existing access road that is located to the South of the inselberg (refer to *Figure 3.2*). The existing road will be

widened by approximately 15 m and will be used only during the construction phase only by various construction vehicles (eg cranes, dump trucks, front end loaders, shovels, excavators etc.) to prepare the open pit for operation.

3.2.5 *Non-mineral Waste Management*

Domestic waste from the contractor's camp and the construction operations will be separated. Paper and plastics will be recycled, with the remaining domestic wastes and disposed of at the existing BMM waste disposal site. General industrial waste produced would include steel, packaging material and material off-cuts. The temporary waste disposal site will be divided between general/ domestic and hazardous wastes and cover a total area of 100 m² and 200m² respectively. A total of 5-10 ton/month of domestic wastes are expected to be generated during construction. Domestic wastes will be stored within the contractor's camp site, covering a total area of half a hectare. All non-hazardous wastes will be disposed of at the existing BMM waste site (which is a registered landfill site), as and when required. This existing landfill site will be used until it reaches full capacity (include total capacity here and when it is expected to be reached) at which point (or before) a separate environmental assessment process will be undertaken to identify another suitable waste disposal site.

Hazardous waste will mainly include oil contaminated wastes, which will be collected and disposed of as and when required. The proposed hazardous temporary storage facility will be located within the contractor's yard and cover a total area of 0.5 hectares. Hazardous wastes will be temporarily stored within closed containers (possibly within covered skips) and removed, as and when needed (about every two weeks). The hazardous waste storage area is expected to cover an area of approximately 0.5 hectares. In order to manage the construction phase wastes, the existing Black Mountain salvage yard and disposal facility will also be utilised. It should be noted that Black Mountain currently has two authorised waste management contractors on site, who are responsible for general and hazardous waste collection and removal. A total volume of 2 ton/month of hazardous waste is expected to be generated during the construction phase. All hazardous wastes will be disposed of at the Vissershok hazardous waste facility. Proof will be obtained from each contractor as to the final disposal location and volume of domestic and hazardous wastes.

3.3 *MINING PHASE*

Based on current estimations, a total of 150,000,000 tons of ore will be mined from the Gamsberg inselberg over the 19 year life of mine. Of this expected tonnage, approximately 18,000,000 tons of zinc concentrate will be extracted. Based on the relatively low grade of the zinc deposit, the treatment process will generate approximately 132,000,000 tons of tailings and approximately 1.5 billion tons of waste rock over the life of mine.

A conceptual mine work plan for an initial 16 years is presented below (*Table 3.5*) and will be refined throughout the process taking into due consideration the environmental, health, safety and social and labour considerations.

Ramp up and phasing of the mine production will have to align with a phased construction of the concentrator plant in three streams. The scope of the infrastructure for mining and the mining process is detailed according to:

- open pit;
- primary crusher;
- explosives storage area and ammonium nitrate and emulsion silos;
- drilling and blasting;
- load and haul of overburden and ore;
- waste rock dumps;
- earth moving equipment;
- engineering workshops;
- mine bulk fuel and lubricant storage facilities; and
- conveyor system network.

Table 3.5 **Conceptual Mine Work Plan**

Years	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
KT	1 083	3 333	4 416	6 666	7 750	10 000	10 000	10 000
Zinc %	6.05	7.11	7.08	6.53	6.17	6.21	5.61	6.12
Years	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16
KT	10 000	10 000	10 000	10 000	10 000	10 000	10 000	7 750
Zinc %	6.32	5.86	5.32	5.89	6.17	5.41	5.29	5.67

3.3.1 *Open Pit*

The Gamsberg deposit is a tabular relatively thin mineralised lens dipping to the south east, which will result in a pit that is initially developed to extract the ore reserve found closest to surface. Following this, a process of sequentially excavating push backs will be undertaken in order to gain depth and access to deeper reserves. The north and western faces will be excavated to final slope angles of approximately 45 to 53 degrees on the footwall face of the deposit, whilst pushbacks will extract ore and hanging wall overburden.

The final pit (as reflected in *Figure 3.1*) is generally determined by the economics of the operation which in turn are determined by, amongst other things, the following parameters:

- resource characteristics (grade of zinc, contaminants, etc.);
- geotechnical parameters (pit slope angle, height and width of benches);
- pit geometrical characteristics (as defined by geotechnical parameters and which determine overall strip ratio (ie waste to ore);
- pit operating costs;
- process plant operating costs; and
- process plant recoveries.

The final open pit is expected to cover a total area of 600 ha, which is expected to be the result of the extraction of some 1.65 billion tons of material. The final depth of the open pit is estimated at approximately 650 metres, while the width and length of the pit are expected to extend 2,220 metres and 2,700 metres. A typical image of an open pit, which is likely to be in a similar order of magnitude to that of the proposed Gamsberg open pit, is shown below (*Figure 3.3*).

Figure 3.3 *Typical Open Pit Operation*



Source: <http://tslope.com/44th-us-rock-mechanics-symposium>.

3.3.2 *Explosive Storage Area and Ammonium Nitrate and Emulsion Silos*

To access the ore, blasting by means of explosives will take place. On average, blasting will be undertaken once a day.

The proposed explosives magazine facility was initially located immediately adjacent to the open pit area however, based on specialist comment, this has been moved to an area southeast of the concentrator plant to avoid three watercourses and reduce the ecological impact (see *Figure 3.1*). This facility is estimated to cover a total area of approximately 20 hectares and will be operated in accordance with the Explosives Act (no 15 of 2003) to store ammonium nitrate fuel oil (ANFO), detonators, boosters and cartridges. The cumulative volume of explosives on-site (at peak capacity) will be 2 x 85 ton Emulsion silos and 2 x 50 ton silos. Provision will also be made for 1 x 200 case detonator magazine and 2 x 200 case explosive magazines. The silos will have a total height of 12 m and cover a total area of 20 hectares m². Explosives will be transported from the storage facility into the pit for blasting operations in specially constructed and marked vehicles. All traffic in the pit will stop during the explosives transport operation to minimise the risk of accidents between explosives vehicles and hauling or service vehicles in the pit.

As indicated earlier, drilling and blasting of rock faces will be required to excavate the ore and overburden waste in the pit. The drilling and blasting operation in the open pit is defined by a compromise between trying to achieve small particles of rock at the minimum possible cost. Drilling patterns are designed to produce rock fragments that are as large as possible but sufficiently small not to require additional drilling and blasting (secondary blasting) before loading and hauling.

The rock particle sizes accepted on the waste material are generally bigger than those required for ore as the crushing efficiency is greatly affected by the size of the biggest fragments in the ore feed. Details of drilling and blasting patterns for the Mine are not defined at this stage but will be designed to satisfy the above requirements during the next stage of the project.

It is expected that two types of drilling equipment will be used in the drilling operations as follows:

- Large diameter electric drill rigs for primary blasting. These machines generally have lower mobility but higher drilling efficiency making them ideal for drilling of regular and pre-determined drilling patterns like those used for daily production blasting in the open pit.
- Smaller hydraulically driven drill rigs. These drill rigs are generally track mounted and due to their smaller size have greater mobility within the pit and provide additional flexibility to drilling operations. They are generally used for secondary drilling (used for blasting of larger rocks not suitable for hauling and left following primary blasting of benches).

Loading and hauling of ore and overburden waste will be performed in the pit using a fleet of large capacity shovels, loaders, excavators, haul trucks and other service equipment. All topsoil will be removed and stored separate to ore and overburden.

Large electric shovels are expected to be used for the excavation and loading of waste material where selectivity of the excavation is not required. Back hoe hydraulic excavators (also large capacity) are expected to be used for the excavation of ore and generally in areas where greater selectivity is required.

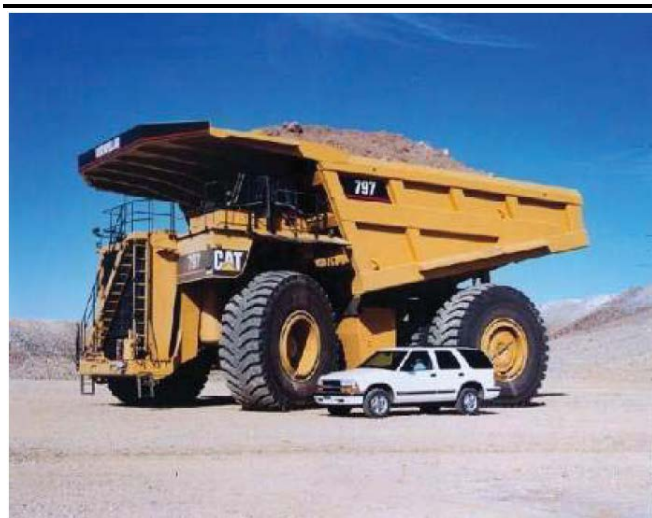
Due to the large dimensions and limited mobility of the electric shovels and to a lesser extent the hydraulic excavators, wheeled front end loaders will also be made available in the open pit to provide additional flexibility to the loading operations.

Hauling of ore to the primary crusher and waste to the waste rock dump will be undertaken using large capacity haul trucks (typically between 220 t and 300 t capacity). Haul trucks of this size are electrically driven with a diesel engine acting as a generator to provide electric power to the electrical drives located in

each wheel. The option of providing an overhead electrical system (trolley system) will also be investigated in order to minimise hauling operation costs.

Service equipment will include graders for road maintenance, water trucks to minimise the generation of dust during hauling operations, dozers and wheel dozers for the effective construction of safety berms along hauling ramps and the safe and efficient construction of the waste rock dumps as well as maintenance and repair equipment including lubrication trucks, tow trucks and wheel replacement cranes amongst others. A typical image of a haul truck expected to be used at the mine, is presented *Figure 3.4*.

Figure 3.4 *Mining Haul Trucks Expected to be used*



Source: <http://boothopia.wordpress.com/2010/01/31/welcome-to-fort-mcmurray/>

3.3.5 *Primary Crusher*

Upon stripping of overburden, the ore will be transported via haul trucks to the primary crusher located adjacent to the open pit, within the inselberg. The bulk ore will be transported to the primary crusher which will have a total processing capacity of 10 Mtpa.

The primary crushed ore will be transported from the Primary Crusher to the ROM (Run of Mine) ore stockpile via a conveyor system to a ROM stock-pile. Ore will be conveyed through a reclaim conveyor to the milling circuit.

3.3.6 *Waste Rock Dumps*

An estimated 1.5 billion tons of waste rock will be generated during the life of mine. The trucks will transport the waste material to the edge of the inselberg where it will be tipped over the edge to form a waste rock dump. In terms of the estimated dimensions of the waste rock dump, it was initially expected to cover an area of 270 hectares and reach a total height of 215 m. However, in order to achieve the natural angle of repose, the footprint of the rock dump was increased

to 480 hectares. An image of an existing waste rock dump, similar to the expected magnitude of waste to be produced at the Mine is presented in *Figure 3.5*.

Figure 3.5 *Image of a Typical Waste Rock Dump*



Source: <http://technology.infomine.com/WasteRockDumps/>

3.3.7 *Earth Moving Equipment*

An inventory for all earth moving equipment required for the Mine at an operational level is included in *Table 3.6* below.

Table 3.6 *Inventory of Equipment*

Mining equipment	No. Required
Excavator (34 M3/45m ³)	6
Trucks (220 / 300 T)	32
Water Carts (40/50 KL)	3
FE Loaders (18 m3) - For Blending	2
Track Dozers - For Pit, Roads and waste Dump	5
Motor Graders for Road Maintenance	2
Rock Breaker (mines)	1
Rock breaker (Crusher)	1
Back Hoes	2
Wheel Dozer	1

3.3.8 *Engineering Workshops*

The Mine will have two workshop areas, one within the concentrator plant and another located between the process plant and the proposed rock waste dump site (refer to *Figure 3.2*). The first workshop (referred to as the Mine workshop) will be

located north of the inselberg adjacent to the pit access road. This workshop will be a dedicated heavy duty workshop and will be responsible for servicing of all mine related equipment. It will cover a total area of approximately 1 hectare, with an internal haul road linking to the mine entrance. The other workshop will be used for minor mechanical servicing and maintenance. It is expected to cover a total area of approximately 1.5 hectares.

3.3.9 *Mine Bulk Fuel and Lubricant Storage Facility*

The mine bulk storage tank farm will be located adjacent to the Mine workshop area, as depicted in the revised layout plan (refer to *Error! Reference source not found.*). This tank farm will store approximately 500 m³ of diesel and cover a total area of approximately 2,500 m². The tank farm may include up to six refuelling bays. The mine would also require the usage of lubricants for equipment and operational activities. Approximately 5,000 litres of various grades of lubricants will be stored in a bunded area adjacent to the Mine workshop area. This proposed storage facility for the lubricants will cover a total area of approximately 1,000 m².

3.3.10 *Conveyor System Network*

The blasted ore from the pit will be trammed ⁽¹⁾ to the primary crusher. The primary crushed ore will be transported by means of a conveyor system to the crushed ore (ROM) stock piles. Subsequently the ore will be reclaimed from under the stockpiles and conveyed to the milling section. The proposed conveyor system will be 2 m wide and extend over a distance of 2.5 km as shown in *Figure 3.2*. The conveyor system will be covered.

3.4 *PROCESSING CONCENTRATOR PLANT*

The full production capacity of the mine will be 10 Mtpa ore. This capacity will be reached in a modular approach following the mine ramp up plan as shown in *Table 3.6*. The current approach will be to ramp up to the full capacity in three modules. With the first module sized to process 3.35 Mtpa ore and with two additional modules to be added at later stages of the mine ramp up. Modules will share some common facilities.

Table 3.7 *Phasing of Concentrator Plant*

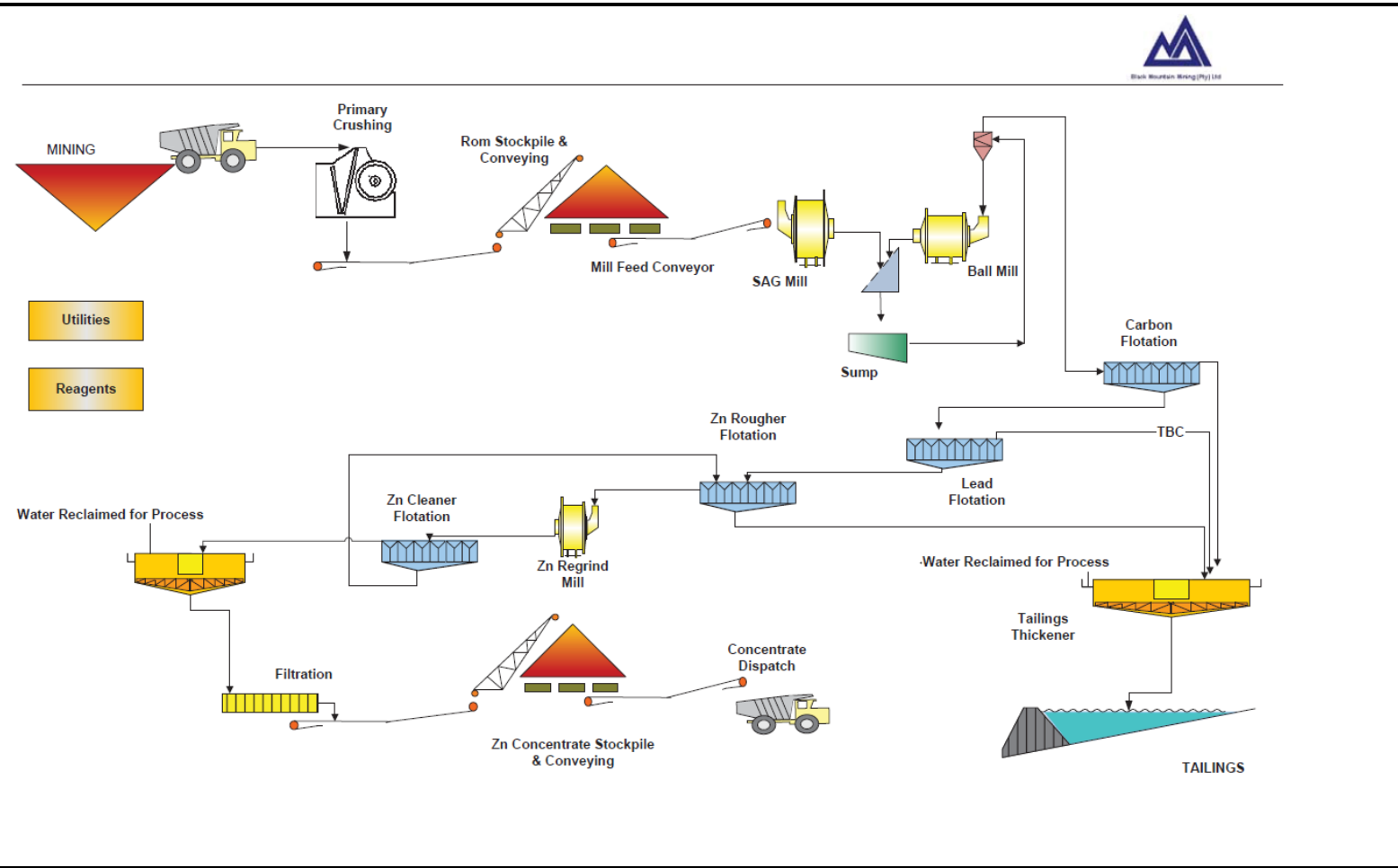
Phase	Infrastructure	Process Capacity
1	<ul style="list-style-type: none"> Supporting utility and supporting infrastructure. First concentrator stream. 	3.35 million tons per annum
2	<ul style="list-style-type: none"> Supporting utility and supporting infrastructure. Second concentrator stream. 	3.35 million tons per annum
3	<ul style="list-style-type: none"> Supporting utility and supporting infrastructure. Third concentrator stream. 	3.35 million tons per annum

(1) A tram is a vehicle or wagon that runs on tracks within the mining license area.

The concentrator processing plant area consists of the following:

- Milling circuit;
- Ore stockpile;
- Flotation;
- Dewatering, filtration and zinc concentrate handling;
- Tailings facility (see tailings section below) (see comments below, would move this to after the filtration and concentrate storage, as it represents to end of the processing process. The other “facilities” not actually part of the processing process).
- Material lay down and storage areas;
- Equipment wash areas;
- Additional on-site plant infrastructure; and
- A block flow schematic diagram, for the ore extraction, processing and transportation is shown below (*Figure 3.7*).

Figure 3.6 Block Flow Schematic Diagram



A typical image of a concentrator plant is presented in *Figure 3.8*, while the schematic above provides an indication of the various components of a Concentrator plant, from mining to concentrate. The proposed concentrator plant will be located between the N14 highway and the Gamsberg inselberg (Refer to *Figure 3.2*).

Figure 3.7 *Typical Image of Concentrator Plant*



3.4.1 *Primary Crusher Plant*

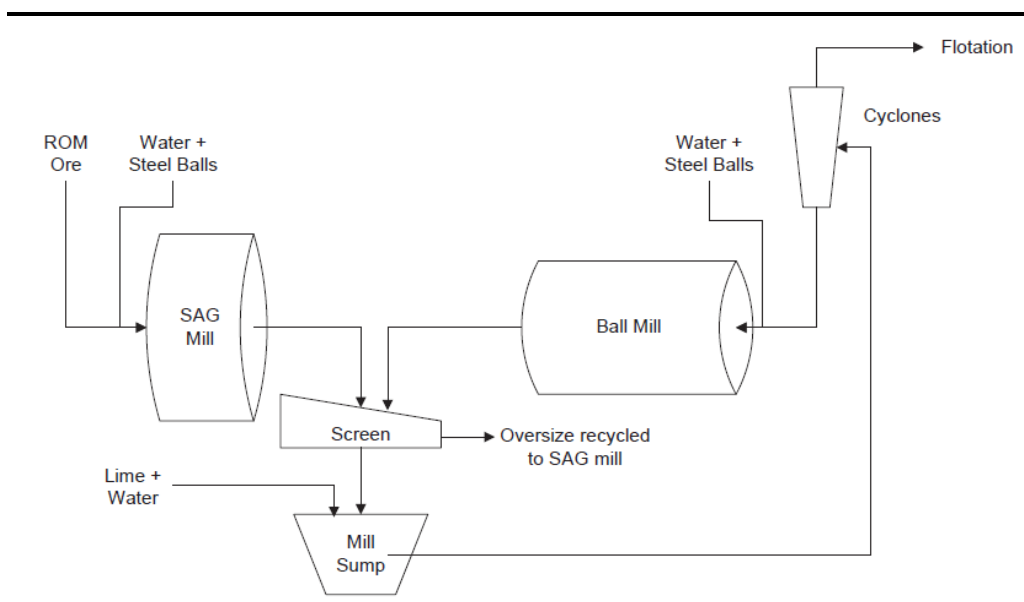
Upon stripping of overburden, the ore will be transported via haul trucks to the primary crusher located immediately adjacent to the northern side of the open pit. The primary crusher will have a total processing capacity of 10 Mtpa. The crusher plant will reach a maximum height of 40 m above ground level and cover a total area of 0.1 hectares. It will also be situated in such a way that the highest point will not extend above the inselberg ridge. As such, the crusher will not be visible from the N14 highway.

The primary crushed ore will be transported from the Primary Crusher to the ROM (Run of Mine) ore stockpiles (high and low grade) via a conveyor system, where it will be stored with a 3 day capacity and a total height of approximately 20 m and length of approximately 90 m. Ore will be conveyed through a reclaim conveyor to the milling circuit.

Based on the 10 Mtpa ROM ore, the process of concentration will produce 1 Mtpa of concentrate after full mine ramp-up. The concentrator plant will be approximately 40 m high, and contain lower end dust extraction vents (four in total) of about 30 m in height. No stacks or stack emission is applicable to this concentrator. The plant and supported infrastructure will cover a total area of about 45 hectares in total.

Milling is performed to reduce broken ore to a size at which the minerals can be liberated (valuable mineral grain exposed) from the ore. A Semi-Autogenous Grinding (SAG) mill will be used together with a ball mill and cyclone to perform this duty. Refer to *Figure 3.9* for circuit configuration.

Figure 3.8 *Milling Circuit Schematic*



The SAG mill is a large rotating drum filled with ore, water and steel grinding balls (*Figure 3.9*). The mill makes use of the material itself being crushed as well as additional grinding balls to reduce the size of crushed ore received. The SAG mill material is screened, with the oversized material recycled back to the SAG mill feed, while the undersized material proceeds to the cyclone (*Figure 3.9*).

A cyclone is used to separate the small particles from the larger particles. The small particles will overflow to the flotation circuit, which will have the required grain size for the flotation circuit. The cyclone underflow (larger sized particles) feeds into the ball mill (*Figure 3.9*). The ball mill is similar to the SAG mill but operates with a higher load of steel grinding balls to achieve a finer product size. Steel balls will be added continuously to both the SAG mill and the ball mill.

The ball mill discharges onto the same screen as the SAG mill screen. The material is then re-circulated through the cyclone in a closed circuit with the cyclone overflow proceeding to flotation.

3.4.3

Ore Stockpile Pads

The Mine will require a total of four stockpile (two ore, blended ore and one concentrate) areas at an operational level. The first two ore stockpiles areas (low grade, high grade and blended) will be open stockpile areas. Given below are approximate dimensions of these stockpiles (*Table 3.8*):

Table 3.8 ***Stockpile Dimensions***

	Length	Width	Height
High Grade	90m	54m	20m
Low Grade	72m	54m	20m
Blended	60m	54m	20m

When mined, the ore will be transferred into the first open stockpile area. The ore is then crushed at the open pit and transported via conveyor to the second open stockpile area within the processing plant. From the second stockpile area the ore will be processed and subsequently transported to the final stockpile area, which is a covered stockpile area that is proposed for the storage of zinc concentrate (ie the final product).

The first open stockpile area (prior to primary crushing) will be located within the open pit area. It will cover an estimated area of 1 hectare and reach a maximum height of 4 metres. The second open stockpile will consist of three stockpiles (High Grade, low Grade and Blended) located within the processing plant, and will cover an area of 1 hectare each. The maximum height of these stockpiles will be approximately 20 metres. The final stockpile area will be located within the processing plant and will cover a total area of 0.25 hectares. The height and length of this stockpile should not extend past 12 metres and 50 metres respectively.

3.4.4

Flotation

In the flotation process, milled ore mixed with water (pulp) are passed through a series of agitating tanks. Various chemicals are added to the pulp in a sequence that renders some minerals hydrophobic (water-repellent) and other minerals hydrophilic (water-loving). Air is dispersed through the tanks and rises to the surface. The hydrophobic particles attach to the rising air bubbles and are removed from the main volume of pulp as froth.

Various combinations of flotation cells in series are utilised to produce a concentrated stream of valuable mineral particles, called the 'concentrate' and a waste pulp stream, called 'tailings'. Similar to the milling plant, the full processing capacity will be obtained with 3 flotation modules, namely Carbon floatation, Lead floatation and Zinc floatation. Each module capable of processing approximately 3.35 Mtpa of ore.

Carbon Floatation

The Carbon flotation circuit consists of carbon conditioning, carbon rougher and carbon cleaner flotation steps. In the carbon flotation circuit graphite is removed

from the ore to prevent downstream contamination. Depressants (zinc sulphate and calcium cyanide) are added to depress the flotation of sphalerite (zinc containing crystal). Frother is added to stabilise the air bubble and froth layer which contains the graphite. The graphite froth overflows and is removed to the tailing plant. The flotation tails (zinc containing particles) proceeds to the lead flotation circuit.

Lead Flotation

The lead flotation circuit consists of lead conditioning, lead rougher and lead cleaner flotation steps. Collector (Sodium ethyl xanthate) is added to the conditioning step to assist with galena (Lead containing particle) flotation. Frother is added to the circuit to assist with bubble and froth stabilisation. The galena froth is removed to the tailings plant. The lead flotation tails (zinc containing particles) proceeds to the Zn flotation circuit.

Zinc Flotation

The zinc flotation consists of zinc conditioning, zinc rougher flotation, zinc concentrate regrind, followed by a zinc cleaner flotation circuit.

Activator (copper sulphate), pH Modifier (lime) and collector (sodium ethyl xanthate) reagents are added to the flotation circuit. The activator makes it possible for the collector to adsorb onto the zinc particle surface. The collector assists with zinc flotation. The pH modifier ensures the discrimination between zinc rich particles and others.

Frother is added to the circuit to assist with bubble and froth stabilisation. The zinc particles froth is removed to the Regrind circuit. The zinc flotation tails (gangue material) proceeds to the tailings plant.

The zinc flotation concentrate requires regrinding in order to improve the quality of the final zinc concentrate. The regrind mill discharge is diluted with water and pumped through a cyclone cluster. The overflow gravitates to the zinc cleaner flotation circuit.

Again activator, collector and frother are added to perform duties as described above. The zinc cleaner flotation concentrate gravitates to the thickening and dewatering circuit. The zinc cleaner flotation tails goes to a scavenging step to recover any zinc left over in the cleaner tails. The scavenger tails is returned to the zinc rougher flotation circuit.

In support of this process, the use of calcium cyanide, copper sulphate according to the regulated Code of Practice will take place as per the International Cyanide Management Code (ICMI) guidelines.

3.4.5 *Dewatering, Filtration and Zinc Concentrate Handling*

The dewatering process is comprised of two stages, thickening and filtration. A thickener is a large cylindrical tank with a conical bottom. The thickener allows solids to settle to the bottom. Conventional thickeners have rakes at the bottom

which moves the solids to an exit point. The solid containing slurry is called the underflow and exits the thickener at the bottom. The liquid in the upper part of the thickener (clear process water) overflows into a launder and is called the overflow.

Underflow from zinc thickener will be taken to the filter plant for further dewatering to reduce water content in concentrate. The thickener overflow will return to the plant for re-use.

In the filtration process excess water is removed in a filter by mechanical/physical means. The remaining solids are termed filter cake with the liquid removed termed as filtrate. The filtrate will be sent to the plant for re-use.

The filter cake (zinc concentrate) will be stored, within the processing plant, under a covered stockpile until dispatched. The stockpile will have a storage capacity of 7 days and will be approximately 12 m high and 50 m in length. In total, the above mentioned stockpile will cover an estimated area of 0.25 hectares.

The balance of the material from the processing process is waste material, with tailings running at a grind size of 80% passing 75 microns. These tailings will be taken to the tailings pump station from where it will be pumped to the tailings dam via safe pipeline. The tailings thickeners that are used to separate the waste material (slurry) from the water content in the tails treatment plant will be a maximum of 9 m high and 45 m in diameter. These will be located within the processing plant. In the tailings dam, the decanted and percolated water will be collected and pumped back to the plant for re-use.

3.4.6 Tailings Dam

The treatment of 10 Mtpa run of mine ore is expected to lead to approximately 9 Mtpa of tailings material (approximately 6.9 million m³ of slurry containing approximately 4.5 million m³ of water). The mineral wastes (tailings) will be sent to the thickener to reduce the water contents and then pumped to a tailings dam (see *Figure 3.2*). Percolated water in the tailings dam will be extracted, returned to a process plant and re-used in the concentrating process, via a return water dam.

Based on the expected production of tailings material, one tailings dam will be constructed with a final height of approximately 70m high, covering a total area of 280 hectares, with a total storage capacity of 132 million tons. Protection of the environment and in particular the potential groundwater resource in the area is critical and this will be taken into account when designing and constructing the tailings facility. Drainage measures will be incorporated in the design such that the potential for seepage into the groundwater is minimised. Preparation of the tailings inundation area will also be undertaken such that the risk of seepage is also minimised. The tailings dam will be constructed in phases and may initially consist of one dam with other dams added later that can be amalgamated to one large dam.

An image of an existing tailings facility, similar to the expected magnitude of waste to be produced at the Mine is presented below (*Figure 3.10*). The location of the proposed tailings dam for the Mine is represented in *Figure 3.1* below.

Figure 3.9 *Typical Example of a Tailings Facility*



Source: http://www.casadei.eng.br/page_7.html

3.4.7 *Pollution Control Dams*

Pollution control dams will be constructed according to the final design and location of the plant and pit. Three pollution control dams will be constructed during the construction phase of the project (refer to *Figure 3.2*). These will all be lined with a 1 mm to 1.5 mm high density polyethylene (HDPE) lining. A total of three dams will be constructed by the operational phase and therefore have a cumulative total storage capacity of approximately 25,000 m³ and cover a total area of approximately half a hectare. The proposed dam wall will be three meters high.

3.4.8 *Concentrator Plant Bulk Fuel and Lubricant Storage Facilities*

There will also be bulk storage of diesel and petrol within the concentrator plant. This storage facility will be developed to store a total capacity of 100 m³ of diesel and petrol and will cover a maximum area of 400 m². The facility will include two fuel supply points, which will be used to re-supply vehicles and equipment.

3.4.9 *Material Lay Down and Storage Areas*

The designated lay down and storage area will be located within the processing plant. The lay down area will cover a total area of 2,500 m² (close to or inside the

plant area) and include approximate quantities of materials and equipment, as shown in *Table 3.8*.

Table 3.9 *Approximate Inventory of Materials*

Material types	Approximate Quantities
Piping	3000 m
Platework	500m ²
Pump spares	10% of installed pipes
General Mechanical Spares	15% of installed mechanicals
Electrical Cable	3000 m

3.4.10 *Equipment Wash Areas*

An equipment wash area is proposed at the Plant and will cover a total area of approximately 750 m². The wash area is expected to store a number of detergents/cleaning solution for cleaning of on-site equipment. It is estimated that a total of 45,000 m³ (1.5 m³/vehicle for 80 vehicles over 364 days) of water will be required annually for washing purposes. The water will be sourced from recycled water reservoirs at the site for washing/cleaning of equipment. In order to reduce potential run-off of contaminated water, a specific storm water management system will be designed to optimise re-use.

3.4.11 *Additional On-Site Plant Infrastructure*

Five back-up generators will be required in the event of a power failure. Each back-up generator will have a generation capacity of 10 MVA. This would be for emergency lighting, security, certain process equipment, instrumentation, information technology (IT) equipment and communications.

3.5 *ASSOCIATED MINE INFRASTRUCTURE*

A suite of associated infrastructure is required for the daily operations of the proposed mine and plant. All associated infrastructure will be located within the approved mine area and is described in detail below in terms of:

- Power Supply and Substation Network;
- Water Supply System and Storage Dams;
- Raw Water Dam;
- Process Water Dam;
- Dust Suppression Dam;
- Storm Water Management Infrastructure;
- Fire Control Systems;
- Waste and wastewater Facilities;
 - Waste Sorting, Re-use and Recycling;
 - Domestic Waste Facility;
 - Temporary Hazardous Waste Facility;
 - Sewerage Treatment Facility;

- Road Network;
 - Transportation Corridor;
 - Entrance and Exit Points;
 - Parking Areas;
 - Mine Area Roads;
 - Plant Area roads;
 - Borrow Pit for Road Network; and
- Administrative Buildings.

3.5.1 *Power Supply and Substation Network*

The proposed mine and associated infrastructure will have a peak power requirement of 70MW and this provision has been secured from Eskom by BMM.

3.5.2 *Water Supply System and Storage Dams*

The proposed mine and associated infrastructure will require 9,125 million m³ of water per annum to meet the mine and associated infrastructure requirements. In order to meet the water requirements, the applicant intends to construct new 5 km off-take pipeline from the existing Pella Drift Water board pipeline to the Mine. A proposed off-take pipeline will be constructed from main line, across the N14 and into the Project area over a distance of 5 km. The proposed off-take pipeline will also be a surface pipeline, with the exception of crossing the N14. The method for constructing across the N14 is pipe jacking, so as not to disrupt the traffic flows during construction.

The percentage water requirements per project component for the operational phase of the proposed project as shown in the table below.

Table 3.10 *Operational Phase Water Requirement*

Operational Activity	Water Volume Requirement (%)
Open pit	10%
Concentrator Plant	40%
Housing	15%
Dust Suppression	10%
Plant infrastructure	10%
On-site staff	15%

All water on the site will be recycled and used where feasible.

Raw Water Dam

A raw water storage dam will be constructed at the processing plant. The proposed water storage dam will have a total capacity of 25,000 m³, cover a total area of 0.5 hectares and have a maximum wall height of 4.5 m. The raw water storage dam serves to provide water to the plant, mine and fire hydrant system. The proposed dam will be supplied from the Orange River, via Pella Water Board.

Process Water Dam

A process water dam will be constructed at the plant and fed with recycled water from the plant, treated water and make-up water from the raw water dam. The proposed dam will cover a total area of 0.5 hectares and has a total storage capacity of 25,000 m³. The proposed dam will have a wall height of 4.5 m and will be used as part of the zinc concentrating process.

Dust Suppression Dam

A dust suppression dam will be constructed adjacent to the open pit, between the Plant and the waste rock dump. The proposed dam will have a total storage capacity of 1,000 m³. The dam wall will reach a maximum height of 5 m and cover a total area of 100 m². Water for dust suppression will be sourced from the raw water dam.

Fire Control System

Due to the types of substances being handled on a daily basis, the risk of fire is high. In response to the suggested risks, a fire control system will be installed adjacent to the open pit, explosives storage area and fuel tank farm. The system will consist of a water tank, which will have a total wall height of 5 m and cover a total area of 200 m². The dam will have a total storage volume of 20,000 m³ and the water will be sourced from the raw water dam.

Stormwater Management Infrastructure

Stormwater management infrastructure is critical for the day to day management of the proposed mine. Based on the nature of on-site activities proposed, the potential for contaminated stormwater run-off is great, and therefore stormwater infrastructure will be constructed to optimise re-use of stormwater.

As part of such management procedures a stormwater dam will be constructed adjacent to the south of the plant, along the western foothills of the Gamsberg inselberg. This dam will have a storage capacity of approximately 5,000 m³ and will cover a total area of 1,000 m². The dam wall will not exceed 3 metres in height (above ground level).

3.5.3

Waste and Wastewater Facilities

The project will have a mineral waste and non-mineral waste stream. Mineral waste will be generated by the open pit; waste rock dumps, tailings facilities and pollution control dams.

Non-mineral waste will consist of general waste in the form of domestic waste that will be disposed of in the existing Black Mountain waste disposal facility and solid waste that will be processed in a sewage treatment facility. Besides the general waste, hazardous waste will be generated from materials stored and used on site such as hydrocarbon fuels and lubricants, laboratory chemicals, radioactive waste from technical equipment, explosives waste and medical wastes.

Waste Sorting, Re-Use and Recycling

Salvageable wastes in the form of metal plate, old tyres, batteries and salvage spares will be separated and stored in the salvage yard. The salvage yard will be located within the Plant area and cover a total area of 750 m². It will have a total storage capacity of 1,800 m³ and wall height that will not extend beyond 3 metres in height. All waste contained in the salvage yard will be temporarily stored and subsequently sold as scrap to local contractors.

Domestic Waste Facility

The proposed temporary domestic waste disposal facility will be constructed within the plant area and will have a total storage area of 100 m² and walls of that will be no higher than 2 metres in height. Upon nearing the maximum storage capacity (ie 150 m³), all domestic wastes will be collected and disposed of at the existing Aggeneys registered landfill site for domestic wastes.

Temporary Hazardous Waste Management Facility

At an operational level, the Mine will result in the generation of hazardous wastes. Based on the proposed operations of the mine, it is likely that hazardous wastes will include fuel or oil laden rags, chemical wastes from the on-site laboratory medical wastes and items contaminated with hazardous substances. Further details of the waste generated by this Project are included into *Chapter 8* below. A temporary hazardous waste management facility will be constructed within the plant area to store this waste before it is removed from site. The temporary hazardous waste management facility will have a total storage capacity of 100m³ and cover a total area of 150 m². All hazardous waste collected will be transferred to the licenced Vissershok hazardous waste disposal facility located ~ 10 km north of the City of Cape Town in the Western Cape Province. The storage, transport and disposal of all hazardous waste will be undertaken in accordance with applicable guidelines and legislation.

Sewage Treatment Facility

Based on the expected number of operational phase employment opportunities generated, the Mine will require sewage treatment plants to fulfil the wastewater management requirements. The sewage treatment plant will be located at the processing plant. The treatment plant will have a daily processing capacity of approximately 200 m³/day to service an expected work force of approximately 750 people which includes the process plant, mining and administrative labour.

A sewage collection sump will be constructed near the open pit area. The sump is expected to collect sewage from the mine work force (approximately 140 people) and pump it to the main sewage treatment plant periodically. Based on the design, the treatment plant will generate approximately 160m³/day of treated effluent and approximately 500 tons of sludge per month. The effluent will be treated to comply with the acceptable water discharge criteria.

The treated effluent will be fed into treated sewage effluent dam. The dam will have a 7 day capacity and will be an HDPE lined pond. The pond is expected to be 5m deep with a total storage capacity of 1,150 m³ and is expected to cover a total area of approximately 250 m². Based on the expected quality of effluent and other wastes produced, effluents will likely be treated and reused.

Lastly, all sludge generated from the proposed sewage treatment plant will be collected and disposed of appropriately or considered for potential re-use.

3.5.4

Road Network

Entrance and Exit Points

The proposed mine will have a main entrance/exit point, located along the southern border of the N14. The proposed entrance/exit point will be tarred and have a total width of 45 m. A second entrance/exit point will be located along the western border of the inselberg, leading onto the existing Loop 10 gravel road. This entrance/exit point will not be tarred, but rather a compacted gravel road. In addition to this, the width of the second entrance/exit is expected to only be 15 metres. Surface material will be sourced from the existing borrow pit located north of the inselberg.

Parking Areas

A parking area will be established adjacent to the Plant. The proposed parking area is expected to cover a total area of approximately 5,000 m² and will be tarred. The proposed area will be designed to accommodate 300 - 350 vehicles, which will include employees and visitors. The proposed parking area will include a design specific stormwater management plan to optimise re-use. The material that will be used to tar the road will be sourced from waste rock or existing Lemoenplaas borrow pits in the region.

Mine Area Roads

A new 60 m wide gravel road will be constructed to access the proposed open pit. The access road will be located on the Northern side of the Gamsberg inselberg and will accommodate haul trucks, commercial vehicles and access to the conveyor. The length of the access road will be approximately 1000 m, with a maximum footprint width at the bottom of approximately 128 m.

Haul Roads will be limited from the Open Pit to the waste rock dumps, from the Open Pit to the Primary Crusher area and from the Open Pit to the mining workshops adjacent to the Open Pit. Additional supporting roads for lighter vehicles may also be required. The slope angle of the roads will not be more than 10 degrees. This requirement results in an extensive road network. The total footprint area of internal haul and mine area roads is expected cover an area of 55 hectares. Surface material for the roads will be sourced from suitable overburden material and/or available borrow pits.

As mentioned above, an existing approach road towards the western side of the Gamsberg inselberg will be widened to 12 metres in width (including a 2 metres shoulder on either side). This will be used for start-up activities. The main permanent approach road will be constructed from the northern side, once permission is granted.

Plant Area Roads

Internal plant roads (a network of roads totalling approximately 4km in length) will be required for operational and maintenance access between the various plant areas. These will generally be between 6 m to 8 m wide, depending on function. It is also important to note that the construction footprint (affected area) is approximately 12 metres wide. Access tracks will be required for inspection and maintenance of outlying features such as stormwater impoundments, sewage treatment ponds and the perimeter fence. These roads are expected to cover a total area of 1,000 m². Off-road parking will also be provided, which is expected to cover a total area of 5,000 m². Surface material for the roads will be sourced from suitable overburden material and/or available borrow pits.

Borrow Pits for Road Network

Surface material for the internal road network will be sourced from either suitable overburden material and/or available borrow pits at Lemoenplaas located to the north of the Black Mountain township and compacted over the road surfaces. The final decision regarding the choice of sources will be informed by the analysis of overburden material.

Administrative Buildings

A building and associated offices will be constructed within the Plant. The building will cover a total area of approximately 1,500 m², and reach a maximum height of 12 m. The proposed building and associated offices will be used to meet the administrative requirements associated with the daily operations of the proposed Mine. The building is expected to accommodate at least 100 employees, working 7 days a week.

A control room will also be constructed at the Plant, to facilitate the logistics and monitor day to day activities associated with the Mine. The proposed control room will cover a total area of approximately 300 m² and reach a maximum height of 12 m. Another office will be housed at the Project area as a control room with total area of approximately 200 m².

A security and induction training area will be constructed near the main entrance to the Mine, along the southern border of the N14. A security office will be single storey building, covering a total area of approximately 120m². Adjacent to the security offices, an induction training area will be constructed, which will cover a total area of approximately 500 m². In line with the Health and Safety requirements of Black Mountain, any person entering the Project area must undertake a health and safety induction training course.

A medical clinic will be established within the Plant area. The proposed clinic will contain basic medical supplies and facilities to treat emergencies related to accidents etc. The facility will not exceed 6 metres in height and will cover a total area of approximately 80 m². The medical clinic is expected to produce around 5 to 6 kg of medical waste per month. All wastes produced at the clinic will be treated as hazardous waste and will therefore be disposed of at the Vissershok Hazardous Waste Site located approximately 20 km north-east of Cape Town in the Western Cape.

3.6 RESIDENTIAL HOUSING DEVELOPMENT

Based on expected employment figures, additional housing will be required to house the expected workforce. The necessary housing will be constructed in accordance with the mining charter and located in Aggeneys, between the existing northern and southern township (refer to *Figure 3.12*).

Preliminary projections for the Aggeneys housing development estimate that approximately 1000 units of varying type/size (ie 1 to 4 bedrooms) will be constructed to accommodate employees and contractors working at the proposed Project site. The total development is expected to cover a total building area of 100 hectares. The average home size is expected to cover an area of approximately 100 m². Various accommodation packages will be put together to enable employee home ownership.

3.6.1 Bulk Service Requirements for the Employment and Residential Housing Development

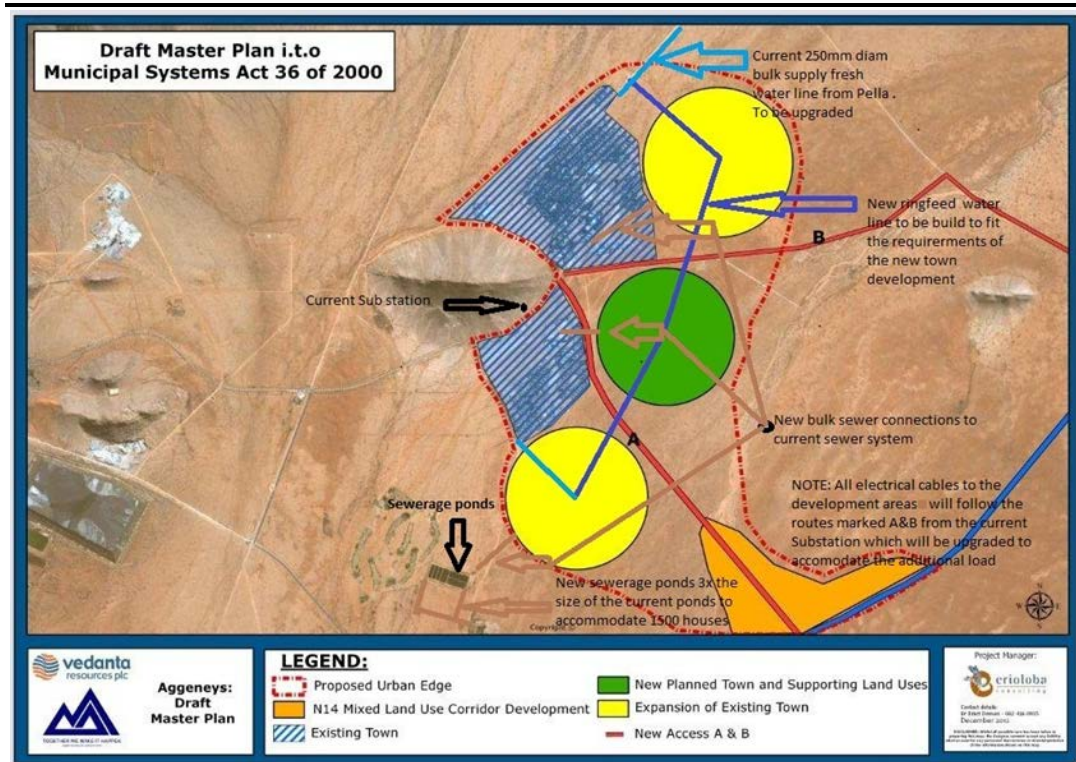
Water

As mentioned before, the Pella Drift Water Board is the official water service provider for the Aggeneys town. The Pella Drift's Water Board current infrastructure includes an existing pumpstation and water treatment works, located along the Orange River, near the town of Pella. An existing pipeline extends from the water treatment works to the town of Aggeneys (refer to *Figure 3.12* above).

In response to the growing demand for water in the towns of Pella, Pofadder and Aggeneys, the Pella Drift Water Board is currently in the process of upgrading the water supply infrastructure. Pella Drift Water Board will therefore provide for the increase in demand, as part of their on-going expansion plan.

According to current estimations, the water requirement for the housing development is approximately 1 500 m³/day and will be sourced from Pella Drift Water Board, via a new 'ringfeed water line', which is shown in *Figure 3.12* above. This water line will be a pipeline constructed from the existing Aggeneys outlet point to the new housing development (refer to *Figure 3.12*).

Figure 3.10 Proposed Staff Housing in Aggeneys



Power

The housing development is expected to require an average power requirement of 12 million kilowatts hourly per annum during the operational phase. In order to meet these requirements Eskom power will be sourced.

Power supply to the housing development will need to be upgraded. This will be managed through expanding the capacity of the existing sub-station (refer to Figure 3.12) from 4 MW to 10 MW. Expansions to the existing substation will fall within the previously disturbed/ fenced off area surrounding the existing Aggeneys substation. Actual power usage is expected to drop proportionately as more energy efficient systems (eg solar geysers) are fitted in the new housing units.

Sewage

The existing sewerage plant has a design capacity of 1235 m³ per day and currently runs at 700m³ per day in serving about 600 homes and businesses in Aggeneys. Running the plant at 80% of its hydraulic load it is therefore calculated that it would handle an additional 300 houses before expansion is required. To cater for the additional 1000 housing units, the capacity of the existing facility will need to be doubled. This will increase the footprint from the existing 61,000 m² to 122,000 m².

The expanded sewage plant will have a treatment capacity of approximately 4 470 m³ per day. This will generate an estimated 800 m³ amount of effluent discharge and 2 500 tons of sludge per month. The discharge after treatment will be according to South African water quality standards and tested for quality before being released. All remaining sludge will be investigated for re-use or final disposal. If the sludge is to be disposed of, it will be removed by an authorised waste contractor and taken to the Vissershok landfill site for final disposal.

Specific details regarding the location and dimension of each of the above mentioned operational phase components (ie buildings, infrastructure and equipment) are attached as *Annex B*.

3.7 *TRANSPORT OPTIONS*

3.7.1 *Transport Option 1: Truck via N14 and N7 National Road to Port of Saldanha*

Based on the phasing of the Project, the transportation requirements will increase as production increases at the Gamsberg mine. Two transport options will be utilised when the Gamsberg mine reaches full production. During Phase 1 (initial two years of the project), a total of 0.335 Mtpa of zinc concentrate will be produced. During Phases 2 and 3, production will increase to 0.67 Mtpa and 1 Mtpa respectively. Phase 2 is expected to last for two years, at which point production will ramp up (ie Phase 3) to 1 Mtpa for next 14 years (assuming Life of Mine of 19 years). Production is expected to reduce during year 19 to 0.67 Mtpa.

Assuming the Port of Saldanha is selected as the preferred export port and based on the anticipated volume for Phase 1, an average of 960 tons per day of zinc concentrate (assuming 350 days a year) will be trucked to the Port of Saldanha. All zinc concentrate produced during Phase 1 will be loaded into 32 ton trucks (axle load) and transported to the Port of Saldanha, via the N14, N7 and R399 (refer to *Figure 3.11* below). The trucks will divert from the N7 onto the R399 and lead to the Port of Saldanha. In order to manage the transportation requirements in Phase 1, 30 trucks per day will be used to transport the concentrate. The existing road infrastructure will not require any form of upgrades to the existing road network.

Based on the anticipated production volume for Phase 2, 50% of concentrate produced (ie 960 tons per day assuming 350 days a year) will be transported by truck to the Port of Saldanha. In order to manage the transportation requirements, 30 trucks per day will be used to transport the concentrate.

During Phase 3, 50% of concentrate produced (ie 1 430 tons per day assuming 350 days a year) will be transported by truck to the Port of Saldanha. In order to manage the transportation requirements, 45 trucks per day will be used to transport the concentrate.

3.7.2

Transport Option 2: Truck to Loop 10 via existing Proclaimed Road (RL(P)5/2002) and then by Sishen-Saldanha Railway Line to Port of Saldanha

During Phase 2 and 3, an additional option will be utilised to transport zinc concentrate to the Port of Saldanha, assuming the port is selected as the preferred option. Transport Option 2 includes the trucking of zinc concentrate via the Loop 10 gravel road (off the N7), to Loop 10 siding along the Sishen-Saldanha railway line (refer to *Figure 3.12* below). The existing Sishen-Saldanha railway line is located approximately 150 km south east of the Gamsberg mine.

Based on the anticipated production volume during Phase 2, 50% of concentrate produced (ie 960 tons per day assuming 350 days a year) will be transported by truck to Loop 10 siding, and railed to the Port of Saldanha. In order to manage the transportation requirements, 30 trucks per day will be used to transport the concentrate to Loop 10, during Phase 2. Each truck will carry 32 tons of concentrate per trip.

During Phase 3, 50% of concentrate produced (ie 1 430 tons per day assuming 350 days a year) will be transported by truck to Loop 10 siding and railed to the Port of Saldanha. In order to manage the transportation requirements, 45 trucks per day will be used to transport the concentrate to Loop 10 siding.

Despite the expected increase in traffic volumes, the existing Loop 10 gravel road will not be widened as the current width of 7 – 10 m is sufficient. Upon arrival at the Loop 10 siding, the zinc concentrate will be unloaded into an existing storage shed and then transferred onto rail carriages via a tippler. Further engagement will be undertaken with Transnet to confirm if sufficient capacity is available along the Sishen-Saldanha Railway Line to accommodate the production volumes during Phase 2 and 3 of the Project.

However, for purposes of this ESIA process, it is assumed that 50% of the zinc concentrate produced will be transported to the Port of Saldanha via trucks (ie via N14, N7 and R399). The remaining 50% of zinc concentrate will be trucked to the Loop 10 siding (via *Proclaimed Road RL(P)5/2002*) along the Sishen-Saldanha railway line, and railed to the Port of Saldanha. A summary of the Transport options are presented below, relative to the Project phasing.

Should the Port of Saldanha not be selected as the preferred option, transport routes to Port Nolloth will be investigated as part of a separate ESIA process.

Table 3.11 ***Summary of Transport Options***

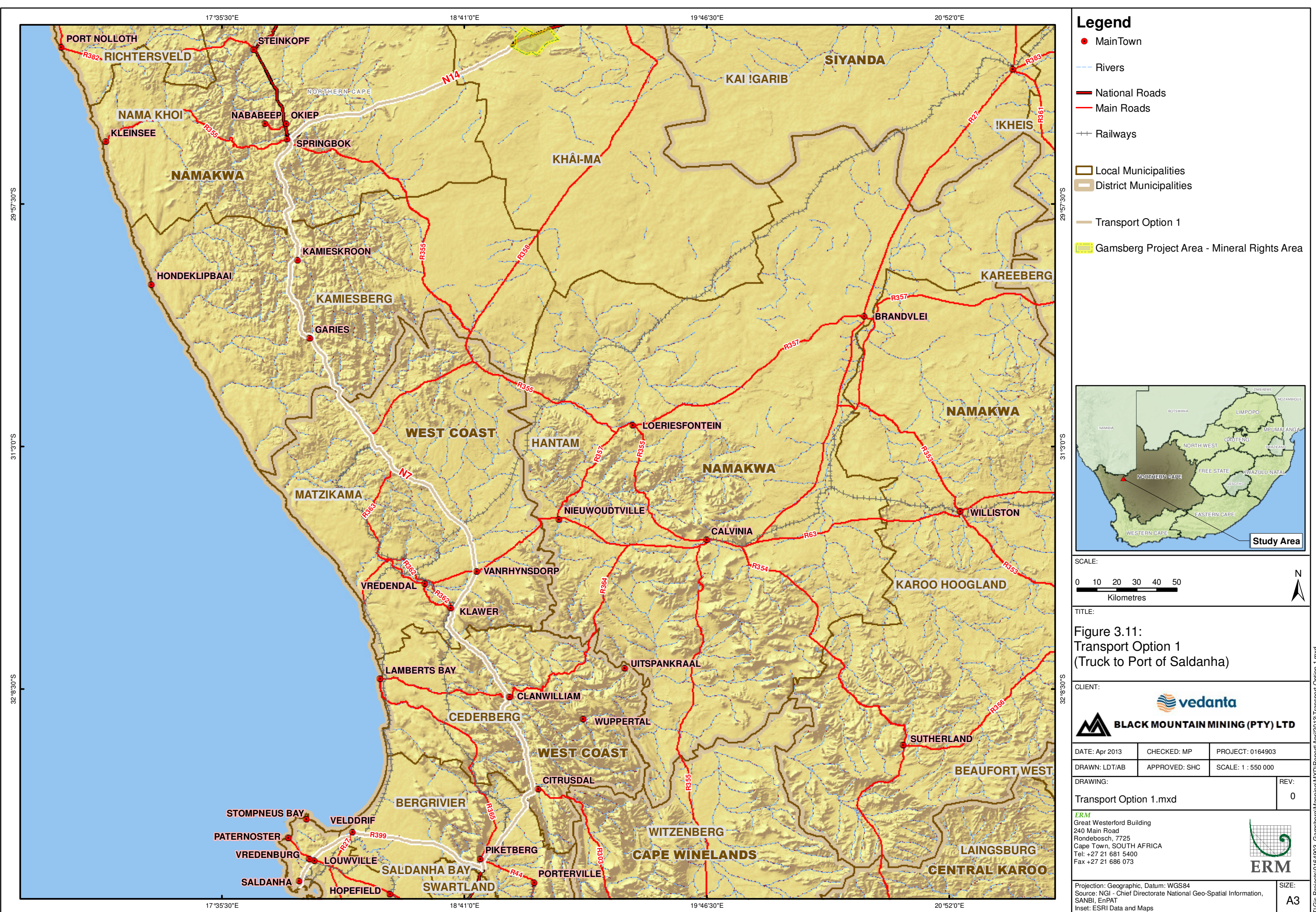
	Phase 1 (Year 1 and 2)	Phase 2 (Year 3 and 4)	Phase 3 (Year 5 – 18)
Transport Option 1: Road	0.335 Mtpa	0.335 Mtpa	0.500 Mtpa
Transport Option 2: Rail	0 Mtpa	0.335 Mtpa	0.500 Mtpa

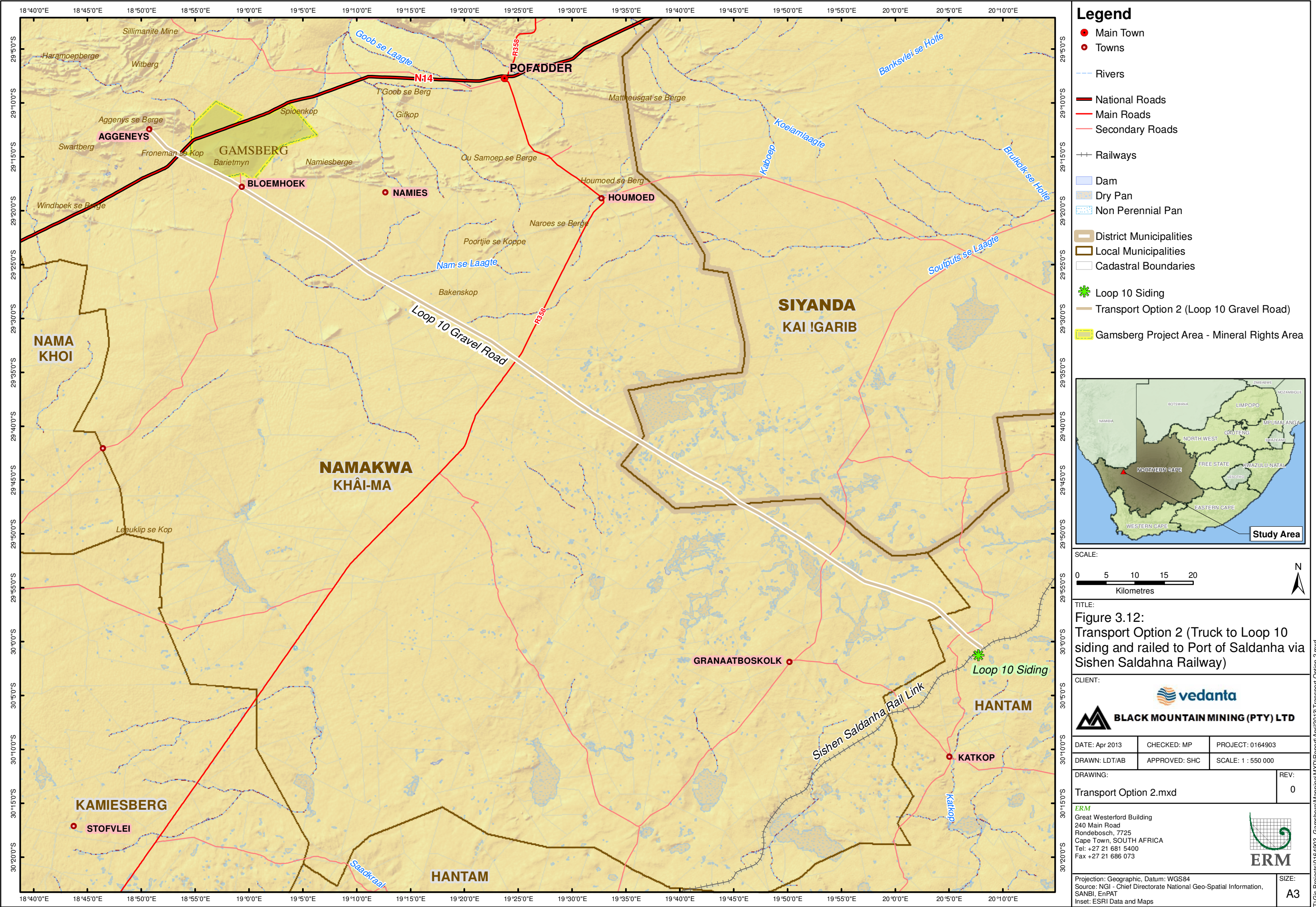
Loop 10 Siding

BMM has an existing offloading facility at Loop 10 siding. The existing storage shed at the siding covers a total area of 2000 m² and has a total height of 10 m. It is anticipated that additional facilities, located within the existing disturbed footprint will accommodate Phase 2 volumes of zinc concentrate generated by Gamsberg. However, due to the expected volumes at Phase 3 of production (500 000 Mtpa), additional infrastructure will be required at BMM's existing Loop 10 siding facility, which is as follows:

- Truck unloading and wash station;
- Truck Loading Facilities and Equipment (324nos of 67t trucks per week);
- Truck Cue/Parking;
- Concentrate Storage Facility;
- Support Facilities/offices/lab;
- Rail Wagon Loading Facilities and Equipment; and
- Rail Yard/Storage.

It should be noted that although the existing facility will be expanded, it will remain within the existing operational boundaries of the site. The site is currently subject to daily operational activities related to offloading and handling of product from the Deeps Mine. The existing access roads will be utilised and all new infrastructure will be located as close as possible to the existing facility, so as to consolidate the existing impacted areas.





Based on current estimates, a total of 1 Mtpa of zinc concentrate will be produced at the Mine. Potential options to export the concentrate are currently being explored by BMM, which include utilising the Port of Saldanha or alternatively constructing a new Port at Port Nolloth in the Northern Cape Province.

Should the Port of Saldanha be the preferred option, the infrastructure requirements will need to be confirmed, however, additional facilities may be required in the form of storage sheds. Should upgrades at the Port of Saldanha trigger a listed activity in terms of the EIA Regulations (2010), a separate ESIA process will be undertaken for the Port upgrade. Alternatively, should the construction of a new port at Port Nolloth be the preferred option, the necessary environmental legislative requirements will be met through a separate ESIA process.

The feasibility to utilise either option is currently being explored. For purposes of this ESIA process, it is assumed that the zinc concentrate will be transported to the Port of Saldanha, with no upgrades required.