Table 6-8: The Measured Dust Fallout Rates for the Period January 2018 To April 2019

Sample Location	Classification	Non-Residential Std	Dust Fallout (mg/m²/day)									
			Jan-18	Mar-18	Apr-18	Jul-18	Aug-18	Oct-18	Nov-18	Jan-19	Feb-19	Apr-19
Kykgat 1	Non-residential	1200	26		29	7	4	30	5	54	25	
Kykgat 2	Non-residential	1200	104		57	14	66	13	6	12	42	
GAMS - SU1	Non-residential	1200	248		135	154	92	59	88	66	13	145
GAMS - SU2	Non-residential	1200	118		75	78	39	46	60	41	44	76
GAMS - SU3	Non-residential	1200	29		25	20	5	11		15	19	18
Achab (House)	Non-residential	1200	32		10	8	6	21	14	18	172	11
Achab (Gams)	Non-residential	1200	85		25	23	18	69	363	21	49	25
BMM TRC	NA	1200	347	842	228							
Gams Bloem	Non-residential	1200	41		13	32	107	63		2	28	
Achab House New	Non-residential	1200	11		11	4	9	12	187	25		39
Achab Gams New	Non-residential	1200	200		19	38	13	14	6	4		23
SND	NA	1200		59	88							

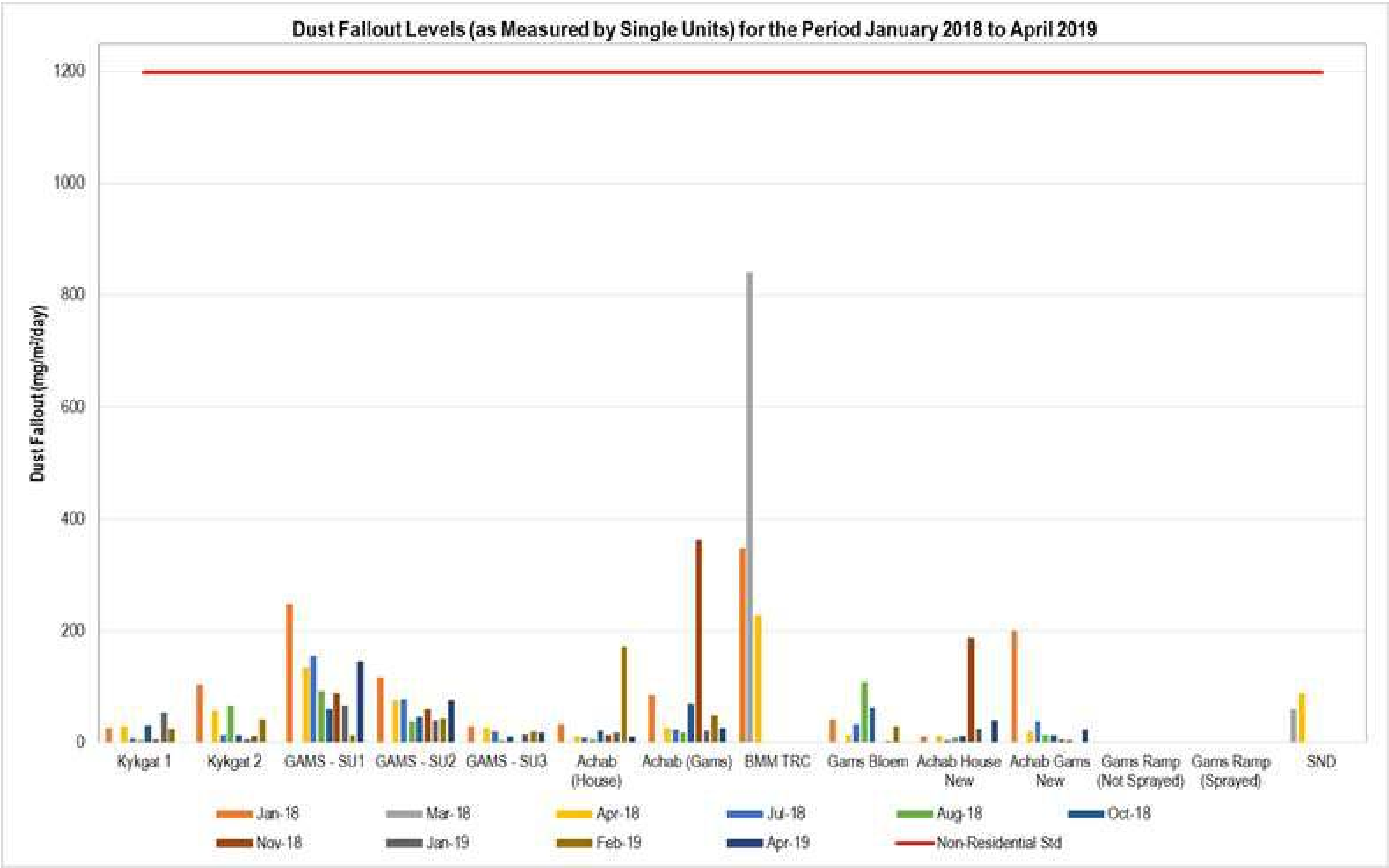

Figure 6-15: The Measured Dust Fallout Rates from the Single Buckets for the Period January 2018 to April 2019

Gaseous Concentrations

In 2009, NO_2 and SO_2 were sampled during the months of June and September at 10 locations (SRK Consulting, 2010). The location of the sampling points is provided in Figure 6-16. In the absence of more recent data, this information was incorporated in the following section.

Sampled SO_2 concentrations for June and September 2009 were well below the daily NAAQS of 125 µg/m^3 for all sampling points. Results received for the month of June were below detection limit for eight sites with two sites GAM A9 and GAM A10 having SO_2 concentrations of 0.47 µg/m^3 and 0.36 µg/m^3 respectively. During September 2009, SO_2 concentrations had increased when compared to June, but the measured levels remained below the daily SO_2 NAAQS (SRK Consulting, 2010).

NO_2 concentrations were below the hourly NAAQS of 200 µg/m^3 for both the June and September 2009 sampling periods. All sampled concentrations were recalculated from 24-hours to 1-hr values, for comparison to hourly NAAQS values.

Table 6-9: Sampled SO_2 and NO_2 Ground Level Concentrations During a 2009 Survey

Sample ID	Daily SO_2 Concentrations (µg/m^3)		Hourly NO_2 Concentrations (µg/m^3)	
	Jun-09	Sep-09	Jun-09	Sep-09
GAM A1	BDL	3.64	BDL	0.32
GAM A2	BDL	0.6	BDL	BDL
GAM A3	BDL	0.32	BDL	0.32
GAM A4	BDL	6.78	BDL	BDL
GAM A5	BDL	0.1	BDL	BDL
GAM A6	BDL	0.1	BDL	0.19
GAM A7	BDL	BDL	BDL	BDL
GAM A8	BDL	0.48	0.09	0.12
GAM A9	0.47	0.62	0.33	BDL
GAM A10	0.36	0.1	0.001	0.42
NAAQS (99th percentile)	125		200	

BDL: Below detection limit

Legend

- Towns / Villages
- Rivers
- Gamsberg Zinc Mine MRA
- Existing Infrastructure
- Dust Sampling Points

Proposed Infrastructure

- Bulk Water Pipeline
- Transmission Line
- Access Road
- Secured Landfill Site
- Switch Yard
- Smelter Complex Footprint

0 1 000 2 000 Meters

Scale: 1:80 000 @ A3

Projection: Transverse Mercator

Datum: WGS1984, Lo23

Gamsberg Smelter Project

Figure 6-15

Location of Air Quality Sampling Points During the 2009 Survey

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720.22013.00002	2020/09/23

Existing Sources of Emissions near the Proposed Project

Mining Activities

Mining activities to the south (Gamsberg Zinc Mine) and west (Black Mountain Mine) of the project site would add to the PM emissions and ground level concentrations in the airshed. Emission sources would include materials handling activities, vehicle entrainment and windblown dust from storage piles and tailings storage facilities.

Simulations were undertaken to determine total particulate deposition due to current mining activities (Figure 6-17). Maximum daily dust deposition due to baseline activities is within the NDCR for residential areas at all sensitive offsite human receptors within the study area.

Vehicle Exhaust Emissions

Air pollution from vehicle emissions may be grouped into primary and secondary pollutants. Primary pollutants are those emitted directly into the atmosphere, and secondary, those pollutants formed in the atmosphere as a result of chemical reactions, such as hydrolysis, oxidation, or photochemical reactions. The significant primary pollutants emitted by motor vehicles include carbon dioxide (CO_2), CO, hydrocarbon compounds, SO_2, oxides of nitrogen (NO_x) and PM. Secondary pollutants include NO_2, photochemical oxidants (e.g. ozone), hydrocarbons, sulphuric acid, sulphates, nitric acid and nitrate aerosols.

Other Fugitive Dust Sources

Fugitive dust emissions may occur as a result of vehicle entrained dust from local paved and unpaved roads and wind erosion from open areas. The extent of particulate emissions from the main roads will depend on the number of vehicles using the roads and on the silt loading on the roadways.

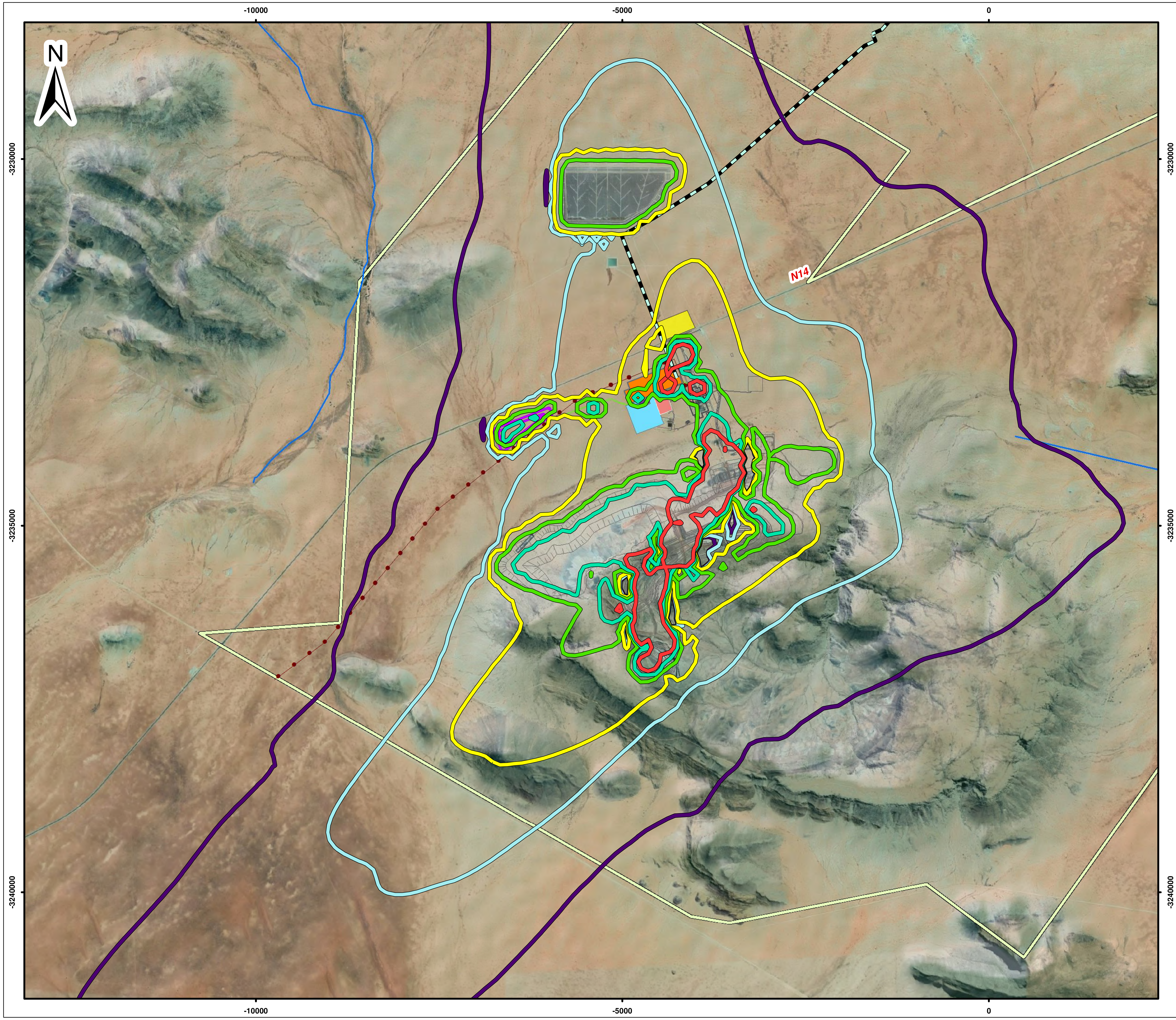
Comparison Between 2013 and 2020 Dust Modelling Input Parameters

For the Gamsberg Zinc Mine EIA (2013) dust modelling was undertaken. Dust modelling was again done by Airshed (2020) using the latest data, therefore, there were some additional changes to the input data as summarised in Table 6-10.

Table 6-10 Input Parameters 2013 Assessment of Dust vs 2020 Assessment of Dust

2013 AQIA	2020 AQIA
Meteorological data used: Pofadder for the period 2007-2009.	Meteorological data used: WRF data for a point extracted at site for the period 2016-2018.
High moisture ore (>4%) emission factor used for the quantification of emissions from the crusher.	More for the moisture provided as 0.4%. Low moisture ore (<4%) emission factor used for the quantification of crushing emissions.
50% control efficiency assumed on all transfer points.	Control efficiency for materials handling was only assumed at the crusher transfer point (50% for wetting and a further 30% for enclosure).
Mean weight of trucks assumed to be 320 t and 32 trucks used to haul ore.	Provided that the trucks will be between 90 t and 180 t capacity. This equates to an average weight of between 120 t and 240 t and ~203 trips per day to move 10 Mtpa ore.

2013 AQIA	2020 AQIA
The silt content on the road was assumed to be 6.9%. this assumption was not qualified.	The silt content on the road was assumed to be 8.4% based on US EPA defaults.
The control efficiency on the haul roads were assumed to be 75%.	Two mitigated scenarios were assessed for the unpaved haul roads: 75% CE achievable through watering 90% CE achievable through chemical suppressants



Legend

Gamsberg Zinc Mine MRA

Existing Infrastructure

Business Partner Camp

Laydown Area

Existing Contractors Camp

Proposed Infrastructure

Proposed Bulk Water Pipeline

Transmission Line

Access Road

Smelter Complex Footprint

Secured Landfill Site

Switch Yard

Maximum Daily Dust Deposition 75% CE (Mine and Smelter Complex)

20 mg/m²/day

50 mg/m²/day

100 mg/m²/day

300 mg/m²/day

600 mg/m²/day

1200 mg/m²/day

0 600 1 200 Meters

Scale: 1:63 000 @ A3

Projection: Transverse Mercator

Datum: WGS1984, Lo23

Gamsberg Smelter Project

Figure 6-17

Total Particulate Deposition due to Baseline Mining Operations

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Noise

The information in this section is sourced from the Noise Impact Assessment undertaken by Airshed Planning Professionals (2020). The Noise Impact Assessment is included in Appendix I.

Noise Sensitive Receptors

Noise sensitive receptors generally include places of residence and areas where members of the public may be affected by noise generated by mining, processing and transport activities.

The impact of an intruding industrial/mining noise on the environment rarely extends over more than 5 km from the source. Potential noise sensitive receptors within the project area (Figure 6-18), include individual homesteads, residential areas (i.e. Aggeneys), areas of industrial activities and recreational areas.

Baseline Noise Survey and Results

Sampling points were selected based on proposed project activities, position of sensitive receptors and previous survey locations (Figure 6-18). Survey results for the campaign undertaken on 9 and 10 September 2019 are summarised in Table 6-11 and for comparison purposes, visually presented in Figure 6-19 (day-time results) and Figure 6-20 (night-time results).

The following was noted:

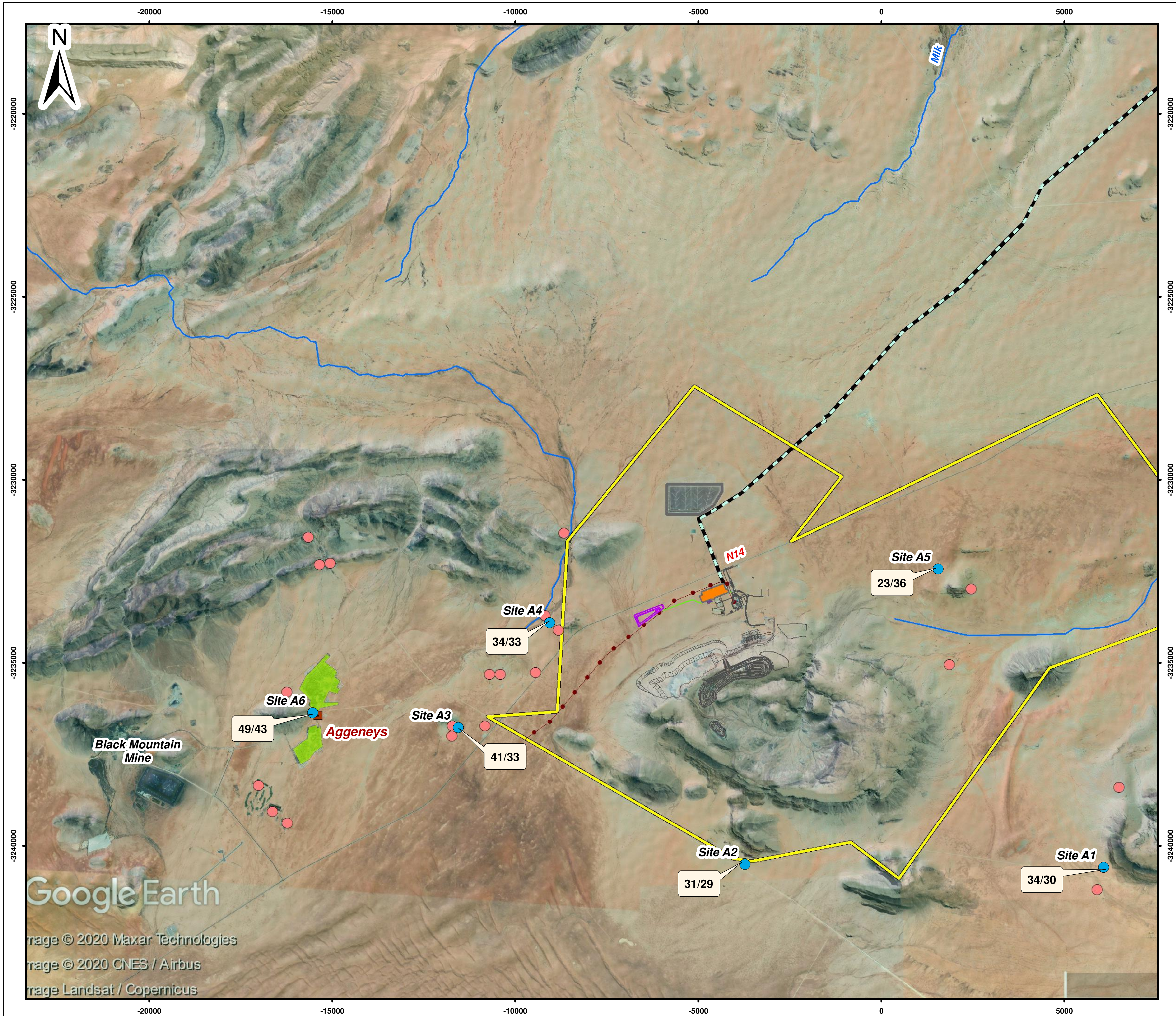
- Weather conditions:
    - During the day, weather conditions consisted of cloudless skies with temperatures between 28ºC and 31.4ºC. Slight to moderate wind conditions (including gusts) with wind speeds between 0.1 and 5.7 m/s mostly from the northerly directions, prevailed.
    - At night, skies were clear with temperatures between 18.9°C and 22.5°C. Slight wind conditions with wind speeds between 0 and 2.3 m/s mostly from the south-westerly direction, prevailed.
- Day-time baseline noise levels:
    - Measurements indicate day-time ambient noise levels that are comparatively quiet but influenced by occasional noisy incidents such as vehicles passing by and community activities (observed at Site 6).
    - L_{Aeq}'s[7] ranged between 23 dBA and 49 dBA which is considered typical of rural to suburban areas according to SANS 10103.
    - Recorded L_{Aeq}'s during the day were within IFC guidelines for residential, institutional and educational receptors (55 dBA).
- Night-time baseline noise levels:
    - Measurements indicate night-time ambient noise levels that are quiet but influenced by community activities (observed at Site 6) and occasional noisy incidents such as vehicles passing by.
    - Mining activities were clearly audible at Site 2 and Site 5 during the night.
    - L_{Aeq}'s ranged between 29 dBA and 43 dBA which is considered typical of rural to urban areas according to SANS 10103.

[7] The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)

- Recorded L_{Aeq}'s during the night were within IFC guidelines for residential, institutional and educational receptors (45 dBA).

In order to illustrate the increase in ambient noise levels as a result of the project, the following representative background noise levels (based on the lowest survey measurements as a conservative approach) were used:

- $L_{Req,d}$ – 23 dBA; and,
- $L_{Req,n}$ – 29 dBA.



Legend

- Towns / Villages
- Rivers
- Gamsberg Zinc Mine MRA
- Existing Infrastructure

Proposed Infrastructure

- Bulk Water Pipeline
- Transmission Line
- Access Road
- Secured Landfill Site
- Switch Yard
- Smelter Complex Footprint

Sensitive Receptors

- Residential Developments
- Individual Households/ Recreational areas/ Industries
- Noise Sampling Locations
- 34/30 Day/Night Ambient Levels

0 1 000 2 000 Meters

Scale: 1:100 000 @ A3
Projection: Transverse Mercator
Datum: WGS1984, Lo23

Gamsberg Smelter Project

Figure 6-20

Location of Potential Noise Sensitive Receptors

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Table 6-11 Project Baseline Environmental Noise Survey Results Summary

Site	Date	Duration (minutes)	L_{AFmax} (dBA)	L_{AIeq} (dBA)	L_{Aeq} (dBA)	L_{AF90} (dBA)	Observations
Day-time							
Site 1	09/09/2019 1:44	30	50.85	37.02	33.97	25.40	Gusty winds throughout the measurements, leaves rustling in the wind
Site 2	09/09/2019 2:42	30	60.69	37.66	31.04	24.09	Gusty winds throughout the measurements, leaves rustling in the wind
Site 3	09/09/2019 3:47	30	55.27	42.91	41.38	31.13	Traffic from the road, leaves rustling in the wind
Site 4	09/09/2019 4:42	30	55.42	39.62	33.93	24.61	Leaves on shrubs and trees rustling in the wind, birds chirping
Site 5	09/09/2019 6:05	30	46.80	30.06	23.28	18.63	Leaves on shrubs and trees rustling in the wind, birds chirping
Site 6	10/09/2019 10:33	30	82.81	56.98	49.06	33.82	Construction vehicles, leaves on shrubs and trees rustling in the wind, community activities, birds chirping
Night-time							
Site 1	09/09/2019 10:07	15	54.97	35.5	29.87	23.25	Insects, birds chirping, leaves on shrubs and trees rustling in the wind
Site 2	09/09/2019 10:07	15	49.39	32.77	28.89	25.9	Mine operations, sounds of insects
Site 3	09/09/2019 11:20	15	55.25	37.37	33.24	27.28	Sounds of insects, birds chirping, cars passing
Site 4	10/09/2019 12:35	15	53.63	41.86	36.05	24.27	Sounds of insects, birds chirping

Site	Date	Duration (minutes)	L_{AFmax} (dBA)	L_{AIeq} (dBA)	L_{Aeq} (dBA)	L_{AF90} (dBA)	Observations
Site 5	09/09/2019 11:55	15	54.3	38.03	33.14	27.96	Noise background (mine operations), sound of insects, car passing
Site 6	10/09/2019 1:23	15	67.06	48.21	43.29	30.89	Dogs barking & sounds of insects, cars passing

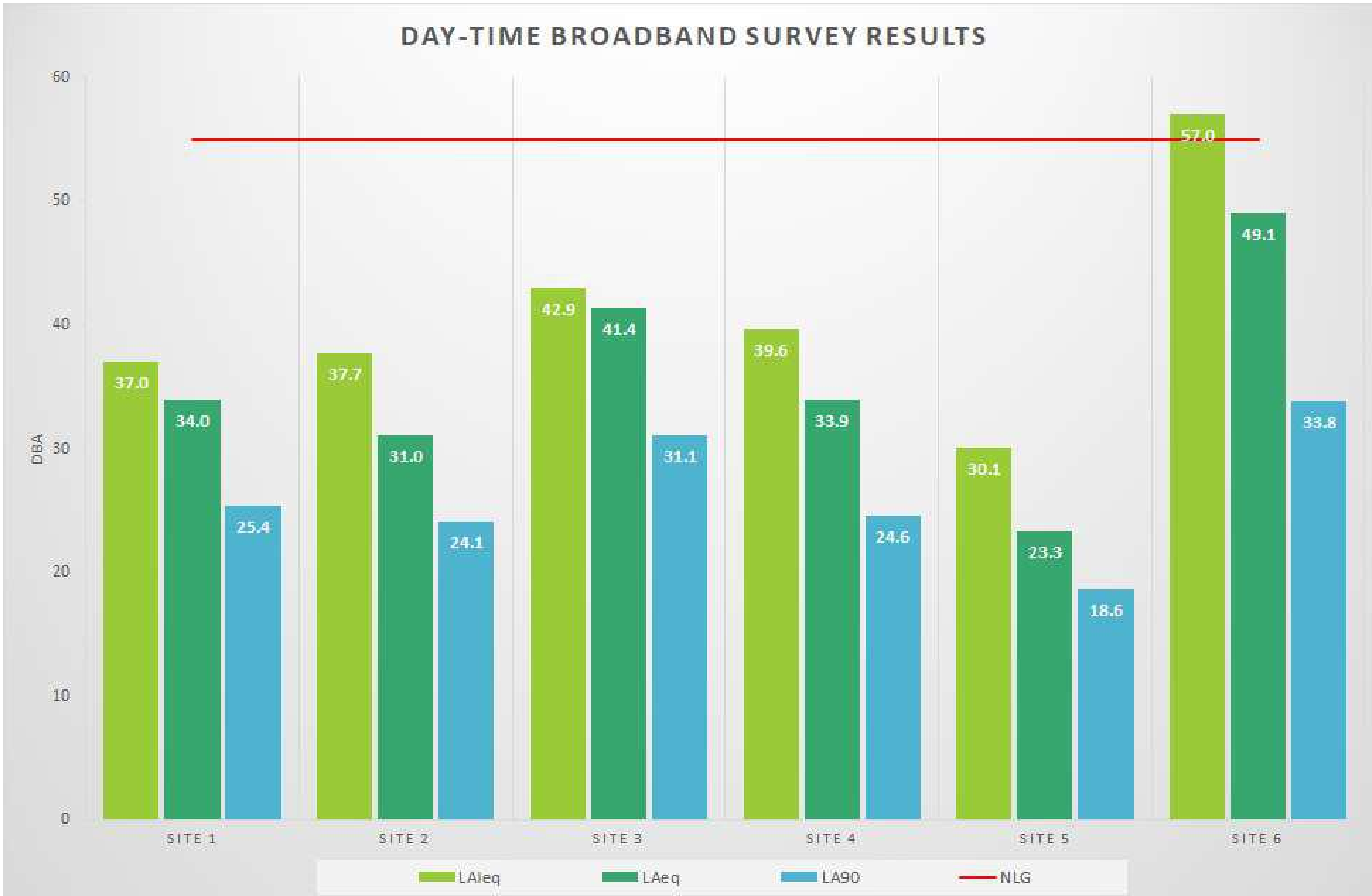


Figure 6-19: Day-Time Broadband Survey Results

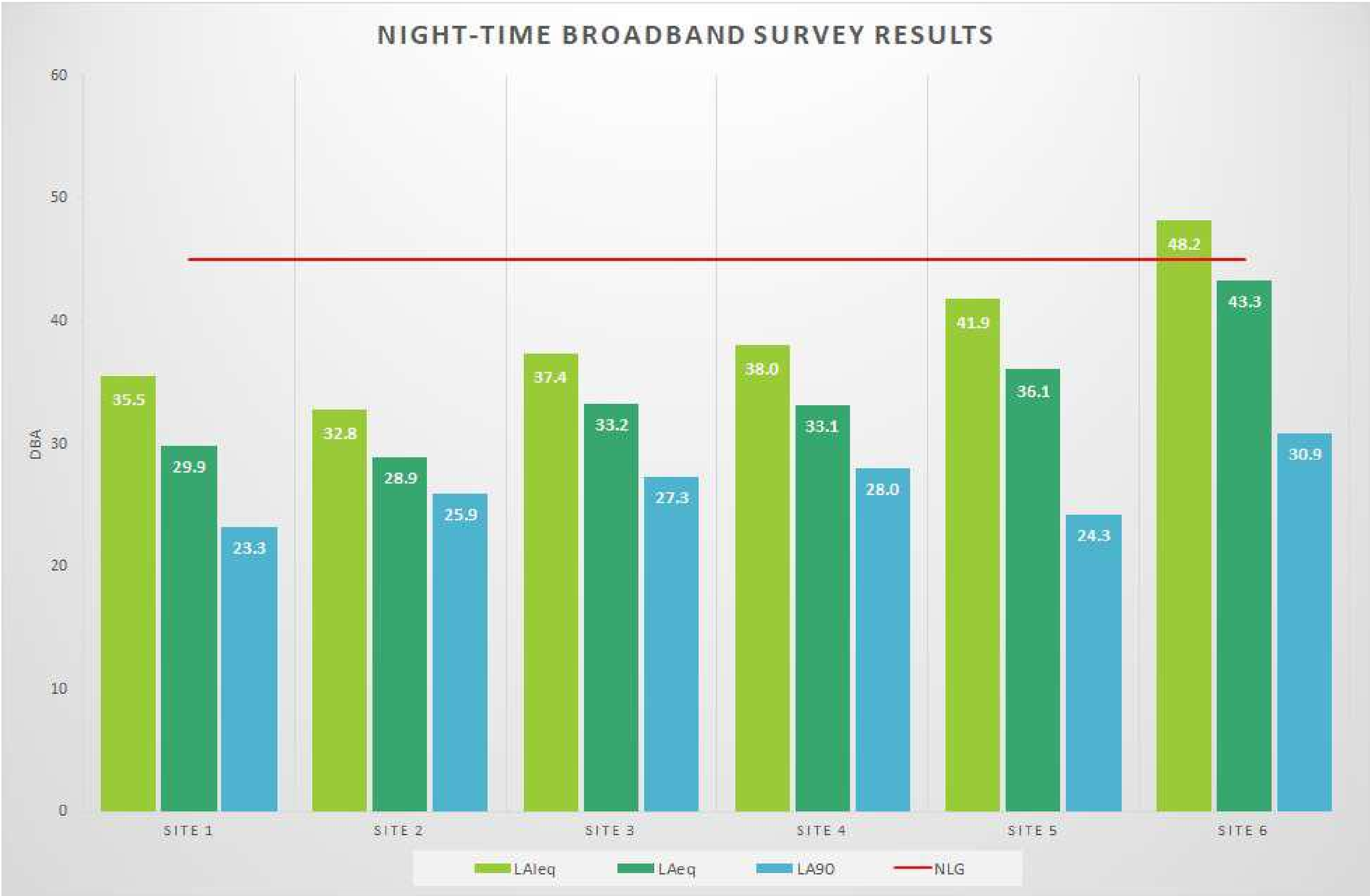


Figure 6-20: Night-Time Broadband Survey Results

Social

Regional Study Area

The regional study area is broadly defined as the Northern Cape Province and specifically the Namakwa District municipal area (Figure 6-21). It is anticipated that the Smelter, in combination with the proposed expansion of the concentrator plant at the Gamsberg Zinc Mine, will contribute to economic growth and employment creation in these two areas. The social baseline for the Northern Cape and Namakwa District Municipality is described in Table 6-12 and Table 6-13 respectively. The Namakwa District Municipality is one of five district municipalities in the Northern Cape Province.

Table 6-12 Northern Cape Social Baseline

Aspect	Description
Population	Notwithstanding its large geographical area (the biggest province by land mass), the Northern Cape Province has the lowest population of all provinces (1.2 million residents), representing about 2% of the national population in 2014/2015. The age category 0-4 years constituted the largest proportion of the population, while the age cohort 70-74 had the lowest population. The total fertility rate for the Province was 2.85 births per woman between 2011 and 2016. The average life expectancy rate at birth was 59 years for males and 65 years for females. Population density was 3.26 persons per square km in 2016. Since 2006, the population has marginally increased year to year. The Province had a positive net migration of 3 311 people in the same years. Its urbanisation rate was 79.9% in 2016.
Economy	In 2016, the Province was the smallest contributor to the national GDP (2.1%). The Namakwa District Municipality, in turn, was the smallest contributor to the provincial GDB (11%). The largest industries were community services (22.5%) and mining (17.5%). The Province's economic growth rate was -2.7% in 2016. This negative economic growth can largely be attributed to contractions in the agriculture, mining, transport and electricity sectors. However, by 2018, the Northern Cape's GDP had expanded by 2.8%, the highest of all provinces. Mining and agriculture were major contributors to the expansion. In 2014, the economy (represented by agriculture, mining, manufacturing and construction) made up 34% of the Northern Cape's output. The largest economic sector was mining, at 22% of the provincial economy, followed by agriculture (7%), manufacturing (3%), and construction (2%). The Northern Cape contributed 6% of national mining.
Employment	Approximately 40% of the working age population was employed in 2015. 64 % of total employment was in the formal sector, compared to the national average of 69%. In 2014, the median formal monthly wage was R2 600 and the median wage for domestic, informal and agricultural workers was R1 400. BMM is one the largest private sector employers in the Northern Cape, employing around 1 692 people at the BBM mine, and 1 171 people at the Gamsberg Zinc Mine Project (employees and business partner employees). Around 80% of BMM's employees are from the Northern Cape, including 60% from the Namakwa district (mainly Khâi-Ma and Nama Khoi municipal areas).

Table 6-13 Namakwa District Municipality Social Baseline

Aspect	Description
Population	The Namakwa District has the lowest population (115 488 in 2016), compared to other districts in the Northern Cape Province (about 10% of the total provincial population). The District's population growth rate was 0.2% in 2014. The population density for Namakwa District is 0.91 people per square kilometre (2014). The urbanisation rate for the District is approximately 91%. Among all local municipalities within the district, the Nama Khoi Local Municipality had the highest population density (3.08 people per square km, followed by Khâi-Ma municipality (1.4 people per square km). A breakdown of the population by age group shows a high and increasing number of economically active people in the Nama Khoi, Hantam and Khâi-Ma local municipalities, which underscores the need for job creation. The age cohort with the largest population size is 25-29 years. The median age in the District Municipality is 31, about 20 % higher than for the Northern Cape Province. 68 % of the population falls in the 15-64 year cohort. Afrikaans is the most dominant language (97%) spoken at home. The district population is dominated by Coloureds, with slightly more females than males. The number of households increased from 33 567 in 2004 to 37 839 in 2014. Approximately 36% of households are female-headed households. The average household size is 3.1 members and the dependency ratio (per 100 of the population between 15 and 64 years) is 47.1.
Education	Poor quality of education is reported as a major concern in the District. About 24% of the population has completed matric, 8% has completed higher education and 4.4% has no school education (2016).
Services provision	The majority of households in the District are housed in formal dwellings. About 2.3% live in informal dwellings. The majority of households have access to piped water (95%) (70.5% inside the dwelling). Access to sanitation has improved since the 2011 census (now at 80%). Refuse removal is around 81.7%.
Economy	The major contributions to the economy of the District is agriculture, community services and mining. The GDP growth rate for the Namakwa District was 3.7% in 2016. The Nama Khoi Municipality was the biggest contributor to the District's GDP (41%) in 2013 while Khâi-Ma municipality contributed 7% (note that this was prior to the establishment of the Gamsberg Zinc Mine). Renewable energy is increasing its contribution to the economy of the District, while tourism is also a relatively large contributor. In 2014, the mining industry in the Namakwa District was led by the Nama Khoi region (58%), followed by the Richtersveld and Khâi-Ma municipalities respectively.
Employment	The District Municipality's labour market is faced with high unemployment, with an official unemployment rate of 21.5% in 2014. The unemployment rate in the Khâi-Ma local municipality was 24.5% in the same year, and that of the Nama Khoi local municipality, 23.5%. The largest increase in the unemployment rate in the District between 2004 and 2014 was in the Khâi-Ma municipality (7.1%). As was mentioned, around 60% of the BMM/Gamsberg Zinc Mines' workforce are located in the Namakwa District area. The average annual income in the district is approximately R30,000. However, some 43% earn less than R20,000 per year.
Poverty	The district municipality had a poverty rate of 50.4 percent in 2004 and 26.2 percent in 2014.

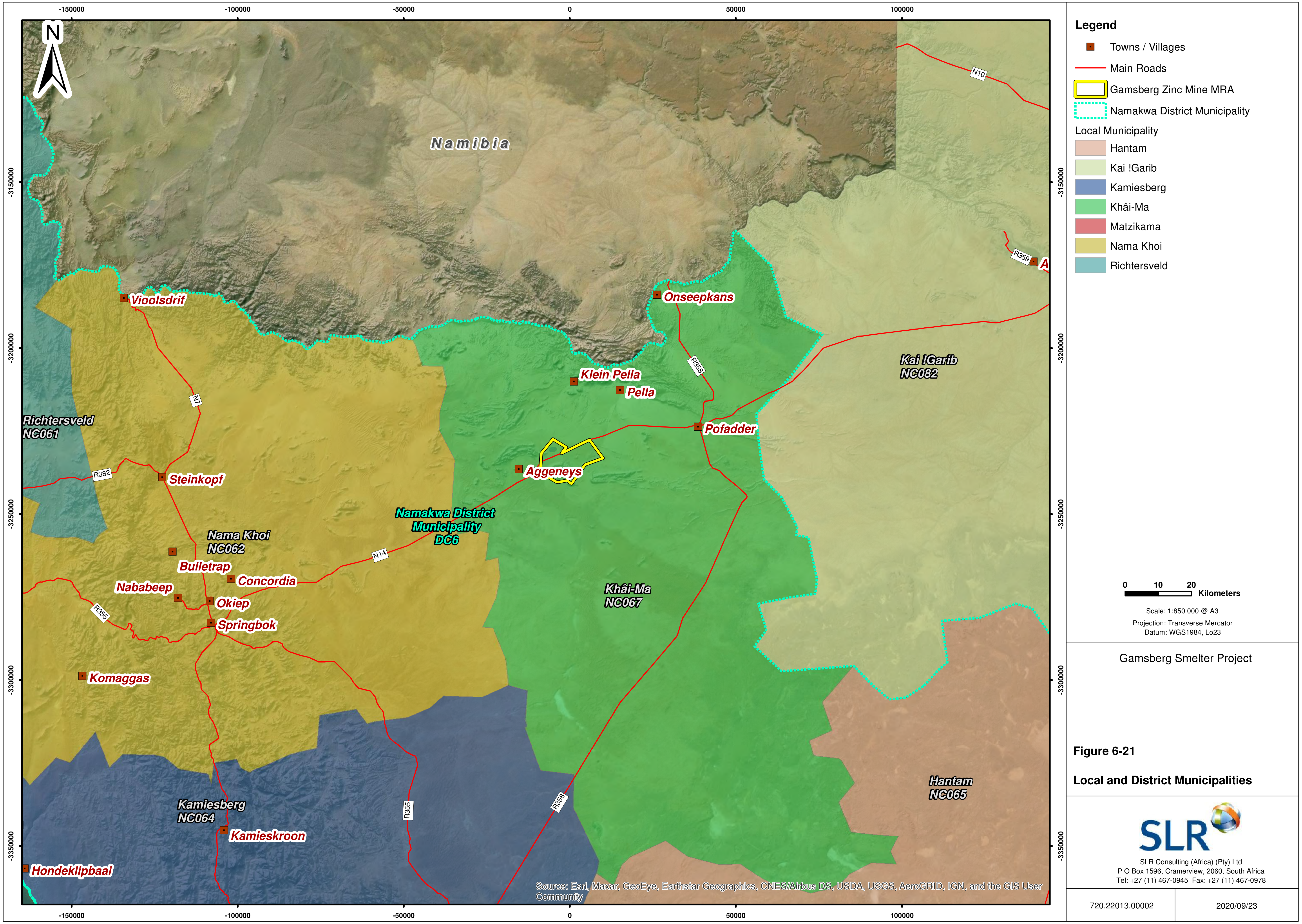


Figure 6-21

Local and District Municipalities

Khâi-Ma Local Municipality

The Project is situated in the Khâi-Ma Local Municipality, which is one of six local municipalities within the Namakwa District Municipality (Figure 6-21).

A basic socio-economic profile of the population residing in the local study area is presented in Table 6-14. The information was mainly sourced from the 2011 Census Survey, the 2016 StatsSA Community Survey, the Khâi-Ma IDP review (2019), Media Monitoring Africa (2018) (via Wazimap) and the Municipalities of South Africa website (municipalities.co.za). [8]

Table 6-14 Khâi-Ma Municipality Social Baseline

Aspect	Description
Administration	The Khâi-Ma municipality is a low capacity municipality (Category B), divided into four wards. The Project is located in Ward 4 of the Municipality. Pofadder, Pella, Aggeneys, Witbank and Onseepkans are all located within the municipal area. Farming settlements include Dwagga, Soutpan, Vrugbaar, Raap-en-Skraap and Klein Pella. The administrative headquarters of the municipality is located in Pofadder. The Khâi-Ma municipality provides basic services to Onseepkans, Blyvooruitsig, Pofadder and Witbank. Aggeneys is a mining town where the residents are mainly employed by BMM and Gamsberg Zinc Mines and the supporting Business Partners. Vedanta/Black Mountain Mining provides basic services to the residents of Aggeneys.
Population	he Khâi-Ma Municipality had a population of 12 333 people in 2016. Population density is around one person per square kilometre, with the majority of the population living in the rural areas (4 035 people). Aggeneys has a population of 2 053 people (845 households) and Pofadder 2 919 people (733 households). More than 71% of the population falls within the 15-64 age cohort, while 22.2% are under 15 years old. About 6% of the population is older than 64 years. The population growth rate in 2016 was 0.21% per year. The current growth rate is estimated to be 0.83%. The dependency ratio is 39.6 per 100 people within the 15-64 age cohort. The median age was 28 years in 2011. There are 4 079 households in the Khâi-Ma municipal area, with an average household size of three persons per household. Almost 34% of households are female-headed households. More than 92% of households live in formal dwellings, while 6.4% live in informal dwellings. The language most spoken at home is Afrikaans (95%), while 75% of the population is considered "Coloured." The poverty headcount was 5.9% in 2016.
Education	Almost 3% of the population has no schooling, 22.2% has Matric and 5.2% has higher education.
Services	About 90% of households have piped water and 84% have flush or chemical toilets. Weekly refuse removal is available to 94% of households, and 87.6% has electricity. In 2016, the Khâi-Ma local municipality was the local municipality within its district which had the most access to basic services (Stats SA, 2018). However, the municipality still has trouble in delivering satisfactory services to its communities due to lack of capacity and an influx of people. The high levels of water consumption is also a big concern in this water stressed region.
Economy	The main economic sectors in the municipality are agriculture, mining, tourism, community services, and renewable energy.

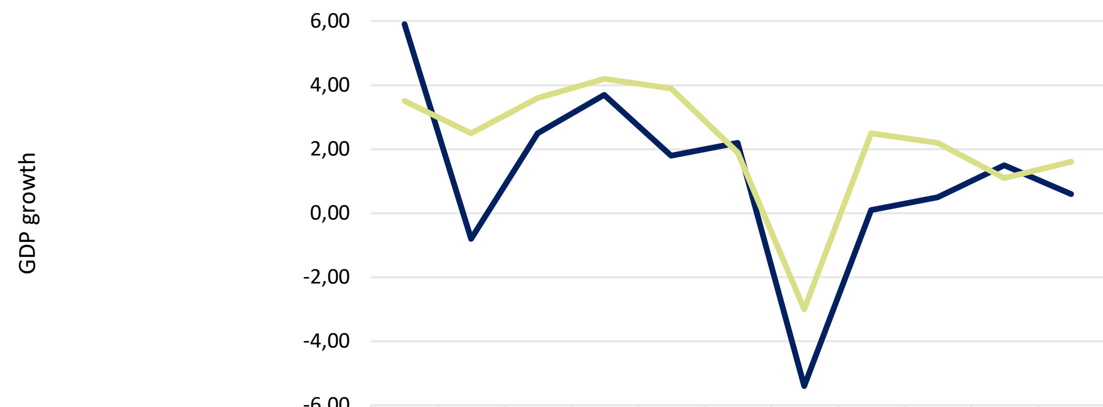
[8] It was noted that various sources contain conflicting data, while data sources used ranged from 2001 to 2016. Most of the information in the IDP is outdated. For example, the role of mining and mining-related employment in the Khâi-Ma municipality is largely missing from the local municipal level data. Where possible, the 2016 Community Survey findings was given preference below.

Aspect	Description
Employment	Close to 55% of the working age population are employed. The average annual income was R29 400 per household in 2011, but 34% earned R20 000 or less. The annual income for individuals was R15 000, with 41% earning between R10 000 and R20 000 per annum. As was mentioned, around 80% of BMM's employees are from the Northern Cape, including 60% from the Namakwa district (mainly Khâi-Ma and Nama Khoi municipal areas).
Health care	Provincial hospitals are located in Pofadder, Springbok and Upington and well as a private hospital in Upington. The various towns in the municipal areas have functional government primary health care clinics.
Ward 4	According to the 2011 Census, the Ward had a population 3 638 people. The median age in Ward 4 was 31, while 66% of the population was between 18 and 64. Around 20% of the households were female-headed households. Employment was around 57%. For almost 80% of the population, Afrikaans is spoken most often at home. Less than 4% are living in informal dwellings. 35.7% have completed matric or higher. Aggeneys is the main town in Ward 4. Approximately 85% of the households have access to piped water, 85.2% have refuse removal and 85.9 have flush toilets. More than 90% of households have access to electricity.
Nama Khoi Local Municipality	The Nama Khoi Local Municipality is briefly discussed as it forms an important labour sending area for Black Mountain Mine and Gamsberg Zinc Mine activities. It is anticipated that the smelter project will also use this local municipality as one of its labour sending area. The Nama Khoi Local Municipality is a Category B municipality. The town of Springbok is the administrative centre and the most densely populated area, as it is the economic hub of the Namakwa District with the highest population. It is also the largest contributor to the District's GDP (41%), and made the largest contribution to employment in the District. Mining used to form the backbone of the economy. According to the 2016 Community Survey, the Khâi-Ma Municipality had a population of 46 513 people, with a population density of 2.6 people per square kilometre. For approximately 97% of the population, Afrikaans is the language most spoken at home.

Economic

Economic Growth Trends

Growth of the Namakwa District Municipality's economy, as measured by real changes in Gross Regional Product (GDPR), was between 0.1% and 1.5% per annum between 2010 and 2013, after recovering from the 2009 recession's low point of -5.4%. The latest available data is shown in Figure 6-22, which shows that the Namakwa District Municipality's economy's trajectory has, to an extent, followed that of the Northern Cape but with more severe periods of retraction and with a downturn in 2013.

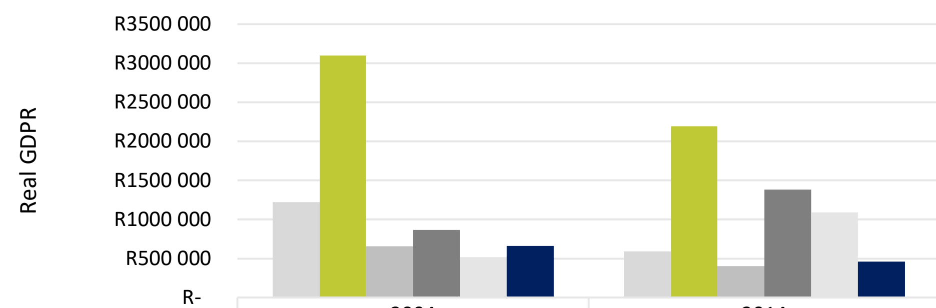


	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Namakwa District Municipality	5,90	-0,80	2,50	3,70	1,80	2,20	-5,40	0,10	0,50	1,50	0,60
Northern Cape Province	3,50	2,50	3,60	4,20	3,90	1,90	-3,00	2,50	2,20	1,10	1,60

Source: NDM, 2018

Figure 6-22 Real GDPR Growth Rates for the Wider Study Area, 2003-2014

Considering growth at a more local level, it is apparent that in real terms, both Khâi-Ma and Nama Khoi Local Municipality's economies contracted between 2004 and 2014. Figure 6-23 shows that Nama Khoi Local Municipality used to be by far the largest contributor to GDPR in the Namakwa District Municipality. While the Nama Khoi Local Municipality was still the largest contributor in 2014, its share of the regional economy relative to that of other municipalities had shrunk considerably (potentially due to mine closures). This is in contrast to the economies of Hantam Local Municipality and Karoo Hoogland Local Municipality, the only two local municipalities in the district which experienced growth during the period.



	2004	2014
Richtersveld LM	R1221 932	R592 223
Nama Khoi LM	R3099 671	R2193 436
Kamiesberg LM	R657 329	R403 334
Hantam LM	R864 570	R1381 970
Karoo Hoogland LM	R517 014	R1093 369
Khai-Ma LM	R661 795	R460 197

Source: NDM, 2018

Figure 6-23: Real GDPR in the Local Municipalities of the Namakwa District, 2004 and 2014

Considering growth by sector shows that Nama Khoi Local Municipality was responsible for over half of the district economy's output in the mining sector in 2014, while Khâi-Ma Local Municipality was responsible for 13%. Nama Khoi Local Municipality contributed around 25% towards the district's manufacturing sector in 2014, down from 34% in 2004, and Khâi-Ma Local Municipality contributed around 8% in 2014 (down from 11% in 2004). Contributions towards the district's economy in other sectors are outlined in Table 6-15.

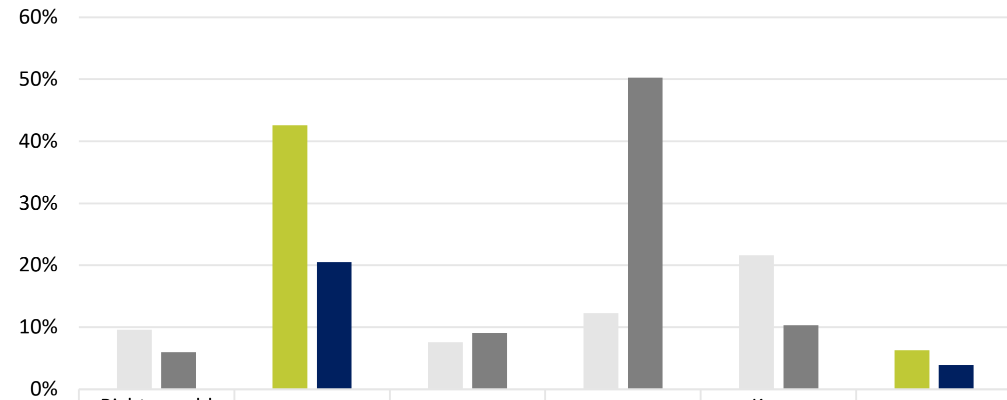
Table 6-15 Contribution of Khâi-Ma Local Municipality and Nama Khoi Local Municipality to District GDPR by Sector, 2004 and 2014

Sector	Year	Nama Khoi LM	Khâi-Ma LM
Agriculture	2004	6.2%	5.1%
	2014	3.4%	2.9%
Mining	2004	52.7%	11.9%
	2014	58.1%	13.1%
Manufacturing	2004	33.8%	10.9%
	2014	25.3%	8.2%
Electricity	2004	48.5%	6.8%
	2014	30.0%	4.2%
Construction	2004	38.1%	5.8%
	2014	27.8%	4.3%
Trade	2004	33.2%	4.7%
	2014	22.9%	3.4%
Transport	2004	38.2%	6.1%
	2014	26.6%	4.5%
Finance	2004	46.1%	6.5%
	2014	38.9%	5.3%
Community services	2004	35.2%	6.7%
	2014	25.2%	4.8%
Total industries	**2004**	**44.1%**	**9.4%**
	2014	**35.8%**	**7.5%**

Source: NDM, 2018

Given that the Standard Industrial Classification does not consider tourism explicitly, it is useful to consider tourism trends separately. Figure 6-24 shows the proportion of the Namakwa District's bed nights for which each local municipality was responsible in 2004 and 2013. The figure suggests that Nama Khoi Local Municipality and

Khâi-Ma Local Municipality have both become less popular tourism destinations relative to the other municipalities in the district. Nama Khoi Local Municipality has gone from accounting for 43% of the district's bed nights in 2004 to 21% in 2013, while Khâi-Ma Local Municipality has gone from 6% to 4%. The greatest increase in the proportion of bed nights has been experienced by Hantam Local Municipality, which has gone from hosting 12% of the district's bed nights in 2004 to 50% in 2013.



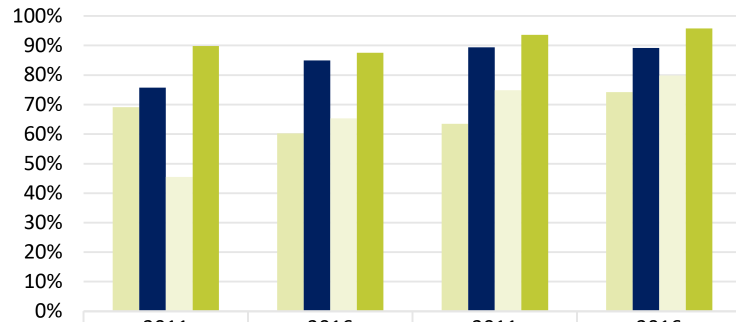
	Richtersveld LM	Nama Khoi LM	Kamiesberg LM	Hantam LM	Karoo Hoogland LM	Khai-Ma LM
2004	10%	43%	8%	12%	22%	6%
2013	6%	21%	9%	50%	10%	4%

Source: NDM, 2018

Figure 6-24: Proportional Contribution of Local Municipalities to Total Tourist Bed Nights in the Namakwa District, 2004 and 2013

Availability of Municipal Services

The two local municipalities' goals to improve access to basic services have had mixed results according to StatsSA (2012; 2017). In the case of Khâi-Ma Local Municipality, improvements have been seen in the areas of refuse removal and water supply, but fewer households have access to flush toilets connected to sewerage and electricity for lighting. For households living in Nama Khoi Local Municipality the trends have been somewhat more positive. A higher proportion of households have access to a flush toilet connected to sewerage, piped water inside their dwellings and electricity for lighting. The proportion of households with access to weekly refuse removal remains unchanged at 89%. These trends are shown in Figure 6-25.



	2011	2016	2011	2016
	Khâi-Ma Local Municipality		Nama Khoi Local Municipality	
Flush toilet connected to sewerage	69%	60%	64%	74%
Weekly refuse removal	76%	85%	89%	89%
Piped water inside dwelling	46%	65%	75%	80%
Electricity for lighting	90%	88%	94%	96%

Source: Stats SA, 2012; Stats SA, 2017

Figure 6-25: Access to key municipal services in the study area, 2011 and 2016

Future Economic Development Objectives

In terms of future economic development goals, the 2020-21 review of the IDP of the Khâi-Ma Local Municipality is most instructive. The IDP identifies the following overall objectives for the municipality (Khâi-Ma Local Municipality, 2020: 76):

- Basic Services and Infrastructure: Creating decent living conditions;
- Good Governance and Public Participation;
- LED;
- Financial Management; and
- Institutional Development and Transformation.

Within the LED objective, the following key priority areas are identified (Khâi-Ma Local Municipality, 2020: 76):

- "Poverty relief through effective basic service delivery and job creation;
- Ensure effective service delivery through transformation, capacity building and infrastructure development;
- Form linkages in order to facilitate skills development;
- Promote business and investment attraction and retention; and
- Assist with economic interventions in sector development (agricultural, mining, tourism and renewable energy)."

In addition, the following development strategies and programmes are outlined under the LED objective:

- "Compile LED strategy with assistance of sector department;
- Appoint functionaries for the promotion of LED;
- Promote Small Medium Micro Enterprise (SMME) development;

- Participate in Khâi-Ma Development Forum to build strong relationship with private sector and business forums;
- Build and update database of small emerging farmers;
- Develop and avail stands for business development;
- Maintenance of a database of available labour and skills to encourage the employment of local people; and
- Give support to sign off projects."

The Namakwa District Municipality IDP 2017-2022, as well as the 2018-2019 revision of the IDP, list the following as being strategic objectives for the area (Namakwa District Municipality, 2017: 41; and 2018: 53):

- "Monitor and support local municipalities to deliver basic services which include water, sanitation, housing, electricity and waste management;
- Support vulnerable groups;
- Improve administrative and financial viability and capability;
- Promote and facilitate LED;
- Enhance good governance:
    - Promote and facilitate spatial transformation and sustainable urban development;
    - Improve communication and communication systems;
    - Establish a customer care system;
    - Invest in the improvement of Information and Communications Technology (ICT) systems;
    - To render a municipal health service;
    - To coordinate the disaster management and fire management services in the district;
    - Implement the climate change response plan; and
    - Caring for the environment".

The Namakwa District Municipality Rural Development Plan lists the following development priorities within the area (Department of Rural Development and Land Reform - DRDLR, 2017: 54):

- "Tourism development;
- Transport strategy;
- Linkages with Namibia;
- Renewable energy generation;
- Mining development; and
- Nodal policy".

Traffic

The respective peak-hour flows for the traffic counts at the relevant intersections were identified as indicated in Table 6-16, Figure 6-26 and Figure 6-27.

Table 6-16 Peak Hour Periods at the Relevant Intersection

Point	Intersection	AM Peak		PM Peak	
		Time Interval	Number of Vehicles	Time Interval	Number of Vehicles
A	Road N14 and Gamsberg Zinc Mine Access Road	06:15 to 07:15	230	15:45 to 16:45	169
B	Road N14 and Loop 10 Road	06:00 to 07:00	194	15:45 to 16:45	159
C	Road N14 and Aggeneys Access Road	06:00 to 07:00	249	15:45 to 16:45	183
D	Road N14 and Road R355	07:00 to 08:00	193	16:15 to 17:15	263
E	Road R355 and Kokerboom Road	07:00 to 08:00	132	16:15 to 17:15	142
F	Kokerboom Road and Road N7 Southbound On-Ramp	07:00 to 08:00	267	15:15 to 16:15	239
G	Kokerboom Road and Road N7 Northbound On-Ramp	07:00 to 08:00	314	15:15 to 16:15	325

It is important to take note that peak periods differ between intersections due to the distance between the relevant intersections under investigations. Distances between intersections are as follows:

- Point A to Point B – 7.7km.
- Point B to Point C – 7.2km.
- Point C to Point D – 102km
- Points E, F and G are within 750m from Point D.

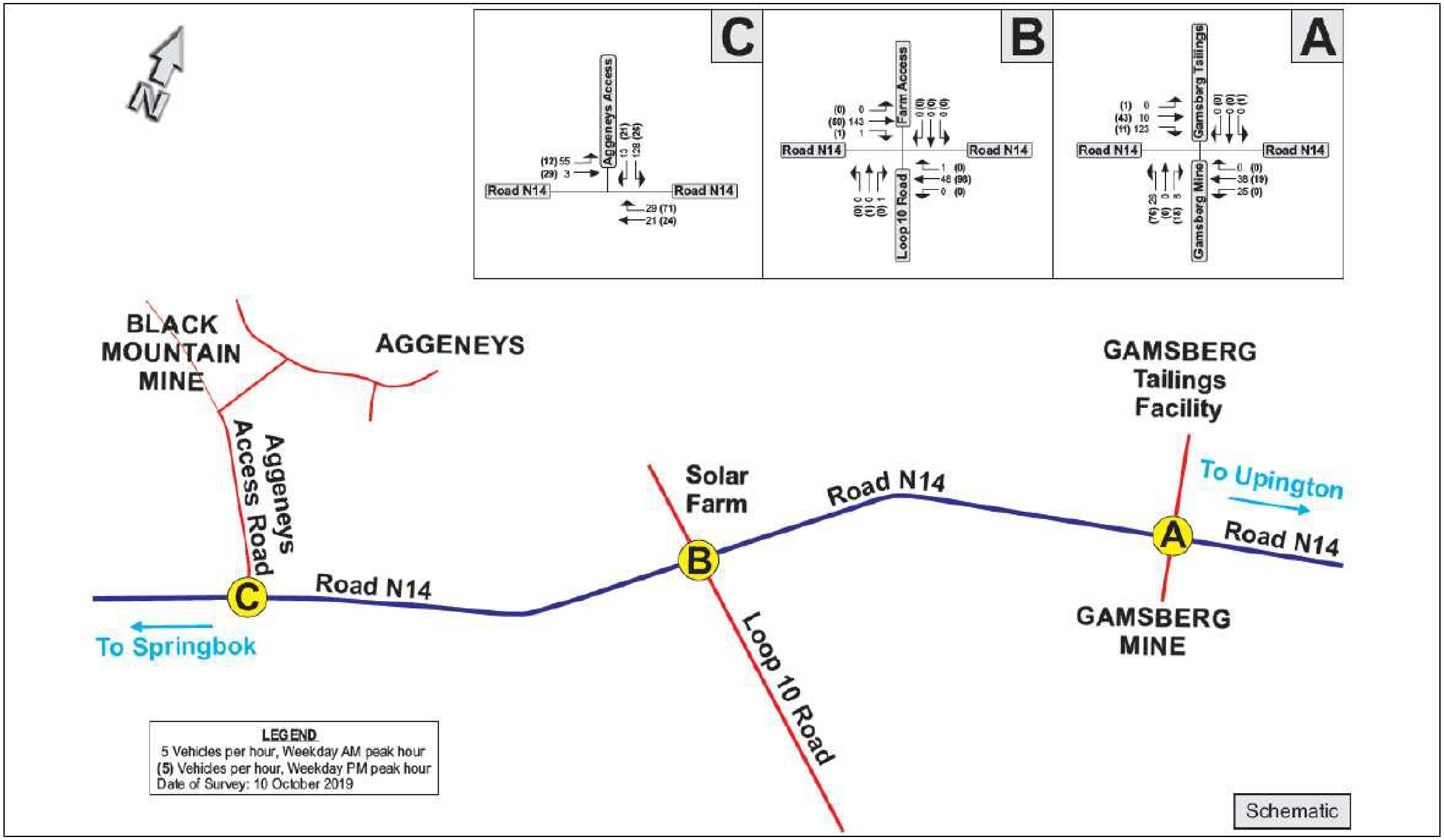


Figure 6-26 2019 Existing Peak Hour Traffic (Vicinity of Gamsberg Zinc Mine)

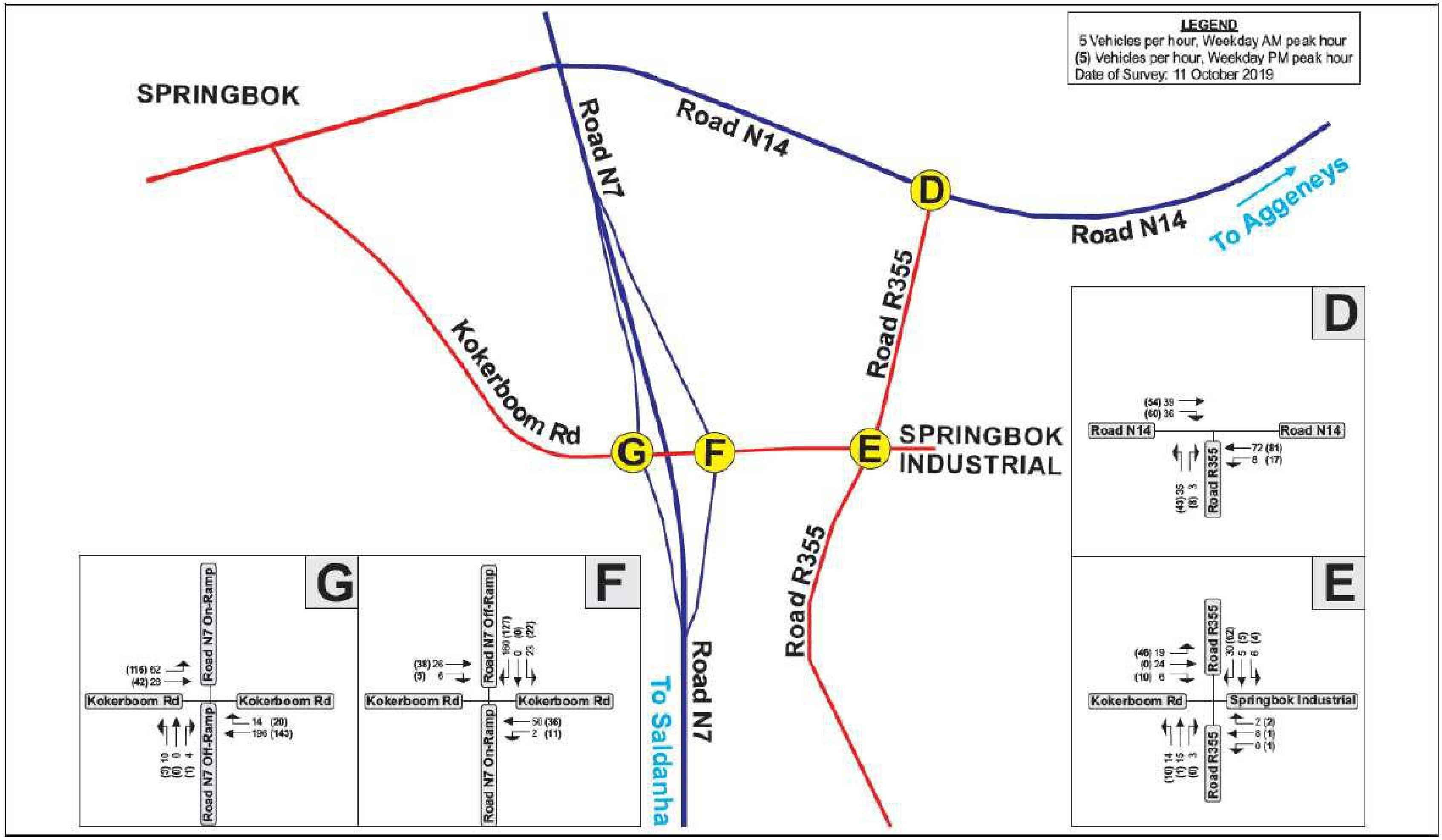


Figure 6-27 2019 Existing Peak Hour Traffic (Springbok)

Climate Change

Global Context

The global context of climate change is discussed in relation to the impact of the project on climate change. Anthropogenic climate change as a global phenomenon is caused by the accumulated greenhouse gas emissions from global emitting sources. Recently CO_2 levels within the atmosphere surpassed 415 parts per million for the first time in recorded history. The impact of this upward trend in emissions is increasingly of concern due to the negative impacts such as extreme weather events, drought and increased rainfall variability accompanying climate change.

The receiving environment for this project, in the context of climate change, is the global atmosphere. The duration of the impact of the greenhouse gas emissions is considered as effectively permanent as the greenhouse gas emissions produced remain in the atmosphere for an extended period of time. In 2015 the world agreed in the Paris Agreement that the target to limit global warming should be a 2°C increase of average global temperature above the pre-industrial average temperature. The Intergovernmental Panel on Climate Change (IPCC) estimated in the 5th Assessment Report[9] that the global limit is to emit 2,900 gigatons of CO_2 above the pre-industrial levels by 2100. By 2012, a total of 1,890 gigatons of CO_2 has already been emitted. This leaves a remaining budget of 1,010 gigatons of CO_2 before the 2°C limit is breached.

The Paris Agreement, however, also states that the world should increase ambition and aim for a target of 1.5°C. This is in order reduce significant and far-reaching impacts associated with climate change, such as; sea level rise, desertification, ocean acidification, biodiversity loss and increase in frequency and intensity of extreme weather events. The IPCC reported in 2018 an estimate of the remaining carbon budget of 580 gigatons CO_2 for a 50% probability of limiting warming to 1.5°C, and 420 gigatons CO_2 for a 66% probability (medium confidence).

The practical implication of having a carbon budget is that this is the maximum amount of emissions that can be emitted. In the context of environmental impact assessments, this constitutes a limited resource. If the limit presented by this amount is exceeded, then the planet as whole will suffer irreparable damage with dire consequences to the global society.

For this analysis, the 2°C increase of average global temperature above the pre-industrial average temperature target is used.

Local Context

South Africa’s NDP 2030 is centred on reducing inequality and eliminating poverty by 2030. Climate change impacts and climate change mitigation are highlighted as critical issues within the NDP and are linked to inequality and poverty.

South Africa’s climate change response is also set out in the National Climate Change Response White Paper[10]. Within this document it is proposed that climate change be addressed through various interventions that build and sustain social, economic and environmental resilience by retaining a fair contribution to the global efforts to stabilise GHG concentrations in the atmosphere. South Africa’s Nationally Determined Contribution (NDC) submitted in 2015 (as a response to the Paris Agreement) sets out the nation’s emissions trajectory up to 2050. South Africa’s emissions are expected to peak between 2020 and 2025, plateau for approximately a decade and decline in absolute terms thereafter (the ‘peak, plateau and decline trajectory’).

South Africa, as a developing nation, makes allowances to increase its emissions in the short-term, to foster economic growth and steadily transition towards a low carbon economy. However, the South African Government expresses through the White Paper and the Integrated Resource Plan that a shift to low-carbon electricity generation options will only be possible in the medium term, and not immediately. Therefore, South Africa is not limiting itself to specific emissions numbers but rather provides a peak, plateau and decline

[9] IPCC, 2014. Fifth Assessment Report of the IPCC, s.l.: s.n.

[10] National Climate Change Response White Paper, 2011. Available at https://www.gov.za/sites/default/files/gcis_document/201409/nationalclimatechangeresponsewhitepaper0.pdf

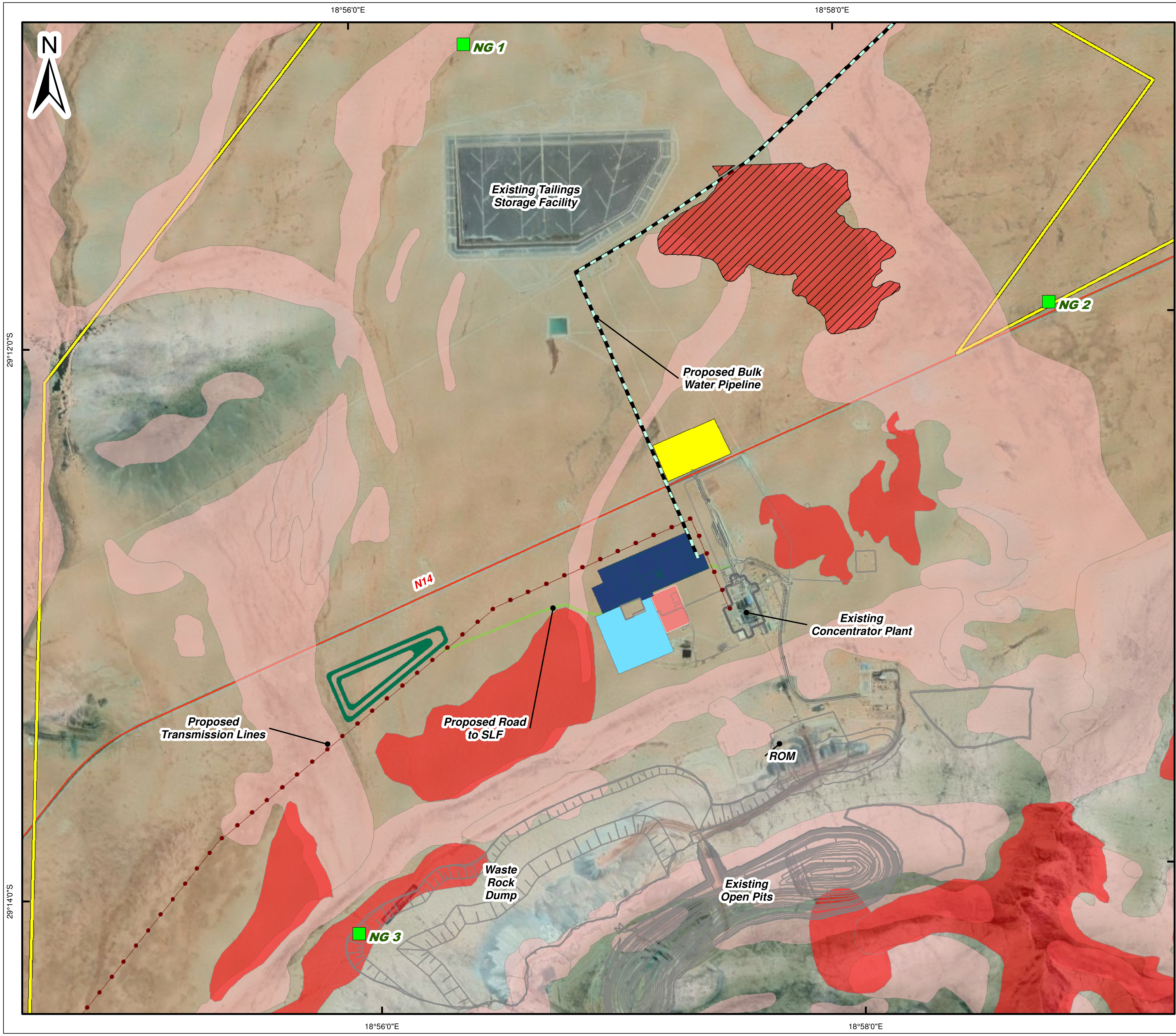
trajectory range from the year 2016 (reference point) to 2050. The country's lower boundary peak, plateau and decline trajectory pledge is set at 398 Mt CO_2e and the upper boundary at 614 Mt CO_2e for the years 2025 to 2030. The Climate Change Bill (which is not yet finalised) will make provision for regular updates of this trajectory, through which it can be better placed within the context of the Paris Agreement and global trends.

The issue under consideration is the global shortfall in targets to reach the goal of limiting average temperatures to well below 2°C above pre-industrial levels. South Africa's NDC has been assessed as insufficient to meet a 2°C target. However, through the ratchet mechanism of the Paris Agreement, countries are able to accelerate efforts to achieve a 1.5°C, which allows countries such as South Africa to negotiate and determine how to achieve such a target. The ratchet mechanism requires countries to submit new NDCs every five years, outlining how much emissions they intend to reduce. Furthermore, it states that each submission should be more ambitious than the last. A ratcheted South African NDC (which could be categorised as a transitional risk) within the approximate period 2022-2025 could have an impact on the longevity of emission intensive projects.

Cultural Heritage and Palaeontology

A Heritage and Archaeological Impact Assessment (Appendix P) and Paleontological Impact Assessment (Appendix Q) for the Gamsberg Zinc Mine was undertaken by Dr David Morris (2013) and Mr John Pether (2013) respectively. These studies covered the whole of the MRA and include the proposed footprint of the smelter complex and associated infrastructure. The findings of these studies remain valid.

The three sites of archaeological importance are included in Figure 6-28.



Legend

- Gamsberg Zinc Mine MRA
- Laydown Area
- Business Partner Camp
- Existing Contractors Camp
- Main Road
- Access Road
- Transmission Line
- Existing Infrastructure
- Archaeological and Paleo Findings

Proposed Infrastructure

- Proposed Bulk Water Pipeline
- Transmission Line
- Access Road

Preferred Alternatives

- Secured Landfill Site
- Smelter Complex Footprint

Botanical Sensitivity

- Irreplaceable
- Irreplaceable (S Todd, 2020)
- Constrained

0 500 1 000 Meters

Scale: 1:25 000 @ A3
Projection: Transverse Mercator
Datum: Lo 23 WGS 84

Gamsberg Smelter Project

Figure 6-28

Heritage Sites or Features Identified

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Heritage and Archaeology

A survey of land surfaces north of the Gamsberg Inselberg and on the northern slope of the inselberg itself on the farms Gams and Aroam revealed minimal archaeological traces. Findings included very few isolated stone flakes (Figure 6-28). Where erosion had cut into the surface there was no indication of any artefacts below the surface there either.

A description of the three sites of archaeological importance are included in Table 6-17.

Table 6-17 Archaeological Observations in the Gamsberg Zinc Mine MRA

Locality	Description	Heritage Significance
NG 1 29.18247 S 18.94130 E	Apparent stone structure: mid-twentieth century drilling site (water or mine prospecting). Cement capping has code '2293 /54'. Bottle glass and wire found in the vicinity. A similar feature occurs further north at 29.18235 S 18.94446 E (P Desmet pers comm). Ostrich eggshell fragments on nearby rise are possibly indicative of Later Stone Age activity, but no stone artefacts found.	Low
NG2 29.19924 S 18.98100 E	A series of dome-shaped bedrock outcrops around which are clustered an abundance of Ceramic Later Stone Age artefacts (stone artefacts, pottery, ostrich eggshell). Elongated grinding grooves were noted on the outcropping bedrock. These features occur on other similar sites in the wider landscape. Hollows in the bedrock occur, which hold water for a time after rains (known locally as !Gorras the Nama word for these natural reservoirs). The sites probably represent repeated short-duration encampments by transhumant herders or hunter-gatherers with pottery, probably mainly in the last millennium. Transhumant farmers of the colonial era evidently used such sites in similar manner (leaving broken glass and porcelain).	High
NG3 29.236 S 18.932 E	Isolated Earlier Stone Age (ESA) cleaver found on the plain below the inselberg, noted by P. Desmet. Such isolated finds indicate off-site activity. Small clusters of ESA artefacts have been found in the basin. This single instance lacks context and is hence of limited archaeological significance.	Low

Palaeontology

The Gamsberg Zinc Mine is situated in the northern part of the Bushmanland Plateau where inselbergs and ridges of bedrock project steeply above the sandy plains. These are rocks of the Namaqua Metamorphic Province and the specific strata comprising Gamsberg belong to a meta-volcano sedimentary succession named the Aggeneys Subgroup of the Bushmanland Group. The age of the Bushmanland Group is between 1 640 and 1 200 Ma. The mining of the zinc ore in unfossiliferous Bushmanland Group bedrock strata does not have an impact on fossil heritage.

The fossils most commonly seen in aeolianites are land snails and tortoises. Closer inspection reveals the incisors, skulls and bones of moles. Other small bones occur sparsely such as bird and micromammal bones. This is the ambient fossil content of dunes and it includes the bones of rodents, lizards, snakes, birds, ostrich eggshell and small mammals (hares, mongooses, cats etc.). The bones of larger animals are generally very sparsely scattered. Notwithstanding, concentrations of bones are found in specific contexts.

Watercourses are present at a variety of scales, from small, ephemeral, braiding-stream courses on alluvial fans to more entrenched, integrated drainage systems. The fossil potential of small-scale systems is very low. In larger drainages fossils such as abraded bone fragments and loose teeth occur sparsely in channel lags. These drainages must have been more active during periods of wetter climate such as occurred during the Quaternary. Finds such as the snail Melanoides, clam Corbicula and freshwater oyster Etheria attest to more perennial freshwater availability in the larger, now seldom-flowing drainages. The latter will also have hosted waterhole and pan deposits in places, with improved fossil potential.

No areas of particular paleontological sensitivity are identified within the area of direct influence. Due to the sparse, very patchy distribution of fossils in the subsurface, the probability of an important fossil find is considered unlikely.

6.4.2 Land Uses

Surface Rights

The surface rights for the property are held by Black Mountain Mining (Pty) Ltd for the properties covered by the Mineral Rights.

Mineral Rights

Black Mountain Mining (Pty) Ltd currently holds the Mining Right issued by DMR in 2013 (Permit 43/2013 Amendment 2) which covers the farms Bloemhoek 61 Portion 1; Gams 60 Portion 1 and Aroams 57 RE. The MRA is depicted as the 'yellow' line in Figure 6-2.

Land Claims

Consultation with the Office of the Regional Land Claims Commissioner: Northern Cape dated 30 October 2019 (Appendix B5) confirmed that as of that date there were no land claims lodged within the Gamsberg Zinc Mine MRA.

Traditional Authorities

No traditional authority has jurisdiction over the project area.

Land use within and surrounding the project area

The current land use in the proposed Gamsberg Smelter Project area is mining. The Project is surrounded by farms used for grazing (mainly sheep) (excluding farms that form part of the Black Mountain Mining (Pty) Ltd's Biodiversity Agreement). A solar farm, two quarries and a guesthouse are located in close proximity to the Project (less than 10 km). Livestock grazing is the main land use in the surrounding rural areas.

The farms surrounding the Gamsberg Zinc Mine are indicated in Figure 6-29.

- Aroams 57 Ptn 1 (Mr. Abrie van Niekerk): current land uses on Aroams 57 Ptn 1 include farming; solar development and a guesthouse);
- Bloemhoek 61 Rem (Mr. Tertius Visser) – the current land use is farming;
- Achab 59 (Black Mountain Mining (Pty) Ltd) – declared Nature Reserve (Gamsberg Nature Reserve) – under Protected Area Act;
- Kykgat 087 Ptn 1 (Mr Tertius Visser) - the current land use is farming
- Gams 60 Ptn 4 (Black Mountain Mining (Pty) Ltd) - the current land use is farming;
- Gams 60 Rem (Black Mountain Mining (Pty) Ltd) - the current land use is farming;
- Aroams 57 Ptn 2 (Mr. Danie Gerber) – the current land use is farming; and
- Aroams Rem Ptn 3 - the current land use is farming.

Biodiversity Offset and Black Mountain Mining (Pty) Ltd Set-Aside Areas

Black Mountain Mining (Pty) Ltd has entered into a Biodiversity Offset Agreement as per the Condition of the Environmental Authorisation for the Gamsberg Zinc Mine. According to Clause 6.1 of the Biodiversity Offset Agreement Black Mountain Mining (Pty) Ltd is required to secure at its sole and exclusive cost additional conservation worthy land comprising of 1) at least 7 of the 12 nearby properties or 2) 12 900 ha containing the characteristics identified in Clause 6.9 of the Biodiversity Offset Agreement.

A total of four farms (Achab 57, Ptn 2 farm Rozynebosch 41, REM of the farm Rozynebosch 41 and the REM of the farm Vogelstruishoek) were secured covering a surface area of 21 021.66 ha. The Gamsberg Nature Reserve was proclaimed on 5 August 2019 as gazetted in the Northern Cape Provincial Gazette.

Portions of the land as indicated in Figure 6-29, consisting of Gams 60 Ptn 1 and 4, Bloemhoek 61 Ptn 1 and Aggeneys 56 Rem and Ptn 1 have been designated as set-aside areas (Clause 5). According to the Biodiversity Offset Agreement Black Mountain Mining (Pty) Ltd acknowledge and agree that the protection of the Black Mountain Mining (Pty) Ltd properties shall be managed and implemented through the EMPr and/ or Biodiversity Management Plan.

The Offset farms that have been secured as well as the set-aside areas are illustrated in Figure 6-29.

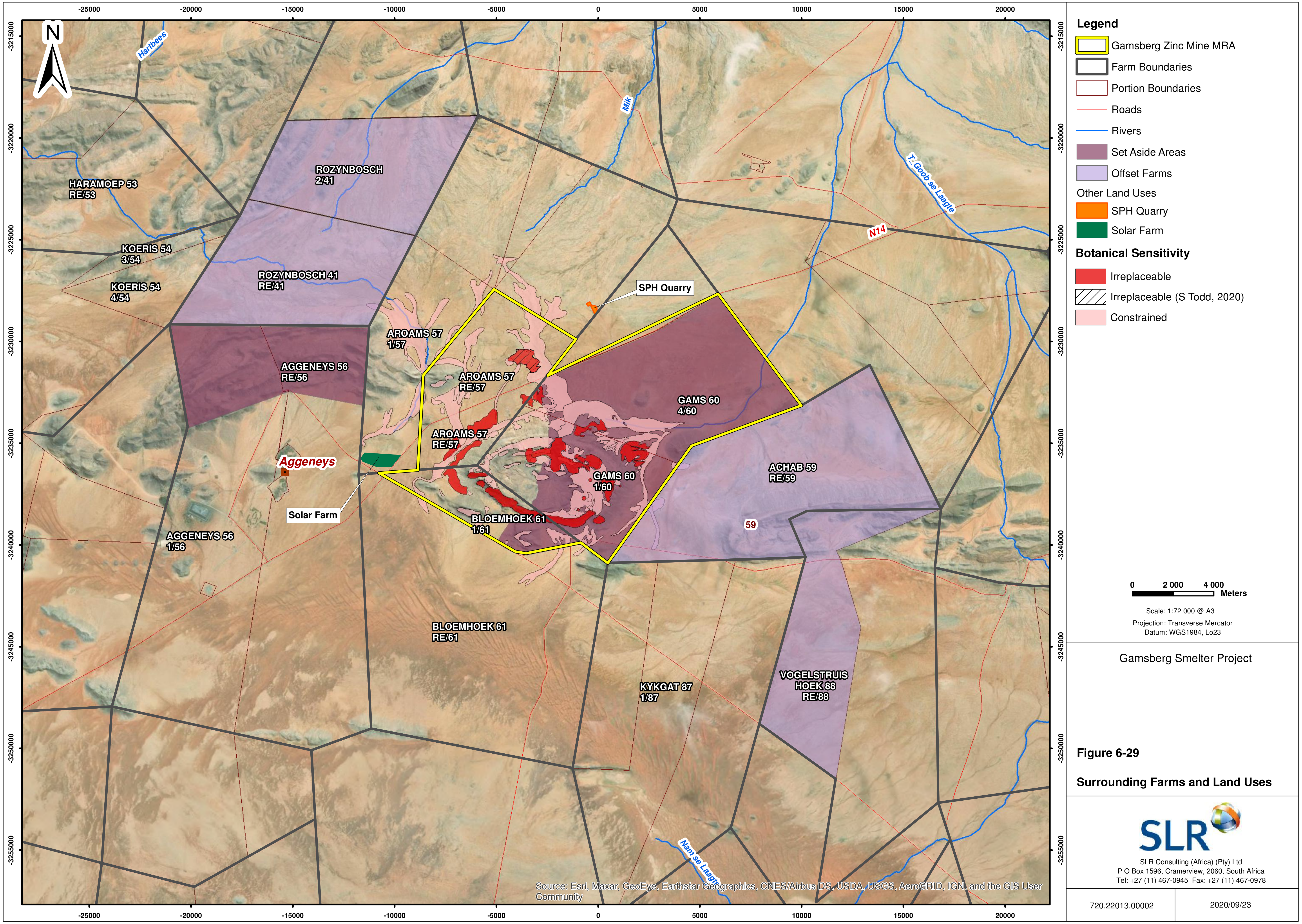


Figure 6-29

Surrounding Farms and Land Uses

Black Mountain Mine

Black Mountain Mine (BMM) is approximately 15km to the south west of the Gamsberg Zinc Mine and is owned and operated by Black Mountain Mining (Pty) Ltd (69.6%) in partnership with Exxaro Resources (owns 24.4%) and employee stock ownership plan (6%). BMM's current operation comprises two underground shafts, Deeps and Swartberg; and a processing plant.

BMM mines zinc, lead, silver and copper, hoisting 1.7Mt of ore per year, and has a production capacity of 90 000tpa metal-in-concentrate.

The Deeps shaft produces copper, lead and zinc, with silver as a by-product. Annual production is of the order of 102ktpa of zinc-equivalent metal-in-concentrate. Production at Deeps is currently scheduled to cease in around 2021.

The Swartberg shaft produces primarily copper and lead, with silver as a by-product. Annual production is of the order of 13.5ktpa of metal-in-concentrate. Plans are well advanced to deepen Swartberg, which will increase production to 1.6mtpa of copper and lead ore, and 60ktpa - 70ktpa of metal-in-concentrate, depending on a favourable economic assessment. Further ramp up is planned for the future, taking copper and lead ore production past the 2mtpa mark.

Concentrate from the Black Mountain operations is transported via road transport to the Port of Saldanha.

BMM has been in operation since 1980 and was acquired by Vedanta Resources from Anglo American in 2010/2011.

Town of Aggeneys

The town of Aggeneys is situated approximately 10km to the south west of the Gamsberg Zinc Mine and is largely for housing the employees from both the Gamsberg Zinc Mine and BMM. Aggeneys town consist of 688 houses of which 167 houses were constructed for the Gamsberg Zinc Mine. Single accommodation units can accommodate 155 people. Educational facilities include two primary schools namely the government school and the Aggeneys International Academy, along with a secondary school. Medical facilities include the mine run clinic and also a smaller state clinic. Limited shops are present in town mainly anchored by the OK.

Solar PV Farm

Aggeneys 40MW Solar Generation Facility is situated on the Farm Aroams approximately 5 km to the north west of the proposed Gamsberg Smelter Project area.

Quarry

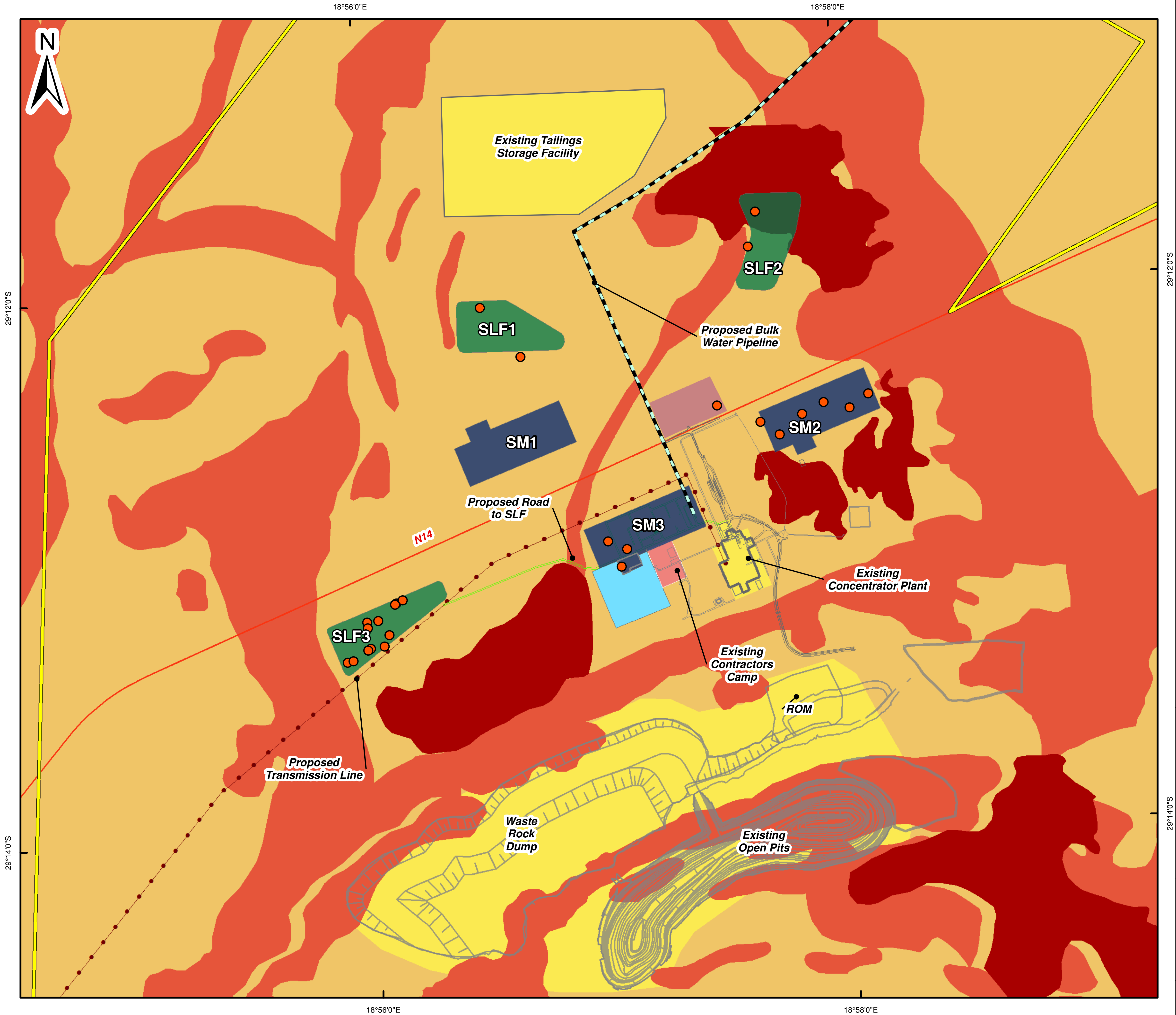
SPH Kundilla Aggregate Quarry Is situated approximately 7 km to the north east of the Gamsberg Smelter Project area.

6.4.3 Description of the Specific Environmental Features and Infrastructure on the Site

The environmental features in the project area are described in Section 6.4.1. Notable environmental features in the vicinity of the proposed Gamsberg Smelter Project include the calcrete patches which are known for their sensitive biodiversity and the drainage line running parallel to the N14 at the base of the northern side of the Gamsberg inselberg, and its tributaries from the north. Figure 6-30 is a sensitivity map of the area and includes confirmed locations of protected, threatened and range-restricted plants.

6.4.4 Environment and Current Land Use Map

See Figure 6-29 for a conceptual map showing topographical information as well as land uses on and immediately surrounding the Gamsberg Smelter Project.



Legend

- Gamsberg Zinc Mine MRA
- Laydown Area
- Business Partner Camp
- Existing Contractors Camp
- Main Road
- Existing Infrastructure

Proposed Infrastructure

- Proposed Bulk Water Pipeline
- Access Road
- Transmission Line

Alternatives

- Alternative Secured Landfill Site
- Alternative Smelter Complex Locations

Ecological Sensitivity

- Very High
- High
- Medium
- Low
- Plant Species of Conservation Concern

0 500 1 000 Meters

Scale: 1:25 000 @ A3
Projection: Transverse Mercator
Datum: Lo 23 WGS 84

Gamsberg Smelter Project

Figure 6-30

Location of Alternatives in Relation to Ecological Sensitivity, and Including Confirmed Locations of Protected, Threatened and Range-Restricted Plants

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6.5 ENVIRONMENTAL IMPACTS AND RISKS OF THE ALTERNATIVES

This section provides a list of potential impacts on environmental and socio-economic aspects that have been identified in respect of each of the main project actions/activities and processes for each of the alternatives considered. The ratings for consequence, probability and significance of each of the impacts in the unmitigated scenario (which assumes that no consideration is given to the prevention or reduction of environmental and social impacts) are provided in the table below in accordance with the Northern Cape DMR report template. The options assessed here include:

- Smelter complex sites 1, 2 and 3; and
- Secured landfill facility sites 1, 2 and 3.

Table 6-18: list of impacts identified for the proposed project including alternatives

The assessment ratings provided in this table are for the unmitigated scenario only which assumes that no consideration is given to the prevention or reduction of environmental and social impacts.

Potential impact	Alternative	Main project activity	Project phase	Consequence			Probability	Significance	Degree to which impact		
				Severity	Duration	Spatial scale			Can be reversed	Causes irreplaceable loss of resources	Can be avoided/ Managed/ Mitigated
Change in groundwater levels	Smelter 1, 2 & 3	• Change in runoff due to construction of smelter complex	Construction Operational Decommissioning	VL	H	VL	H	L	The impact can be mostly reversed if management measures are put in place and followed	Unlikely	Can be managed/mitigated to acceptable levels
	SLF 1, 2 & 3	• Operational activities • Seepage from secured landfill facility	Construction Operational Closure	VL	H	VL	H	L	Low during operational phase.		
Deterioration of groundwater quality	Smelter 1, 2 & 3	• Construction activities • Operational activities	Construction Operational Decommissioning	VL	H	VL	M	VL	Can be reversed with mitigation	Unlikely	Can be managed/mitigated to acceptable levels
	SLF 1, 2 & 3	• Construction activities • Operational activities • Seepage from secured landfill facility	Construction Operational Closure	M	H	VL	H	M	Cannot be reversed during operational phase, but impact can be minimised if management measures are put in place	Possible	Can be managed/mitigated to acceptable levels
Contamination of surface water resources	Smelter 1 & 3	• Construction activities • Operational activities • Decommissioning activities	Construction Operational Decommissioning	L	H	L	L	VL	Can be reversed with mitigation	Unlikely	Can be managed/mitigated to acceptable levels
	Smelter 2	• Construction activities • Operational activities • Decommissioning activities	Construction Operational Decommissioning	L	H	L	VL	Insignificant	Can be reversed with mitigation	Unlikely	Can be managed/mitigated to acceptable levels
	SLF 1 & 2	• Construction activities • Operational activities • Closure	Construction	L	H	L	M	L	Can be reversed with mitigation	Possible	Can be managed/mitigated to acceptable levels
	SLF 3	• Construction activities • Operational activities within a 1:100 year flood line • Closure	Operational	H	H	M	H	H	Can be reversed with mitigation	Possible	Can be managed/mitigated to acceptable levels
Alteration of natural drainage patterns	Smelter 1, 2 & 3	• Construction activities • Operational activities	Construction Operational Decommissioning	VL	H	L	VL	VL	High	Conceivable	Can be managed/mitigated to acceptable levels
	SLF 1 & 2	• Construction activities • Operational activities • Permanent change to the local topography	Construction Operational Closure	L	VH	L	L	L	Secured landfill facility will be a permanent feature	Possible	Can be managed/mitigated to acceptable levels

Potential impact	Alternative	Main project activity	Project phase	Consequence			Probability	Significance	Degree to which impact		
				Severity	Duration	Spatial scale			Can be reversed	Causes irreplaceable loss of resources	Can be avoided/ Managed/ Mitigated
	SLF 3	• Construction activities • Operational activities • Permanent change to the local topography within 1:100 year flood line	Construction Operational Closure	L	VH	L	H	M	Secured landfill facility will be a permanent feature	Possible	Can be managed/mitigated to acceptable levels
Impact on vegetation and flora due to construction phase site clearance	Smelter 1, 2 & 3	• Physical site clearance during construction	Construction	L	VH	L	H	M	Can be reversed with mitigation	Possible	Can be managed/mitigated to acceptable levels
	SLF 1 & 3			L	VH	L	H	M	Site clearance will cause permanent loss of faunal habitat in the footprint.	Possible	Can be managed/mitigated to acceptable levels
	SLF 2			VH	VH	L	VH	VH		Sited in an area of irreplaceable habitat with range-restricted and threatened plants in a newly identified calcrete gravel patch.	Considered fatally-flawed.
Impact on biodiversity due to dust, noise, and traffic	Smelter 1, 2 & 3	• Construction activities - physical site clearance, increased traffic, increased noise	Construction	L	VH	L	H	M	Can be reversed with mitigation	Possible	Can be managed/mitigated to acceptable levels
	SLF 1 & 3			L	VH	L	H	M	Site clearance will cause permanent loss of faunal habitat in the footprint.	Possible	Can be managed/mitigated to acceptable levels
	SLF 2			VH	VH	L	VH	VH		Sited in an area of irreplaceable habitat with range-restricted and threatened plants in a newly identified calcrete gravel patch.	Considered fatally-flawed.
Impact on biodiversity due to reduced ambient air quality	Smelter 1, 2 & 3	• Emissions from smelter operations • Generation of dust	Operational	M	VH	M	M	M	Should this impact occur it would be difficult to reverse	Possible	Can be managed/mitigated to acceptable levels
	SLF 1, 2 & 3	• Generation of dust		M	VH	M	M	M	Should this impact occur it would be difficult to reverse	Possible	Can be managed/mitigated to acceptable levels
Impact on vegetation due to groundwater contamination	Smelter 1, 2 & 3	• Construction activities • Operational activities • Decommissioning activities	Construction Operational	L	H	L	VL	VL	Should this impact occur it would be difficult to reverse as the groundwater pollution would persist for a long time.	Unlikely	Can be managed/mitigated to acceptable levels
	SLF 1, 2 & 3	• Seepage from SLF	Operational Closure	L	VH	M	L	L		Unlikely	Can be managed/mitigated to acceptable levels
Change in ambient air quality (impact on human health)	Smelter 1, 2 & 3	• Construction activities e.g. dust and emissions from vehicles and generators • Emissions from smelter during operational phase • Decommissioning activities e.g. dust and emissions form vehicles and generators	Construction Operational Decommissioning	L	H	M	L	L	Can be reversed with mitigation	Unlikely	Can be managed/mitigated to acceptable levels

Potential impact	Alternative	Main project activity	Project phase	Consequence			Probability	Significance	Degree to which impact		
				Severity	Duration	Spatial scale			Can be reversed	Causes irreplaceable loss of resources	Can be avoided/ Managed/ Mitigated
	SLF 1, 2 & 3	• Construction activities e.g. dust and emissions from vehicles • Operational activities including emissions from trucks during transport of jarosite	Operational Closure	VL	H	M	L	VL	Can be reversed with mitigation	Unlikely	Can be managed/mitigated to acceptable levels
Increase in ambient noise levels	Smelter 1, 2 & 3	• Construction activities • Operational activities : smelter operations, transport of zinc ingots and sulphuric acid • Decommissioning activities	Construction Operational Decommissioning	L	H	M	L	L	Can be reversed with mitigation	Unlikely	Can be managed/mitigated to acceptable levels
	SLF 1, 2 & 3	• Operational activities: truck transport of jarosite	Operational	L	H	M	L	L	Can be reversed with mitigation	Unlikely	Can be managed/mitigated to acceptable levels
Loss of soil resources and land capability	Smelter 1, 2 & 3	• Construction activities: land clearance, leaks and spills • Operational activities • Decommissioning activities	Construction Operational Decommissioning	L	L	VL	VH	L	Can be reversed with mitigation	Medium	Can be managed/mitigated to acceptable levels
	SLF 1 & 3	• Construction activities: land clearance • Operational activities	Construction Operational Closure	M	H	VL	H	M	Medium	Medium due to the secured landfill facility that could affect the soil quality post-decommissioning.	Can be managed/mitigated to acceptable levels
	SLF 2	• Construction activities: land clearance • Operational activities	Construction Operational	H	H	VL	H	M	Low due to highly sensitive calcrete patch	High	Site should be avoided.
Change in landscape and related visual impacts	Smelter 1	• Construction activities • Operational activities • Decommissioning Activities	Construction Operational Decommissioning	VH	H	H	H	VH	Can be reversed at decommissioning	Low	Can be managed/mitigated to acceptable levels
	Smelter 2 & 3	• Construction activities • Operational activities • Decommissioning Activities	Construction Operational Decommissioning	H	H	H	H	H	Can be reversed at decommissioning	Low	Can be managed/mitigated to acceptable levels
	SLF 1 & 2	• Construction activities • Operational activities • Closure	Construction Operational Closure	M	VH	H	M	M	No	Medium	Long term rehabi8litatiuon could minimise impact
	SLF 3	• Construction activities • Operational activities • Closure	Construction Operational Closure	H	VH	H	M	H	No	Medium	Long term rehabilitation could minimise impact
Road disturbance and traffic safety	Smelter 1	• Construction activities • Operational activities: transport of concentrate across N14 • Decommissioning Activities	Construction Operational Decommissioning	M	H	VH	H	H	High	Medium	Can be managed/mitigated to acceptable levels

Potential impact	Alternative	Main project activity	Project phase	Consequence			Probability	Significance	Degree to which impact		
				Severity	Duration	Spatial scale			Can be reversed	Causes irreplaceable loss of resources	Can be avoided/ Managed/ Mitigated
	Smelter 2 & 3	• Construction activities • Operational activities • Decommissioning Activities	Construction Operational Decommissioning	L	H	VH	M	M	High	Medium	Can be managed/mitigated to acceptable levels
	SLF 1 & 2	• Construction activities • Operational activities: transport of jarosite across N14	Construction Operational	M	H	VH	H	H	High	Medium	Can be managed/mitigated to acceptable levels
	SLF 3	• Construction activities • Operational activities	Construction Operational	L	H	VH	M	M	High	Medium	Can be managed/mitigated to acceptable levels
Loss of heritage/cultural and palaeontological resources	Smelter 1, 2 & 3 SLF 1, 2 & 3	• Site clearance for construction activities	Construction	L	VH	VL	L	L	Very Low should a heritage resource be damaged	Very high	Can be managed/mitigated to acceptable levels
Inward migration	Smelter 1, 2 & 3 SLF 1, 2 & 3	• Employment opportunities	Construction Operational Decommissioning	H	L	H	H	H	Low	N/A	Can be managed/mitigated to acceptable levels
Economic impact – Project Expenditure	Smelter 1, 2 & 3	• Increased spending power in local area	Construction Operational Decommissioning	L+	H	M	H	M+	High	Very low	Can be enhanced with management

6.6 METHODOLOGY USED IN DETERMINING THE SIGNIFICANCE OF ENVIRONMENTAL IMPACTS

The methodology used for the assessment of impacts is set out in Table 6-19. This assessment methodology enables the assessment of environmental impacts including: cumulative impacts, the intensity of impacts (including the nature of impacts and the degree to which impacts may cause irreplaceable loss of resources), the extent of the impacts, the duration and reversibility of impacts, the probability of the impact occurring, and the degree to which the impacts can be mitigated.

Table 6-19 SLR EIA Methodology

PART A: DEFINITIONS AND CRITERIA*		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, spatial extent and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.
	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.
	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	**VL**	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity)
	VH	Very long, permanent, +20 years (Irreversible. Beyond closure)
Criteria for ranking the EXTENT of impacts	**VL**	A part of the site/property.
	L	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours
	H	Local area, extending far beyond site boundary.
	VH	Regional/National

PART B: DETERMINING CONSEQUENCE							
			EXTENT				
			A part of the site/property	Whole site	Beyond the site, affecting neighbours	Local area, extending far beyond site.	Regional/ National
			VL	L	M	H	VH
INTENSITY = VL							
DURATION	Very long	VH	Low	Low	Medium	Medium	High
	Long term	H	Low	Low	Low	Medium	Medium
	Medium term	M	Very Low	Low	Low	Low	Medium
	Short term	L	Very low	Very Low	Low	Low	Low
	Very short	VL	Very low	Very Low	Very Low	Low	Low
INTENSITY = L							
DURATION	Very long	VH	Medium	Medium	Medium	High	High
	Long term	H	Low	Medium	Medium	Medium	High
	Medium term	M	Low	Low	Medium	Medium	Medium
	Short term	L	Low	Low	Low	Medium	Medium
	Very short	VL	Very low	Low	Low	Low	Medium
INTENSITY = M							
DURATION	Very long	VH	Medium	High	High	High	Very High
	Long term	H	Medium	Medium	Medium	High	High
	Medium term	M	Medium	Medium	Medium	High	High
	Short term	L	Low	Medium	Medium	Medium	High
	Very short	VL	Low	Low	Low	Medium	Medium
INTENSITY = H							
DURATION	Very long	VH	High	High	High	Very High	Very High
	Long term	H	Medium	High	High	High	Very High
	Medium term	M	Medium	Medium	High	High	High
	Short term	L	Medium	Medium	Medium	High	High
	Very short	VL	Low	Medium	Medium	Medium	High
INTENSITY = VH							
DURATION	Very long	VH	High	High	Very High	Very High	Very High
	Long term	H	High	High	High	Very High	Very High
	Medium term	M	Medium	High	High	High	Very High
	Short term	L	Medium	Medium	High	High	High
	Very short	VL	Low	Medium	Medium	High	High

PART C: DETERMINING SIGNIFICANCE							
PROBABILITY (of exposure to impacts)	Definite/ Continuous	VH	Very Low	Low	Medium	High	Very High
	Probable	H	Very Low	Low	Medium	High	Very High
	Possible/ frequent	M	Very Low	Very Low	Low	Medium	High
	Conceivable	L	Insignificant	Very Low	Low	Medium	High
	Unlikely/ improbable	VL	Insignificant	Insignificant	Very Low	Low	Medium
			VL	L	M	H	VH
			CONSEQUENCE				

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely to be required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Insignificant	Inconsequential, not requiring any consideration.

***VH = very high, H = high, M= medium, L= low and VL= very low and BLUE denotes a positive impact.**

6.7 POSITIVE AND NEGATIVE IMPACTS OF THE PROPOSED ACTIVITY AND ALTERNATIVES

A comparative assessment of alternative sites (smelter and secured landfill facility) is summarised in Table 6-20 and Table 6-21. The ranking system is a simple three score relative ranking system. For each criterion, a score of one is allocated to the best option and a score of three to the worst. The option with the lowest total score is the preferred option. Results of the alternatives options analysis indicate that the preferred alternative for the smelter complex is Site 3. For the secured landfill facility Site 1 and 3 are preferred, however, from an economic perspective it makes sense to keep the secured landfill facility in close proximity to the smelter complex to reduce transport costs and minimise traffic safety impacts on N14 road users. As site 2 was not fatally flawed from an environmental perspective, this site was preferred.

Table 6-20 Comparative Site Assessment for the Smelter Complex

1 = Preferred; 3 = Least preferred

	Criteria	Alternative Site Options			Discussion
	Aspect/ Impact	Site 1	Site 2	Site 3	
1	Visual impact	3	2	1	All three options will be visible from the N14 highway, however, site 1 is assumed to have the least impact due to the TSF in the background, which will slightly diminish the impact.
2	Loss of soil and land capability through removal, erosion, compaction and contamination				The soil type is likely to be the same for all three options due to them being located on the plains area. There is no relative score difference.
3	Physical loss and/or general disturbance of constrained or irreplaceable vegetation types	1	3	2	Site 1 is considered acceptable for ecological reasons as there are no species or habitats of concern within the footprint, even though the footprint of the development may increase slightly if placed here because of the need to construct additional services to this site. It is also within a CBA2 (while the other two options are in CBA1). Site 2 is in CBA1 and in close proximity and between two calcrete gravel patches that are considered irreplaceable and as a result, is not considered a desirable option for the smelter complex. Although located within a CBA1 and close to a large calcrete gravel patch to the west, Site 3 does not infringe on the calcrete gravel patch as may be expected for Site 2. The site also has low abundance of plant species of conservation concern, with only a few *Euphorbia braunsii* individuals and would therefore be preferred over Site 2.
4	Reduction in surface water quality affecting third party users	2	2	3	Site 3 is situated closer to a wash than site 1 and site 2.
5	Reduction in ground water quality affecting downstream users	2	1	3	The primary criterion for assessing the groundwater impacts was based on and the avoidance of privately-owned farm boreholes. The nearest privately-owned farm boreholes to the smelter complex is DMBH06 located approximately 5.0 km towards the northwest.
6	Reduced air quality from project emissions	2	2	1	Site 1 and 2 are further from the operational mining area and are thus likely to have a more significant impact on cumulative air quality. As such Site 3 is preferred.

	Criteria	Alternative Site Options			Discussion
	Aspect/ Impact	Site 1	Site 2	Site 3	
7	Increase in noise levels				Due to the general lack of sensitive receptors in the near vicinity, the noise impact from all three sites is assumed to be similar. There is no relative score difference.
8	Effect on roads due to project related traffic	3	2	1	Site 1 will have the highest impact in terms of traffic on the N14 due to the need to transport concentrate across the road for processing. Site 2 will require a longer distance for transportation of concentrate but will not require that the N14 be crossed. As such Site 3 is the best in that concentrate needs only to be moved a short distance. In terms of export of product and by-product, all sites would be the same in terms of impact.
9	Loss or damage to heritage and/or palaeontological resources				None of the proposed site options would interfere with known existing heritage resources. There is no relative score difference.
10	Positive and negative socio-economic impacts				All three options have the potential to have positive and/or negative socio-economic impacts. There is no relative score difference.
11	Positive and negative impacts on community health				It is not likely that emissions from the smelter construction and operations would have distinguishable impacts based on the sites. There is no relative score difference. .
12	Impact on surrounding land uses				All options are within the MRA and are thus unlikely to have any distinguishable impact on surrounding land uses. There is no relative score difference.
	Total	**13**	**12**	**11**	**Site 3 is the preferred option.**

Table 6-21 Comparative Site Assessment for the Secured Landfill Facility

1 = Preferred; 3 = Least preferred

	Criteria	Alternative Site Options			Discussion
	Aspect/ Impact	Site 1	Site 2	Site 3	
1	Visual impact	1	3	2	All three options will be visible from the N14 highway, however, Site 1 is assumed to have the least impact due to the TSF in the background.

	Criteria	Alternative Site Options			Discussion
	Aspect/ Impact	Site 1	Site 2	Site 3	
2	Loss of soil and land capability through removal, erosion, compaction and contamination	3	3	2	The soil type is likely to be the same for all three options due to them being located on the plains area. Some potential for soil contamination if Jarosite/ Jarofix needs to be transported. Hence it is preferable to minimise the distance between the smelter complex and the secured landfill facility. Thus, assuming that the preferred smelter complex site is site 3, site 3 is preferred for the secured landfill facility.
3	Physical loss and/or general disturbance of constrained or irreplaceable vegetation type	1	3	2	Site 1 is south of the existing TSF and represents an area of typical open plains with low abundance of plant species of conservation concern. Site 1 is the preferred secured landfill facility alternative from an ecological perspective and would have low impacts on fauna and flora. Site 2 is sited in an area of irreplaceable habitat with range-restricted and threatened plants in a newly identified calcrete gravel patch. It is therefore considered fatally-flawed. Site 3 is located in CBA1, is located adjacent (to the north) to a large calcrete gravel patch; is on the edge of an ephemeral stream course or wash; is within a relatively ecologically productive area with deeper soils than the other alternatives (possibly due to its location at the edge of an ephemeral streamline or wash) and has a higher abundance of plant species of conservation concern than Site 2. From an ecological perspective this site is not ideal for the secured landfill facility, however, it is considered more acceptable than Site 2.
4	Reduction in surface water quality affecting third party users	2	3	3	Site 2 is directly adjacent to a wash. Site 3 falls within the 1:100 year flood line which could result in the flooding of the secured landfill facility during rainy periods.
5	Reduction in ground water quality affecting downstream users	2	1	3	The primary criterion for assessing the groundwater impacts was based on the avoidance of privately-owned farm boreholes. The nearest privately-owned farm boreholes to the Site 3 is 2.5 km towards the northwest. Site 2 is the furthest from privately owned boreholes.
6	Reduced air quality from project emissions	2	2	1	Site 1 and 2 are further from the operational mining area and are thus likely to have a more significant impact on cumulative air quality. As such Site 3 is preferred.

	Criteria	Alternative Site Options			Discussion
	Aspect/ Impact	Site 1	Site 2	Site 3	
7	Increase in noise levels				Due to the general lack of sensitive receptors in the near vicinity, the noise impact from all three sites are assumed to be similar. There is no relative score difference.
8	Effect on roads due to project related traffic	3	3	1	Sites 1 and 2 will have the highest impact in terms of traffic on the N14 due to the need to transport Jarosite/ Jarofix across the road for storage/disposal. In addition, the related costs for transporting the Jarofix over the longer distance would be much higher.
9	Loss or damage to heritage and/or palaeontological resources				None of the proposed layout options would interfere with known existing heritage resources. There is no relative score difference.
10	Positive and negative socio-economic impacts				All three options have the potential to have positive and/or negative socio-economic impacts. There is no relative score difference.
11	Positive and negative impacts on community health				It is not likely that emissions from the smelter construction and operations would have distinguishable impacts based on the sites. There is no relative score difference. .
12	Impact on surrounding land uses				All options are within the MRA and are thus unlikely to have any distinguishable impact on surrounding land uses. There is no relative score difference.
	Total	**14**	**18**	**14**	**Site 1 and 3 are the preferred options.**

6.8 POSSIBLE MITIGATION MEASURES THAT COULD BE APPLIED AND THE LEVEL OF RESIDUAL RISK

A list of the potential impacts identified by SLR, the project specialists and/or raised by I&APs, as well as the possible management and mitigation measures, is provided in Table 6-22. The level of residual risk after management or mitigation, associated with the proposed project, is included.

Table 6-22 Mitigation Measures and Anticipated Level of Residual Risk

No.	Potential impact identified	Activity	Possible mitigation/ enhancement measures	Potential for residual risk
1	Change in groundwater levels	Construction related clearing. Additional surface infrastructure. Potential seepage from the secured landfill facility over time.	See management actions included under Appendix D Issue 1.	Very low - insignificant
2	Deterioration of groundwater quality	Potential spills from construction activities. Potential spills from operational activities. Potential seepage from the secured landfill facility over time.	See management actions included under Appendix D Issue 2.	Very low - insignificant
3	Contamination of surface water resources	Potential spills from construction activities. Potential spills from operational activities. Potential seepage from the secured landfill facility over time.	See management actions included under Appendix D Issue 3.	Medium - low
4	Flooding	Clearance of surface areas for the secured landfill facility and smelter complex. Construction of the secured landfill facility within 1:100 year flood line.	See management actions included under Appendix D Issue 4.	Medium
5	Alteration of natural drainage patterns	Clearance of surface areas for the secured landfill facility and smelter complex. Construction of the secured landfill facility and smelter complex.	See management actions included under Appendix D Issue 5.	Very low
6	Impact on vegetation and flora due to construction phase site clearance	Clearance of surface areas for secured landfill facility and smelter complex.	See management actions included under Appendix D Issue 6.	Medium
7	Impact on vegetation and flora due to construction-related dust	Clearance of surface areas for secured landfill facility and smelter complex. Earthworks on-site.	See management actions included under Appendix D Issue 7.	Low

No.	Potential impact identified	Activity	Possible mitigation/ enhancement measures	Potential for residual risk
		Movement of vehicles.		
8	Impact on fauna due to construction phase site clearance	Clearance of surface areas for secured landfill facility and smelter complex. Earthworks on-site. Movement of vehicles.	See management actions included under Appendix D Issue 8.	Medium
9	Impact on fauna due to construction phase noise and disturbance	Clearance of surface areas for secured landfill facility and smelter complex. Earthworks on-site. Movement of vehicles.	See management actions included under Appendix D Issue 9.	Low
10	Impact on vegetation due to dust deposition during operational phase	Movement of vehicles. Cumulative impact with mining activities.	See management actions included under Appendix D Issue 10.	Medium
11	Impact on vegetation due to increased air emissions (SO_2, NO_2, Pb and Zn) during operational phase	Emissions from the stacks during smelter operations. Vehicle emissions.	See management actions included under Appendix D Issue 11.	Medium
12	Impact on vegetation due to groundwater contamination in operational phase	Potential seepage from the secured landfill facility over time. Accidental spills during operational phase.	See management actions included under Appendix D Issue 12.	Low
13	Faunal impacts due to operational activities: dust, noise, and traffic	Movement of vehicles. Operational phase activities.	See management actions included under Appendix D Issue 13.	Low
14	Ecological impacts during decommissioning phase	Dismantling and removal of infrastructure. Movement of vehicles. Accidental spills during decommissioning phase.	See management actions included under Appendix D Issue 14.	Low
15	Change in ambient air quality	Potential human health impacts due to construction related activities.	See management actions included under Appendix D Issue 15.	Very low

No.	Potential impact identified	Activity	Possible mitigation/ enhancement measures	Potential for residual risk
		Potential human health impacts due to emissions from the smelter complex.		
16	Increase in ambient noise levels	Noise generated due to construction activities i.e. vehicle and machinery noise. Noise generated due to operational activities i.e. smelter operations and vehicle noise.	See management actions included under Appendix D Issue 16.	Very low
17	Loss of soil resources and land capability construction activities	Land clearance for the smelter complex and secured landfill facility. Long term storage of soils in stockpiles. Permanent sterilisation of areas due to the development of the secured landfill facility.	See management actions included under Appendix D Issue 17.	Low
18	Loss of soil resources due to contamination	Potential spills from construction activities. Potential spills from operational activities. Potential seepage from the secured landfill facility.	See management actions included under Appendix D Issue 18.	Low
19	Change in landscape and related visual impacts due to the smelter complex	Land clearance for the smelter complex and associated earthworks. Smelter complex infrastructure. Operational activities.	See management actions included under Appendix D Issue 19.	Medium – very low
20	Change in landscape and related visual impacts due to the secured landfill facility	Land clearance for the secured landfill facility and associated earthworks. Development of secured landfill facility. Operational activities.	See management actions included under Appendix D Issue 20.	High - medium
21	Impact of the project on climate change	Emissions from the Gamsberg Smelter Project and contribution to global and local carbon budget.	See management actions included under Appendix D Issue 21.	High - low
22	Impact of climate change on the project	Effect of changing local climate on operational activities.	See management actions included under Appendix D Issue 22.	High - low

No.	Potential impact identified	Activity	Possible mitigation/ enhancement measures	Potential for residual risk
23	Significance of project expenditure	Investment of Gamsberg Smelter Project in the local economy.	See management actions included under Appendix D Issue 23.	High (positive) – medium (positive)
24	Impacts on key macro-economic variables	Increased foreign exchange earnings. Balance-of-payments benefits resulting from import substitution. Increased tax revenues.	See management actions included under Appendix D Issue 24.	High (positive)
25	Impact on tourism	Increased spend in the local tourism economy.	See management actions included under Appendix D Issue 25.	Low – very low
26	Impacts on surrounding landowners and land uses	Construction phase activities. Operational phase activities.	See management actions included under Appendix D Issue 26.	Low – very low
27	Impacts on municipal finances	Net increases in rates and other income due to construction and operational phase activities.	See management actions included under Appendix D Issue 27.	Low (positive)
28	Road disturbance and traffic safety	Construction related vehicle movement. Increased traffic volumes due to movement of trucks carrying product and by-product from site.	See management actions included under Appendix D Issue 28.	Low
29	Damage to or disturbance of heritage (including cultural)	Clearance of surface areas for secured landfill facility and smelter complex. Earthworks on-site.	See management actions included under Appendix D Issue 29.	Very low
30	Damage to or disturbance of palaeontological resources	Clearance of surface areas for secured landfill facility and smelter complex. Earthworks on-site.	See management actions included under Appendix D Issue 30.	Very low
31	Employment creation, skills development and economic stimulus	Construction phase employment opportunities (direct and indirect). Operational phase employment opportunities.	See management actions included under Appendix D Issue 31.	Very high (positive)

No.	Potential impact identified	Activity	Possible mitigation/ enhancement measures	Potential for residual risk
32	Multiplier effect on the local and regional economy (construction phase)	Construction phase employment opportunities (direct and indirect).	See management actions included under Appendix D Issue 32.	High (positive)
33	Project-induced population influx	Construction phase employment opportunities (direct and indirect).	See management actions included under Appendix D Issue 33.	Low
34	Negative impacts related to the presence of construction workers	Construction phase employment opportunities (direct and indirect).	See management actions included under Appendix D Issue 34.	Very low
35	Community health, safety and security	Construction phase employment opportunities (direct and indirect).	See management actions included under Appendix D Issue 35.	Low

6.9 MOTIVATION WHERE NO ALTERNATIVE SITES WERE CONSIDERED

This section is not applicable as alternatives were assessed as part of the scoping process and are analysed in Table 6-20 and Table 6-21.

6.10 STATEMENT MOTIVATING THE PREFERRED ALTERNATIVE

All alternatives considered for the Gamsberg Smelter Project are included in Section 6.1, however, the assessment of the site for the smelter complex and the secured landfill facility are summarised in the following sections.

6.10.1 Smelter Complex Site

The major determining factors for the comparative site assessment were visual, proximity to constrained or irreplaceable vegetation types, groundwater, air quality and traffic as the impact from other environmental criteria was determined to be very similar for the three alternative sites and therefore not distinguishing factors (Table 6-20).

Based on the comparative assessment, the preferred site for the smelter complex is Site 3 (Figure 6-2) for the following reasons:

- Although all sites would be visible from the N14 and surrounding areas, Site 3 is assumed to be marginally less so due to the waste rock dumps and mine infrastructure in the background.
- Site 3 scored the best in terms of traffic impact due to its close proximity to the concentrator plant, thus requiring shorter distances for movement of concentrate and no need for crossing the N14.
- Air quality impacts due to the positioning of Site 3 closer to the centre of the mining area means that the cumulative impacts on air quality can be minimised.
- In terms of sensitive ecological areas, although located within a CBA1 area and close to a large calcrete gravel patch to the west, Site 3 does not infringe on the calcrete gravel patch as may be expected for Site 2. The site also has low abundance of plant SCCs, with only a few *Euphorbia braunsii* individuals and would therefore be preferred over Site 2.
- Site 3 although the closest to a privately owned borehole is not expected to have any impact (see Appendix D).
- In addition, in terms of proximity to the concentrator plant, from where concentrate would be transported to the smelter complex, Site 3 was the preferred choice.

When considering all the criteria, Site 3 is considered to be the preferred site for the smelter complex.

6.10.2 Secured Landfill Facility Site

The comparative assessment for the three alternative sites for the secured landfill facility is in Table 6-21. The major determining factors for the comparative site assessment were visual, proximity to constrained or irreplaceable vegetation type, ground and surface water, air quality and traffic as the impact from other environmental criteria was determined to be very similar for the three alternative sites and therefore not distinguishing factors.

Based on the comparative assessment, the preferred site for the secured landfill facility is Site 3 (Figure 6-2) for the following reasons:

- In terms of visual impact Site 1 is assessed to be the preferred alternative as the TSF in the background would minimise the visual impact.
- As with the smelter complex, Site 3 considered for the secured landfill facility is located in CBA1, is located adjacent (to the north) to a large calcrete gravel patch, is on the edge of an ephemeral stream

course or wash, is within a relatively ecologically productive area with deeper soils than the other alternatives (possibly due to its location at the edge of an ephemeral streamline or wash) and has a higher abundance of plant SCCs than Site 2. From an ecological perspective this site is not ideal for the secured landfill facility, however, it is considered more acceptable than Site 2.

- Site 3 in terms of groundwater is the closest to a privately owned borehole, however, according to modelling undertaken (Appendix E) no privately owned boreholes would be impacted on by groundwater contamination.
- Site 3 falls within the 1:100 year flood line of the ephemeral stream running from north to south across the MRA, however, with mitigation measures put in place the impact can be minimised.
- The distinguishing factor is the relatively higher costs of transporting the jarosite to Site 1 or 2 as well as the potential traffic impacts on the N14 should the jarosite require to be transported across the highway, rendering Site 3 as the preferred site.

Site 3 is thus considered to be the preferred site for the secured landfill facility. However, due to the proximity of Site 3 to both constrained and irreplaceable vegetation types, strict mitigation measures will need to be put in place to avoid additional impact on these areas.

7. FULL DESCRIPTION OF THE PROCESS UNDERTAKEN TO IDENTIFY IMPACTS

7.1 DESCRIPTION OF THE PROCESS UNDERTAKEN TO IDENTIFY IMPACTS

Environmental and socio-economic impacts associated with the project were identified through site visits undertaken by SLR and various specialists, consideration of the project description, site layout and the specialist studies. As part of the public participation process, I&APs (Section 6.2) were given an opportunity to provide input to the project at the public open day sessions and focussed meetings, and through the review of the BID, advertisements, site notices and the Draft Scoping Report. I&APs will be given a further opportunity to provide input through the review of the EIA Report and/or summary. The feedback received from I&APs also provided input into the identification of environmental and socio-economic issues to be assessed.

7.2 DESCRIPTION OF THE PROCESS UNDERTAKEN TO ASSESS AND RANK THE IMPACTS AND RISKS

A description of the assessment methodology used to assess the severity of identified impacts (including the nature of impacts and the degree to which impacts may cause irreplaceable loss of resources), the extent of the impacts, the duration and reversibility of impacts, the probability of the impact occurring, and the degree to which the impacts can be mitigated is provided in Section 6.6.

7.3 A DESCRIPTION OF THE ENVIRONMENTAL IMPACTS AND RISKS IDENTIFIED DURING THE ENVIRONMENTAL ASSESSMENT PROCESS

A description of the environmental impacts and risks identified during the EIA is included in Section 8 and Appendix D.

7.4 ASSESSMENT OF THE SIGNIFICANCE OF EACH IMPACT AND RISK AND AN INDICATION OF THE EXTENT TO WHICH THE ISSUE AND RISK CAN BE AVOIDED OR ADDRESSED BY THE ADOPTION OF MANAGEMENT ACTIONS

The assessment of the significance of potential impacts, including the extent to which impacts can be avoided or mitigated, is included in Section 8 and Appendix D.

8. ASSESSMENT OF EACH POTENTIALLY SIGNIFICANT IMPACT AND RISK

A summary of the assessment of the biophysical and socio-economic impacts associated with the proposed project is provided in Table 8-1 below. A full description of the assessment is included in Appendix D.

Table 8-1 Assessment of Significant Impacts and Risks

#	Activity	Potential impact	Aspects affected	Phase	Unmitigated impact rating					Management actions type	Mitigated impact rating					Extent to which the impact can be reversed, avoided or cause irreplaceable loss and the degree to which the impact and risk can be mitigated	Cumulative and latent impact
					Intensity	Duration	Spatial scale	Probability	Significance		Intensity	Duration	Spatial scale	Probability	Significance		
1	• Construction related clearing. • Additional surface infrastructure.	Change in groundwater levels	Groundwater	Construction	L	L	VL	H	VL	• Containment of contaminated water. • Implementation of storm water controls. • Continuation of the mine and regional groundwater monitoring plan.	L	L	VL	L	VL	• Fully reversed • Unlikely to cause irreplaceable loss. • Can be managed/ mitigated to acceptable levels.	No cumulative impact or additional latent impacts have been identified.
	• Changes to runoff from the surface due to hardstanding areas etc.	Change in groundwater levels due to smelter complex	Groundwater	Operational	VL	H	VL	M	L	• Implementation of storm water controls. • Continuation of the mine and regional groundwater monitoring plan.	L	H	VL	L	VL	• Largely reversed • Unlikely to cause irreplaceable loss. • Can be managed/ mitigated to acceptable levels.	No cumulative impact or additional latent impacts have been identified.
		Change in groundwater levels due to smelter complex	Groundwater	Decommissionin g	VL	VH	VL	M	L	• Remediation and rehabilitation of the footprint areas. • Continuation of the mine and regional groundwater monitoring plan.	Insignificant					• Largely reversed • Unlikely to cause irreplaceable loss. • Can be managed/ mitigated to acceptable levels.	Insignificant
	• Potential seepage from the secured landfill facility over time. • Changes to surface runoff	Change in groundwater levels due to secured landfill facility	Groundwater	Operational	L	H	VL	VH	L	• Containment of contaminated water and runoff via collection trenches and pollution control dam. • Implementation of storm water controls. • Installation of Class A liner in secured landfill facility. • Continuation of the site and regional groundwater monitoring plan.	L	H	VL	L	VL	• Low potential for reversibility during operational phase. • Unlikely to cause irreplaceable loss. • Can be managed/ mitigated to acceptable levels.	No cumulative impact or additional latent impacts have been identified.
		Change in groundwater levels due to secured landfill facility	Groundwater	Closure	L	VH	VL	H	L	• Cap filled cells during operational life. • Installation of Class A liner in secured landfill facility. • Continuation of the site and regional groundwater monitoring plan. • Remediation and rehabilitation of the footprint areas.	L	VH	VL	L	VL	• Can largely be reversed post rehabilitation. • Unlikely to cause irreplaceable loss. • Can be managed/ mitigated to acceptable levels.	No cumulative impact or additional latent impacts have been identified.

#	Activity	Potential impact	Aspects affected	Phase	Unmitigated impact rating					Management actions type	Mitigated impact rating					Extent to which the impact can be reversed, avoided or cause irreplaceable loss and the degree to which the impact and risk can be mitigated	Cumulative and latent impact
					Intensity	Duration	Spatial scale	Probability	Significance		Intensity	Duration	Spatial scale	Probability	Significance		
2	• Potential spills from construction activities.	Deterioration of groundwater quality	Groundwater	Construction	L	L	VL	H	VL	• Implement mine Incident management operating procedure to reduce impact of potential spills. • Continuation of the site and regional groundwater monitoring plan. • Good housekeeping practices on-site. • Good waste management practices on-site.	L	L	VL	L	VL	• Fully reversed • Unlikely to cause irreplaceable loss. • Can be managed/ mitigated to acceptable levels.	Cumulative impacts are predicted to be VERY LOW.
	• Potential spills from operational activities.	Deterioration of groundwater quality due to smelter complex	Groundwater	Operational	VL	H	VL	M	L	• Implement hazardous reagents and materials procedure to prevent spillage. • Implement current mine Incident management operating procedure to reduce impact of potential spills. • Smelter complex infrastructure, should be constructed and operated so as to comply with the NWA guidelines.	Insignificant					• Can largely be reversed post rehabilitation. • Unlikely to cause irreplaceable loss. • Can be managed/ mitigated to acceptable levels.	Insignificant
	• Potential spills from decommissioning activities.	Deterioration of groundwater quality due to smelter complex	Groundwater	Decommissionin g	VL	VH	VL	M	L	• Implement hazardous reagents and materials procedure to prevent spillage. • Implement mine Incident management operating procedure to reduce impact of potential spills. • Remediation and rehabilitation of the footprint areas. • Continuation of the site and regional groundwater monitoring plan. • Update the numerical groundwater model and use as a predictive tool.	Insignificant					• Can largely be reversed post rehabilitation. • Unlikely to cause irreplaceable loss. • Can be managed/ mitigated to acceptable levels.	Insignificant
	• Potential spills from operational activities. • Potential seepage from the secured landfill facility over time.	Deterioration of groundwater quality due to secured landfill facility	Groundwater	Operational	M	H	VL	H	M	• Implement current mine Incident management operating procedure to reduce impact of potential spills. • Comply with the NWA guidelines. • Remediation and rehabilitation of the footprint areas. • Update the numerical groundwater model and use as a predictive tool. • Construction of the secured landfill facility with a Class A liner. •	L	H	VL	L	VL	• Cannot be reversed. • Moderate potential for irreplaceable loss of resource. • Can be managed/ mitigated to acceptable levels.	Cumulative impact is assessed to be LOW provided mine plan remains as is.
	• Potential seepage from the secured landfill facility over time.	Deterioration of groundwater quality due to secured landfill facility	Groundwater	Closure	M	H	VL	H	M	• . • Implementation of the site specific rehabilitation plan. • Continuation of the site and regional groundwater monitoring plan. • Update the numerical groundwater model and use as a predictive tool.	L	H	VL	L	VL	• Cannot be fully reversed. • Moderate potential for irreplaceable loss of resource. • Can be managed/ mitigated to acceptable levels.	Cumulative impacts are predicted to be VERY LOW.