Terrestrial Biodiversity

Vegetation Types & Plant Communities

Broad-Scale Vegetation Types

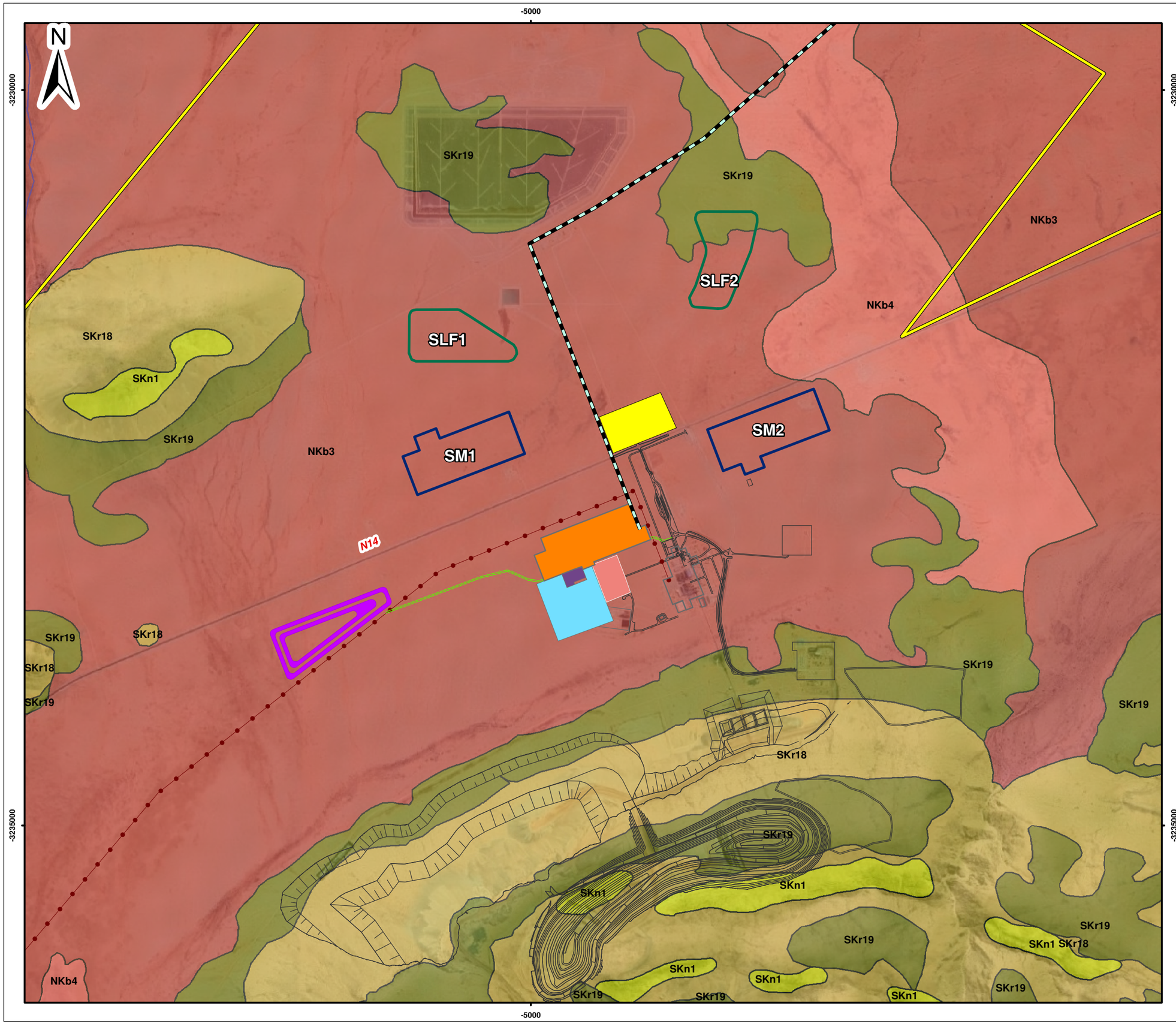
There are several national vegetation types in the broader study area (Figure 6-8), however, only Bushmanland Arid Grassland and Aggeneys Gravel Vygieveld fall within the Gamsberg Smelter Project's area of influence. Bushmanland Arid Grassland is an extensive vegetation type; the second most extensive vegetation type in South Africa, occupying an area of 45,478 km^2. Due to the arid nature of the unit, which receives between 70 and 200 mm annual rainfall, it has not been significantly impacted by intensive agriculture and more than 99% of the original extent of the vegetation type is still intact. Mucina and Rutherford (2006) list six endemic species for the vegetation type, which is a relatively low number given the extensive nature of the vegetation type.

Aggeneys Gravel Vygieveld occurs on the foothills and peneplains of inselbergs in northern Bushmanland scattered between Pofadder and Aggeneys and a little further westwards to the edges of the Namaqualand granite hill ridges. This unit occurs on flat or slightly sloping plains with a distinctly white surface layer of quartz pebbles on reddish soils. It supports sparse low-growing vegetation dominated by small to dwarf leaf-succulents of the families *Aizoaceae*, *Crassulaceae*, *Euphorbiaceae*, *Portulaceae* and *Zygophyllaceae*. Although this is not a threatened vegetation type, it has an extent of only 62 km^2 and reportedly (Mucina & Rutherford 2006) has 17 endemic species which is a very high number for such a small vegetation unit. Due to the presence of numerous endemic and specialised species associated with this vegetation type, it is considered to represent irreplaceable habitat. The presence of these local endemic flora species is a key basis for the identification of the entire Gamsberg area as a Critical Biodiversity Area (CBA).

Fine-Scale Habitats and Plant Communities

Desmet (2013) identified and delineated a number of habitat units as depicted in Figure 6-9. In the Aggeneys Gravel Vygieveld vegetation type, six habitat units were mapped: four occurring in the Gamsberg Zinc Mine study area are Mountain Plateau, Plains Quartz Gravel patches; Plateau Quartz Gravel patches and Plains Intermediate Quartz Gravel patches. Two additional units that occur to the east of the study area include Feldspar Gravel patches and Rocky Plains.

The Plains Quartz Gravel patches habitat occurs in the vicinity of the Gamberg Smelter Project although the smelter site itself comprises sandy plains habitat (Figure 6-9). According to Desmet (2013) the surface of quartz gravel patches is characterised by a fairly uniform and dense layer (lag) of small quartz pebbles with rock and boulders absent or in low density. Quartz patches can be divided into plateau patches or fine-grained quartz patches with a dense pebble covering of often very small (<5 mm diameter) and brilliant white pebbles. Plains Quartz patches occur mainly on the lower foot slopes of larger inselbergs; and Intermediate Quartz patches appear physically similar to the other quartz patches but are devoid of any of the characteristic plant species. Quartz Gravel patches are always found in association with quartz or quartzite rocks. While a number of succulent plant species occur in this habitat unit, the only species restricted to plains Quartz Gravel patches and which do not occur on the plateau are the diminutive annual succulent, *Mesembryanthemum inachabense*, and *Conophytum angelicae* (Desmet 2013).



Legend

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

Proposed Infrastructure

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

Alternatives

- Alternative Secured Landfill Site
- Alternative Smelter Complex Locations

Vegetation Areas (2018)

- NKb 3 Bushmanland Arid Grassland
- NKb 4 Bushmanland Sandy Grassland
- SKn 1 Namaqualand Klipkoppe Shrubland
- SKr 18 Bushmanland Inselberg Shrubland
- SKr 19 Aggeneys Gravel Vygieveld

0 400 800 Meters

Scale: 1:23 500 @ A3

Projection: Transverse Mercator
Datum: WGS1984, Lo23

Gamsberg Smelter Project

Figure 6-8

Broad-Scale overview of the Vegetation In and Around the Gamsberg Zinc Mine. The Vegetation map is Based on the 2018 National Vegetation Map. (SANBI, 2018)

SLR Consulting (Africa) (Pty) Ltd
P O Box 1596, Cramerview, 2060, South Africa
Tel: +27 (11) 467-0945 Fax: +27 (11) 467-0978

720.22013.00002 | 2020/09/23

-5000

-3230000

N

SLF1

SLF2

SM1

SM2

N14

-3235000

-5000

Fine Scale Vegetation Types

- Calcrete Patch - S Todd, 2020

Aggeneys Gravel Vygieveld
- Mountains Plateau
- Rocky Plains
- Plains Quartz Gravel Patches
- Plateau Quartz Gravel Patches
- Plains Intermediate Quartz Gravel Patches

Bushmanland Inselberg Shrubland
- Mountains

Bushmanland Inselberg Succulent Shrubland
- Bushmanland Inselberg Succulent Shrubland

Bushman Arid Grassland
- Hummocky Sandy Plains
- Flat Sandy Plains
- Calcrete Gravel Patches

Azonal
- Wash
- Kloof

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
- Switch Yard
- Smelter Complex Footprint (Preferred)
- Secured Landfill Site (Preferred)

Alternatives
- Alternative Secured Landfill Site
- Alternative Smelter Complex Locations

0 400 800 Meters

Scale: 1:23 500 @ A3

Projection: Transverse Mercator
Datum: WGS1984, Lo23

Gamsberg Smelter Project

Figure 6-9

Fine Scale Vegetation Types in the Gamsberg Area (Note the hatched Calcrete Gravel patches to the east and west of the Smelter)

SLR Consulting (Africa) (Pty) Ltd
P O Box 1596, Cramerview, 2060, South Africa
Tel: +27 (11) 467-0945 Fax: +27 (11) 467-0978

720.22013.00002

2020/09/23

Desmet (2013) identified three different habitat units within the Bushmanland Arid Grassland vegetation type namely, Plains Sand Flats (Bushmanland Flat Arid Grassland), Plains Hummocky (Bushmanland Hummock Arid Grassland) and Plains Gravel Calcrete. Apart from the Plains Gravel Calcrete, these habitat units do not have diverse plant communities and generally contain few Species of Conservation Concern (SCC).

The Plains Gravel Calcrete patches (Figure 6-10) are considered unique and contain several taxa not found elsewhere including *Brownanthus divaricata, Drosanthemum hispidum, Kleinia longiflora, Pteronia divaricata, Cucumis rigidus, Euphorbia gariepina, Euphorbia mauritanica, Euphorbia spinea, Sarcocaulon crassicaule, Avonia albissima, Ceraria fruticulosa, Zygophyllum cf. decumbens* as well as several endemic species restricted to these Calcrete Gravel patches such as *Titanopsis hugo-schlechteri, Crassula mesembrianthemopsis, Anacampseros bayeriana, Lithops julii subsp. fulleri var. fulleri,* and *Ruschia aff. divaricata* (Desmet 2013).

Figure 6-10 Plains Gravel Calcrete patch north of the N14, in the vicinity of secured landfill facility Alternative 2

Indigenous Flora Species

Typical and dominant species in the smelter complex footprints include *Eriocephalus* sp., *Pteronia unguiculata*, *Rhigozum trichotomum*, *Stipagrostis brevifolia*, *S.obtusa* and *Ebracteola fulleri*. Notable species confirmed during the January 2020 survey comprised six species, all of which are protected in the Northern Cape (Table 6-6, Figure 6-10 and Figure 6-11). Several individuals of three of these species were commonly found in the selected smelter complex and secured landfill facility footprints: *Euphorbia braunsii, Hoodia gordonii,* and *Aloidendron dichotomum* (Quiver Tree), none of which are considered uncommon or rare in the Project Area.

Table 6-6: Plant species confirmed during the January 2020 survey in the Gamsberg Smelter Project area and alternative sites

Species	Status	Habitat Unit	Location
Titanopsis hugo-schlechteri	NC Protected	Calcrete Gravel Plains	SLF 2
Avonia papyracea subsp. *papyracea*	NC Protected	Calcrete Gravel Plains	SLF 2
Boscia foetida subsp. *foetida* (Stink Shepherd's Tree)	NC Protected	Calcrete Gravel Plains	SLF 2
Euphorbia braunsii	NC Protected	Flat Sandy Plains	SLF 3, SM 3
Hoodia gordonii	Data Deficient NC Protected	Flat Sandy Plains	SLF 3
Aloidendron dichotomum (Quiver Tree)	Vulnerable NC Protected	Flat Sandy Plains	SLF 3 (many) SLF 1 (few)
Titanopsis hugo-schlechteri	NC Protected	Calcrete Gravel Plains	SLF 2

Figure 6-11 *Titanopsis hugo-schlechteri* and *Avonia papyracea* subsp. papyracea observed at SLF Alternative 2 (SLF2)

Figure 6-12 Notable species observed within Secured Landfill Facility Alternative 3 includes *Hoodia gordonii*, *Euphorbia braunsii* and *Aloidendron dichotomum* (VU)

Earlier surveys in the Calcrete Gravel patches to the south of the preferred secured landfill facility and to the east of the proposed location of the smelter complex by Desmet (2013) recorded the following floral species: *Titanopsis hugo-schlechteri, Crassula mesembrianthemopsis,* and *Lithops julii* subsp. *fulleri;* all endemic to the region and restricted to Calcrete Gravel patches. Additional species confirmed in the vicinity of the smelter complex to the east include *Avonia quinaria subsp alstonii* in quartz gravel plains*,* and *Euphoriba friedrichiae. Titanopsis hugo-schlechteri* and *Crassula mesembrianthemopsis* are considered Vulnerable and have an estimated distribution range of less than 1 000 km^2. Calcrete Gravel patches are considered to be of high conservation concern and evaluated as irreplaceable due to the presence of restricted-range species.

Alien Plants

Alien plant species abundance at the site was low. This can partly be ascribed to the prevailing drought conditions as well as an actual low abundance of such species within the site. The major species of concern in this regard is the alien invasive tree *Prosopis glandulosa* and its' various hybrids which is common in the area and tends to invade along drainage lines and more generally in areas with deeper soils. This species is not seen as a current threat in the immediate area of the Gamsberg Zinc Mine.

Faunal Communities

Mammals

The mammalian community at the project site is likely to be of moderate diversity. Although more than 50 species of terrestrial mammals are known from the wider area, the habitat diversity of the project site is low and would not support a very wide range of mammals. Species that can be confirmed present in the proposed Gamsberg Smelter Project area based on camera trapping and previous site visits to the area include Leopard (*Panthera pardus*), Caracal (*Caracal caracal*), Black-backed Jackal (*Canis mesomelas*), African Wildcat (*Felis silvestris*), Cape Fox (*Vulpes chama*), Chacma Baboon (*Papio ursinus*), Rock Hyrax (*Procavia capensis*), South African Ground Squirrel (*Xerus inauris*), Steenbok (*Raphicerus campestris*), Common Duiker (*Sylvicapra grimmia*), Springbok (*Antidorcas marsupialis*), Gemsbok (*Oryx gazella*), Cape Porcupine (*Hystrix africaeaustralis*), Yellow Mongoose (*Cynictis penicillata*), Cape Grey Mongoose (*Herpestes pulverulentus*), Small-spotted Genet (*Genetta genetta*), Striped Polecat (*Ictonyx striatus*), Cape Hare (*Lepus capensis*), Smiths's Red Rock Rabbit (*Pronolagus rupestris*), Springhare (*Pedetes capensis*), Aardvark (*Orycteropus afer*), Aardwolf (*Proteles cristata*), Round-eared Elephant Shrew (*Macroscelides proboscideus*), Western Rock Elephant Shrew (*Elephantulus rupestris*), Namaqua Rock Mouse (*Aethomys namaquensis*), Pygmy Rock Mouse (*Petromyscus collinus*) and Hairy-footed Gerbil (*Gerbillurus paeba*). The open plains which characterise the majority of the proposed Gamsberg Smelter Project area are likely to be dominated by species associated with open hard or sandy ground such as various gerbils including the Hairy-footed Gerbil, Cape Hare, Steenbok, Cape Fox, Bat-eared Fox (*Otocyon megalotis*), Aardvark and Aardwolf. There are also burrows of Ground Squirrels and Yellow Mongoose at the site and these appear to be the most common fauna within the affected area.

No bats were observed during the January 2020 survey. A previous survey by GroundTruth (2013) which included mist-netting and bat acoustic monitoring detected only one bat - Darling's Horseshoe Bat (*Rhinolophus darling*) - classed as Least Concern by IUCN (IUCN 2017). Bats are likely to be restricted to the vicinity of the inselberg where they can shelter in rock crevices or caves and have access to water while some individuals may only fly over the gravel plains area for foraging.

Three Red-listed species have been confirmed or may occur in the broader area, the Black-footed cat (*Felis nigripes*) (Vulnerable), Brown Hyaena (*Hyaena brunnea*) (NT) and Leopard (*Panthera pardus*) (Vulnerable). Given the existing levels of anthropogenic disturbance at the site, it is not likely that these three species will remain active in close proximity to the mine and the proposed Smelter Project footprint. However, leopard have been recorded at the Gamsberg kloof and Achab farm.

Reptiles

Although reptile diversity in the broader area is high with as many as 60 species known from the area[5], a much smaller subset of these is likely to be present within the site. A total of 24 species have previously been recorded from the site according to the previous studies conducted for the Gamberg Zinc Mine ESIA. Species observed during the current field assessment or within the study area previously, are typical of the area and include Verrox's Tent Tortoise (*Psammobates tentorius verroxii*), Western Rock Skink (*Trachylepis sulcata sulcate*), Western Three-striped Skink (*Trachylepis occidentalis*), Namaqua Sand Lizard (*Pedioplanis namaquensis*), Spotted Desert Lizard (*Meroles suborbitalis*), Southern Rock Agama (*Agama atra*) and Plain Sand Lizard (*Pedioplanis inornata*).

No snakes were observed during the January 2020 site visit, although species likely to occur include Black Spitting Cobra (*Naja nigricincta*) and Cape Cobra (*Naja nivea*). The Desert Mountain Adder (*Bitis xeropaga*) was confirmed in 2012 and is a range-restricted endemics confined to the lower Gariep River and adjacent regions, and is restricted to rocky, mountainous habitat and therefore unlikely to occur on the flat sandy plains. Conditions at the time of the site visit were relatively poor for reptiles as a result of the prolonged drought and the depressing effect this is likely to have had on local reptile populations. There are only two Red-listed species recorded from the area, Good's Gecko (*Pachydactylus goodi*) (VU) and the Speckled Padloper (*Homopus signatus*) (VU).

Amphibians

Eight frog species are known from the area around the site (Appendix 6). This is likely an overestimate of the number of amphibian species present within the Gamsberg Inselberg where there is a spring and kloof. However, there is no natural perennial water in or near the open plains which characterise the current potential development areas of the proposed Gamsberg Smelter Project. The only species likely to be present within the affected area would be species that are relatively independent of water such as the Karoo Toad (*Vandijkophrynus gariepensis*) and the Paradise Toad (*Vandijkophrynus robinsoni*). The ephemeral drainage lines present in the area are likely to be the most important areas for amphibians, but given the extreme drought conditions which characterise the area, there are not likely to be any parts of the site that are of high importance for amphibians.

Avifauna

The most commonly recorded species at the site includes the Chat Flycatcher (*Melaenornis infuscatus*), Karoo Chat (*Cercomela schlegelii*), and Anteating Chat (*Myrmecocichla formicivora*). Other typical and characteristic species include Spike-heeled Lark (*Chersomanes albofasciata*) and Tractrac Chat (*Emarginata tractrac*). Although the near-threatened Karoo Korhaan (*Eupodotis vigorsii*) was observed in the area, it was not observed in close proximity to the proposed Gamsberg Smelter Project footprint. The near-threatened Sclater's Lark *Spizocorys sclateri* is also present in the area, but no observations were made in the vicinity of the current site. Raptors observed in the general area include the Endangered Martial Eagle *Polemaetus bellicosus,* Black-chested Snake-eagle *Circaetus pectoralis*, Verreaux's Eagle *Aquila verreauxii* and Jackal Buzzard *Buteo rufofuscus*, suggesting that large raptors are still relatively common in the area and are likely using the affected plains of the site for foraging. Although the endemic Red Lark *Calendulauda burra* (Red-listed as Vulnerable), is present in the wider area, it was not observed in close proximity to the site due to the lack of suitable red dune habitat near the Project Area.

Red-listed species which occur in the wider area include Martial Eagle (*Polemaetus bellicosus*) (Endangered), the endemic Red Lark (*Calendulauda burra*) (Vulnerable), Verreaux's Eagle (*Aquila verreauxii*) (Vulnerable), Lanner Falcon (*Falco biarmicus*) (Vulnerable), Secretarybird (*Sagittarius serpentarius*) (Vulnerable), and the near-endemic Sclater's Lark (*Spizocorys sclateri*) (Near-threatened). The Lanner Falcon (*Falco biarmicus*) has a high probability of occurring within the affected area, while Secretarybird has a low probably of occurrence, based on SABAP2 reporting. Verreaux's Eagles (*Aquila verreauxii*) are confirmed present on the Gamsberg Plateau with nesting sites present on the cliffs along the kloof. These species, including the Secretarybird (*Sagittarius*

[5] ReptileMap 2020 http://sarca.adu.org.za/

serpentarius), have large home ranges and are thus unlikely to be affected by the proposed Gamsberg smelter complex and secured landfill facility.

Critical Biodiversity Areas

CBAs are areas required to meet biodiversity targets for ecosystems, species and ecological processes, as identified in a systematic biodiversity plan[6]. Most provinces have developed, or are in the process of developing, maps of CBAs and Ecological Support Areas (ESAs) in the form of provincial spatial biodiversity plans. A map of the Critical Biodiversity Areas (CBAs) in the proposed Gamsberg Smelter Project area is depicted in Figure 6-13. CBAs are areas that have been identified as being essential for meeting biodiversity targets for the protection or retention of specific ecosystems. Two categories of CBAs are defined (CBA1 and CBA2), as well as ESAs and Other Natural Areas (ONAs).

CBA1 sites are considered 'irreplaceable' and are required for meeting South Africa's biodiversity targets and there are no or few other options for meeting biodiversity targets for features associated with these areas. As such, development within such areas is likely to result in an irreplaceable loss of biodiversity, contrary to the NEMA principles. Development within CBA1 which may impact on the ecological features, processes or condition should be avoided. CBA2 units are also required to meet conservation targets for biodiversity features or ecological processes but offer more flexibility for development than CBA1 units.

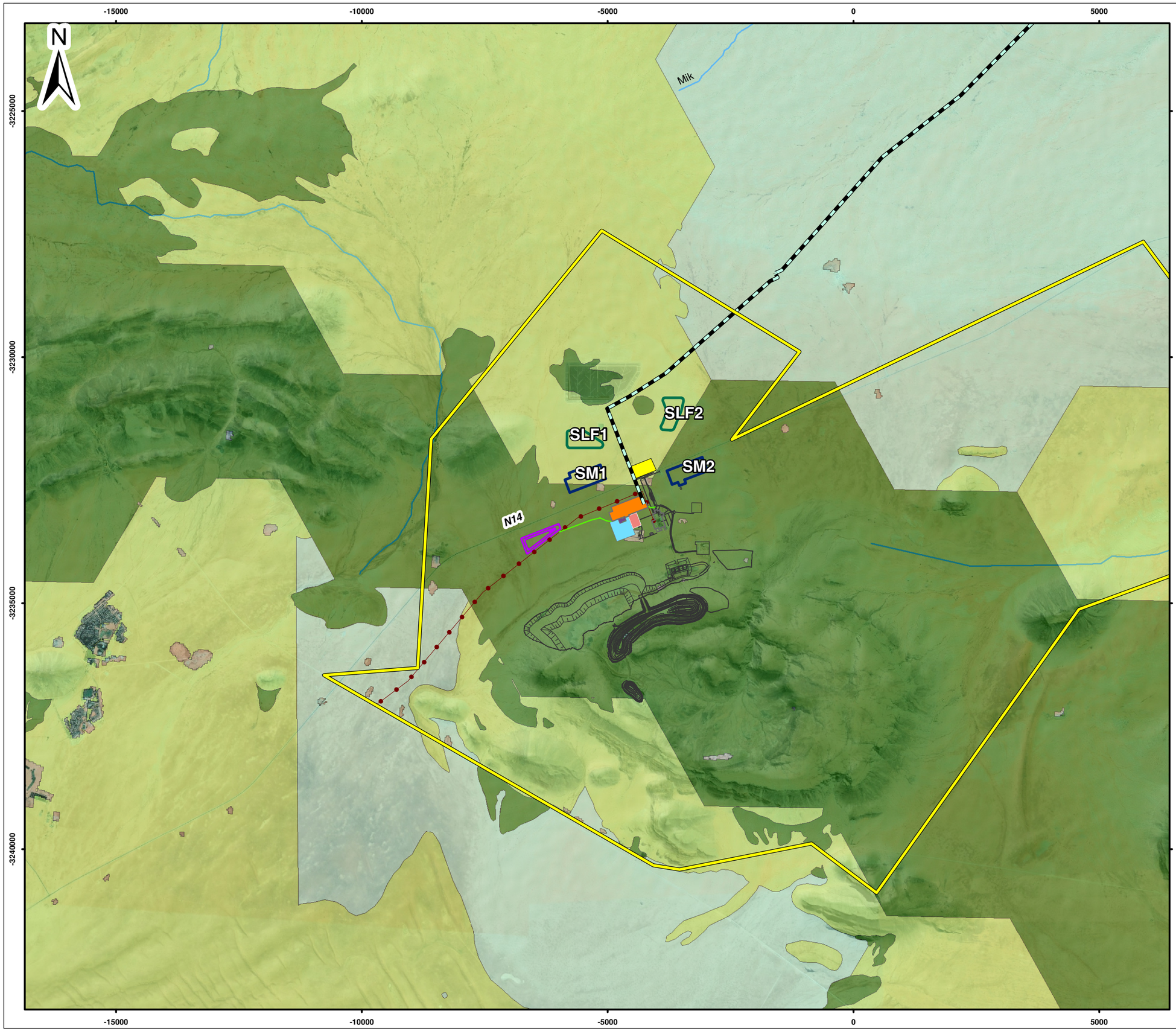
The proposed Gamsberg Smelter Project development footprint and the existing Gamsberg Zinc Mine lies almost entirely within an area designated as a CBA1 while the area to the north of the N14 is designated as CBA2. The designation of the Gamsberg area as a CBA1 is largely based on the presence of localised habitat types and range-restricted flora. Within the CBA1 unit around Gamsberg there are specific habitat units, such as the calcrete gravel patches, that are of higher conservation importance (and considered 'irreplaceable') than the adjacent extensive areas of flat sandy plains.

Although the mine has had to implement a biodiversity offset, habitats such as the calcrete gravel patches are considered irreplaceable and not-offsettable as species of high conservation concern in these habitats are not well-represented elsewhere.

Habitat Modification

Habitats within the footprint of the proposed Gamsberg Smelter Project components are considered largely natural, affected mainly by historical grazing and more recently by dust from the adjacent mining operations on the Gamsberg Inselberg. It is possible that succulent plants in the wider area around Aggeneys may be targeted for illegal collection. Future threats to habitats are expected to occur in the wider area from the expansion of renewable energy projects which may have a significantly greater footprint of between 2 000 and 6 000 ha over time, considerably increasing the risk of cumulative negative impacts.

[6] http://biodiversityadvisor.sanbi.org/industry-and-conservation/biodiversity-in-the-urban-economy/understand/definitions-related-to-urban-land-use-planning/critical-biodiversity-areas-and-ecological-support-areas/ - Accessed 17 September 2020



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
- Switch Yard
- Smelter Complex Footprint (Preferred)
- Secured Landfill Site (Preferred)

Alternatives

- Alternative Secured Landfill Site
- Alternative Smelter Complex Locations

Critical Biodiversity Areas

- Critical Biodiversity Area (CBA1)
- Critical Biodiversity Area (CBA2)
- Ecological Support Area (ESA)
- Other Natural Areas (ONA)

0 600 1 200 Meters

Scale: 1:75 200 @ A3

Projection: Transverse Mercator
Datum: WGS1984, Lo23

Gamsberg Smelter Project

Figure 6-13

Critical Biodiversity Areas (Holness & Oosthuysen 2016) Map for the Study Area, Showing that the Majority of Infrastructure Lies Within Areas Classified as CBA1

SLR Consulting (Africa) (Pty) Ltd
P O Box 1596, Cramerview, 2060, South Africa
Tel: +27 (11) 467-0945 Fax: +27 (11) 467-0978

720.22013.00002	2020/09/23

Air Quality

Air Quality Sensitive Receptors

Potential sensitive receptors within the project area include individual homesteads, residential areas (i.e. Aggeneys), areas of industrial activities, recreational areas and sensitive biodiversity as discussed in previous section (Figure 6-14).

Ambient Air Quality within the Region

Ambient Particulate Concentrations

Ambient PM_{10} sampling was undertaken at the site during 2018 and 2019 by the mine. The location of the PM_{10} sampling points is provided in **Error! Reference source not found.**. A summary of ambient PM_{10} concentrations measured at the GB Mining Offices, GB South Access, Aggeneys Highschool, GB Camp and GB NW is provided in Table 6-7.

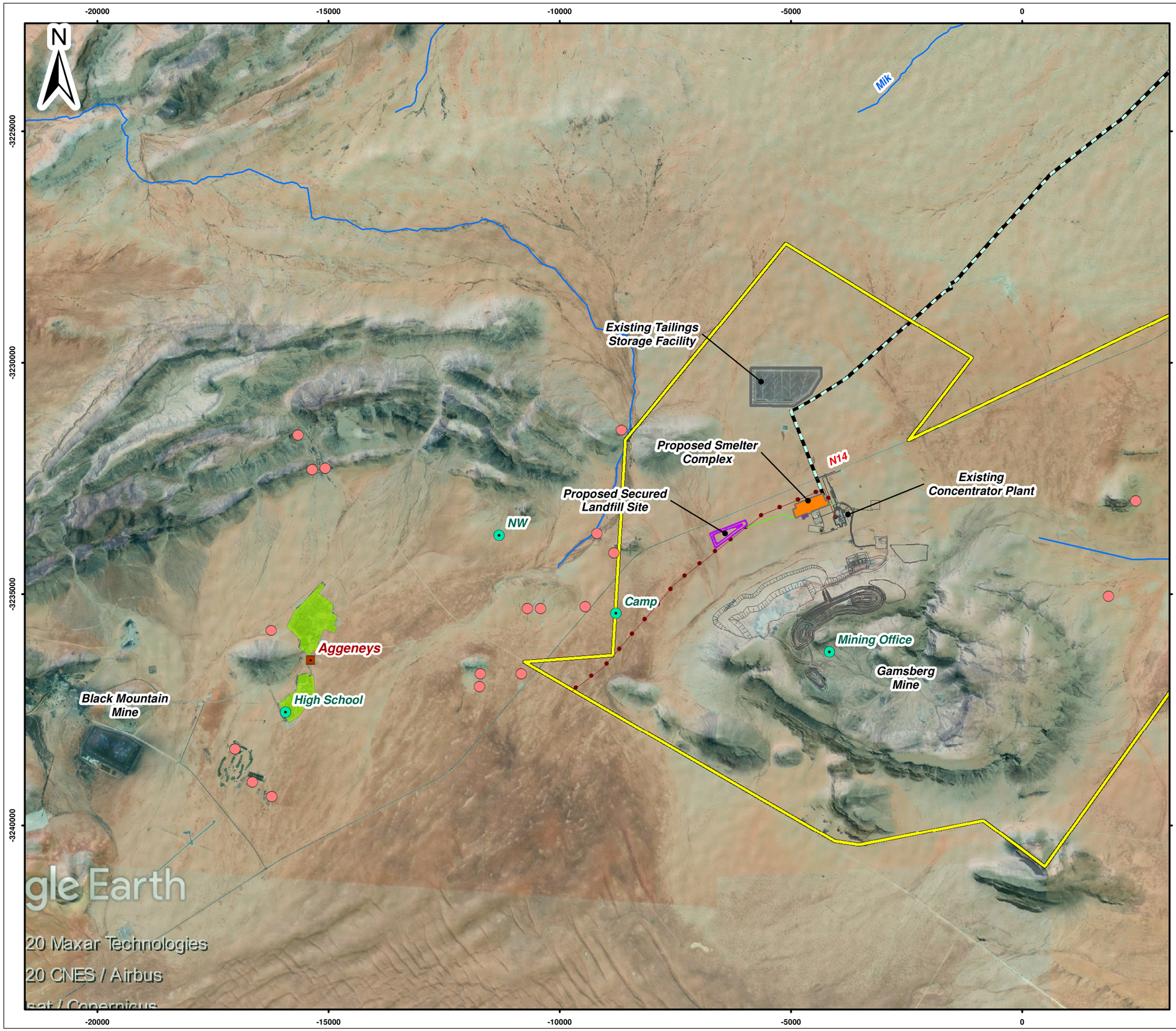
The GB NW site could be classified as a background site (representative of natural desert windblown dust). The daily PM_{10} concentrations were 21 µg/m³ (99th percentile). It should be noted that the daily PM_{10} National Ambient Air Quality Standards (NAAQS) at this site was exceeded three times during the sampling period and the data availability was only 58%.

Table 6-7 Summary of the Ambient Particulate Measurements in the Study Area (Units: µg/m^3)

Pollutant	Availability (%)	Daily				No of recorded exceedances
		Max	99th Percentile	90th Percentile	50th Percentile	
GB Mining Offices (January - May 2018)						
PM_{10}	100	273.5	39.0	11.3	2.2	12
GB South Access (January - June 2018)						
PM_{10}	96	50.6	7.4	2.1	0.3	0
Aggeneys High School, South Village (January - September 2019)						
PM_{10}	97	564.5	23.0	9.0	2.7	5
GB Camp (January - September 2019)						
PM_{10}	98	337.0	27.8	11.5	3.5	7
GB NW (January - September 2019)						
PM_{10}	58	498.0	21.0	8.5	0.0	3

Dust Fallout

Sampled dust fallout data for 14 single dust buckets was provided for the assessment by Black Mountain Mining (Pty) Ltd (2020). The dustfall classification and location (where available) is given in Table 6-8. The measured dust fallout for the period January 2018 to April 2019 is provided in Figure 6-15 and Table 6-8.



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
- PM10 Sampling Locations

0 1 000 2 000 Meters

Scale: 1:69 700 @ A3

Projection: Transverse Mercator
Datum: WGS1984, Lo23

Gamsberg Smelter Project

Figure 6-14

Location of Potentially Sensitive Human Receptors to Air Quality Impacts

SLR Consulting (Africa) (Pty) Ltd
P O Box 1596, Cramerview, 2060, South Africa
Tel: +27 (11) 467-0945 Fax: +27 (11) 467-0978

720.22013.00002	2020/09/23

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							

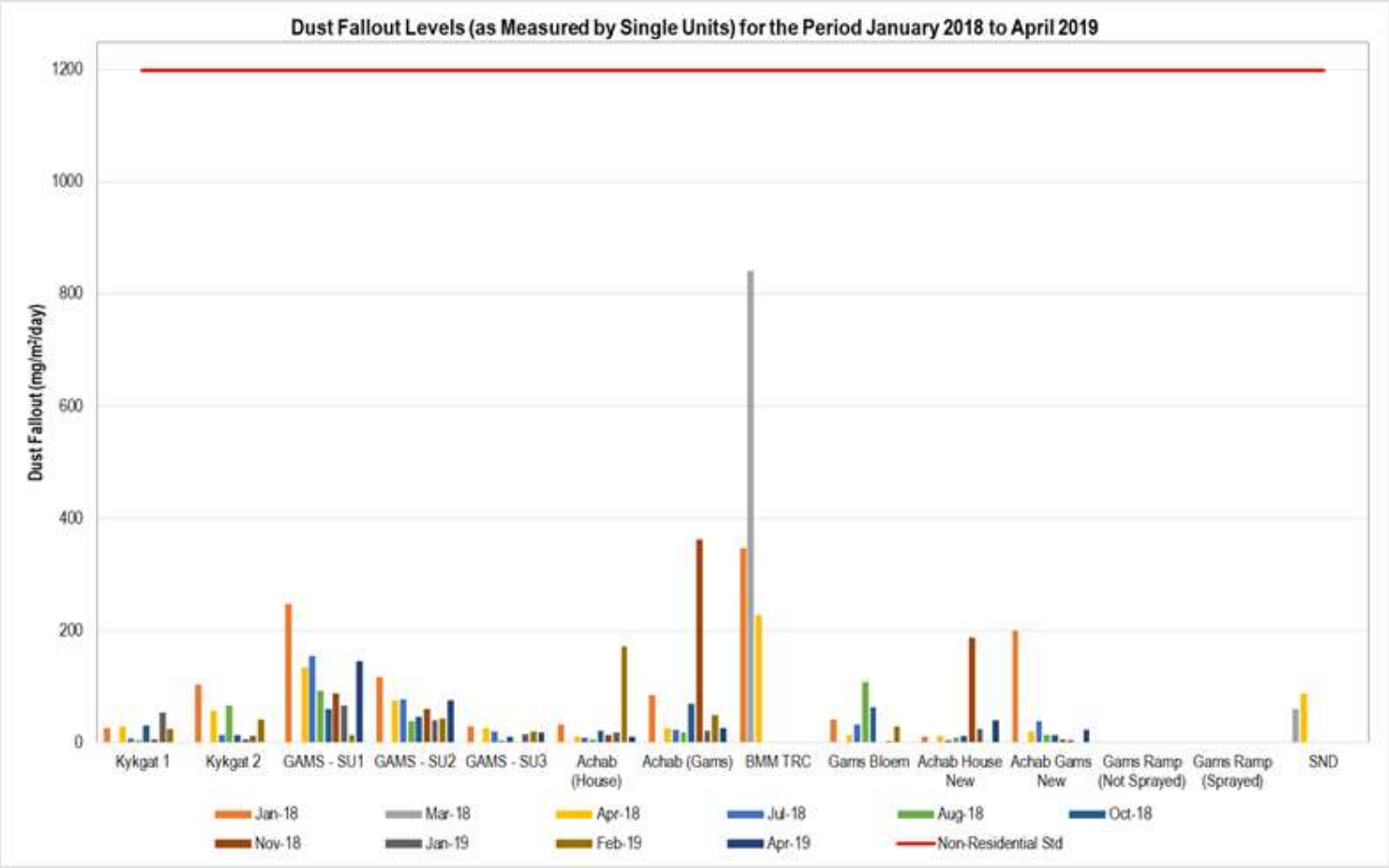


Figure 6-15: The Measured Dust Fallout Rates from the Single Buckets for the Period January 2018 to April 2019

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

SLR Consulting (Africa) (Pty) Ltd
P O Box 1596, Cramerview, 2060, South Africa
Tel: +27 (11) 467-0945 Fax: +27 (11) 467-0978

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

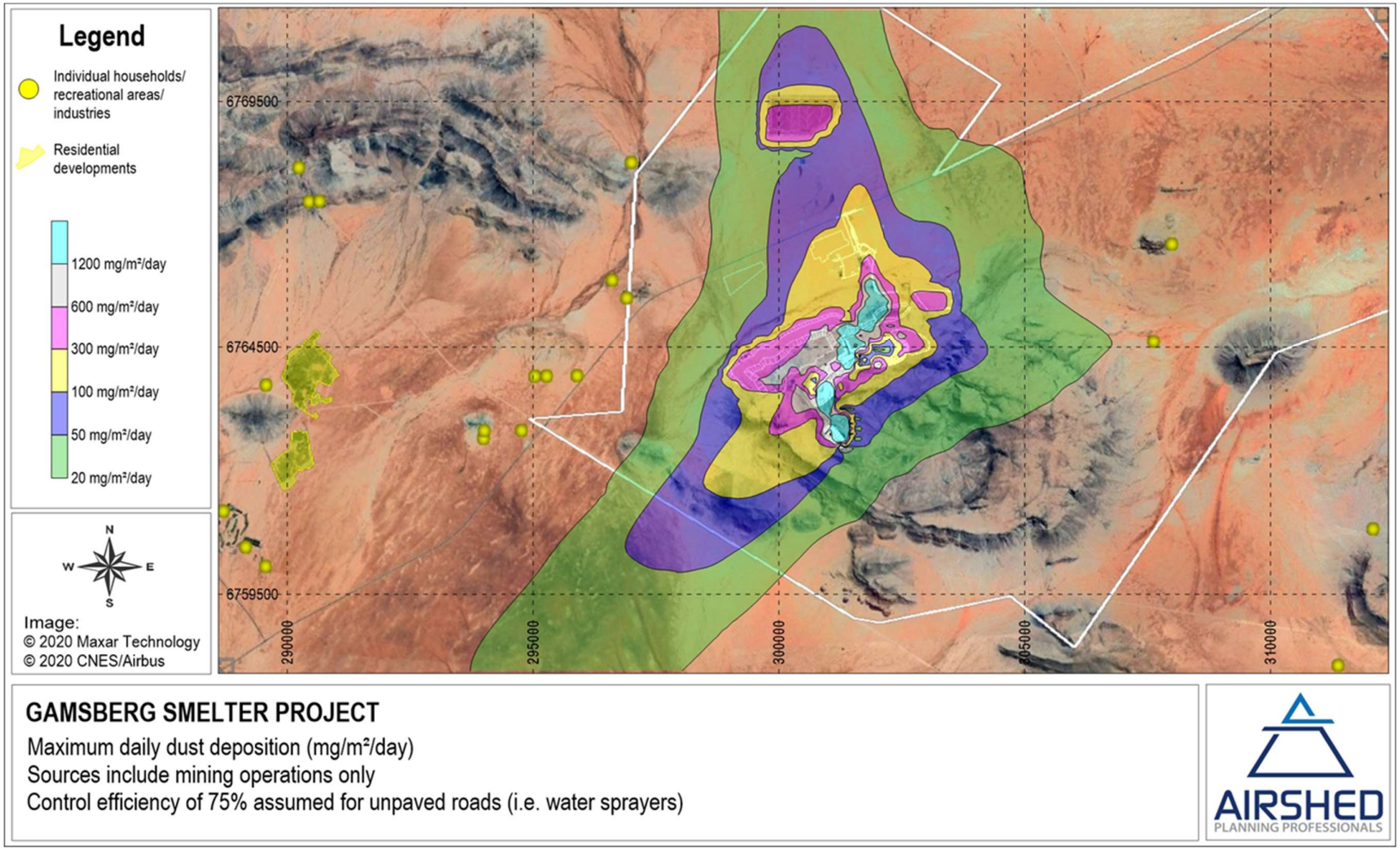


Figure 6-17 Total Particulate Deposition due to Baseline Mining Operations

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 (**Error! Reference source not found.**). 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:

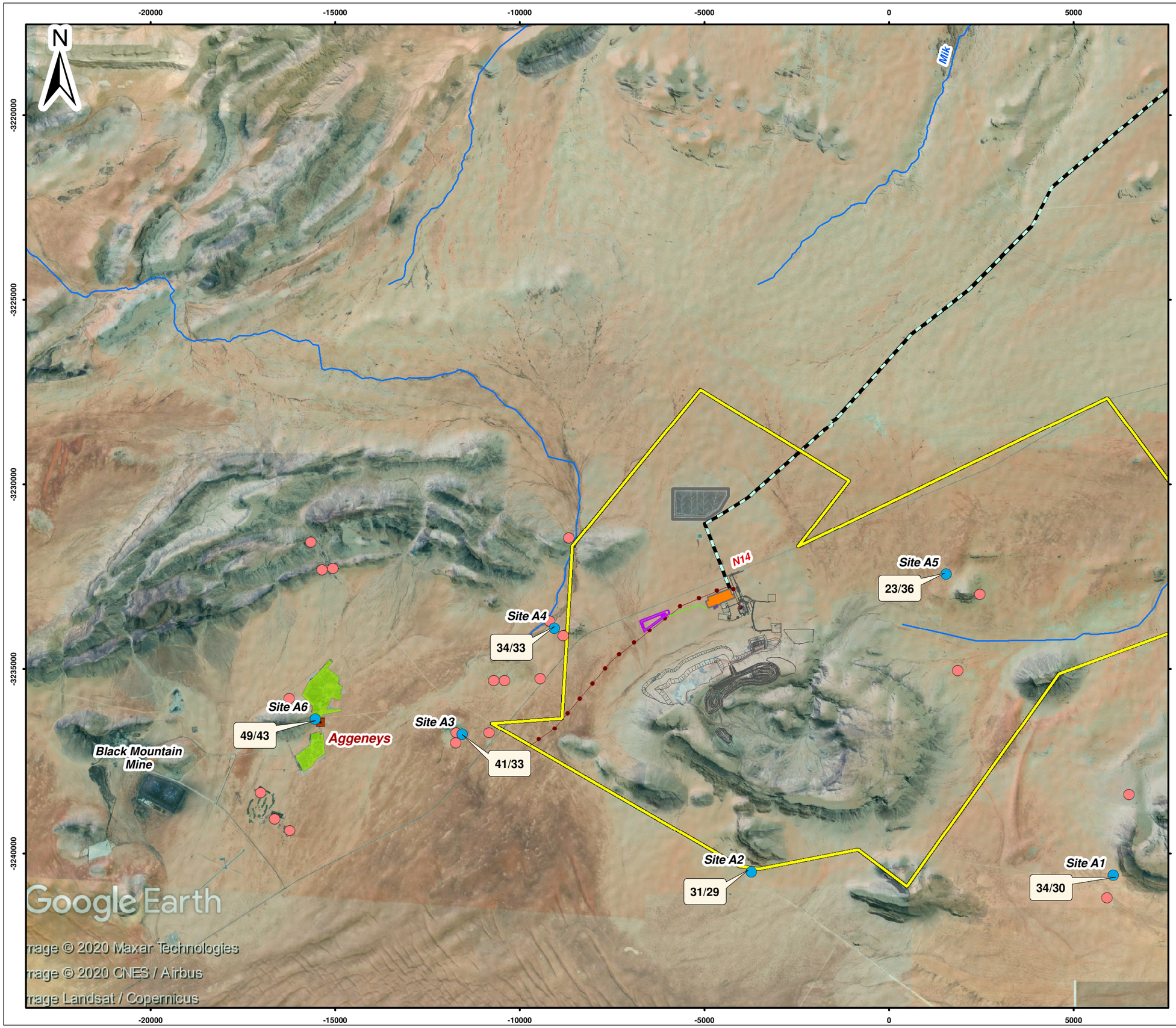
- Weather conditions:
    - During the day, weather conditions consisted of cloudless skies with temperatures between 28ºC and 31.4ºC. Slight to moderate wind conditions (including gusts) with wind speeds between 0.1 and 5.7 m/s mostly from the northerly directions, prevailed.
    - At night, skies were 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

SLR Consulting (Africa) (Pty) Ltd
P O Box 1596, Cramerview, 2060, South Africa
Tel: +27 (11) 467-0945 Fax: +27 (11) 467-0978

720.22013.00002 | 2020/09/23

Table 6-11 Project Baseline Environmental Noise Survey Results Summary

Site	Date	Duration (minutes)	L_{AFmax} (dBA)	L_{Aleq} (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_{Aleq} (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

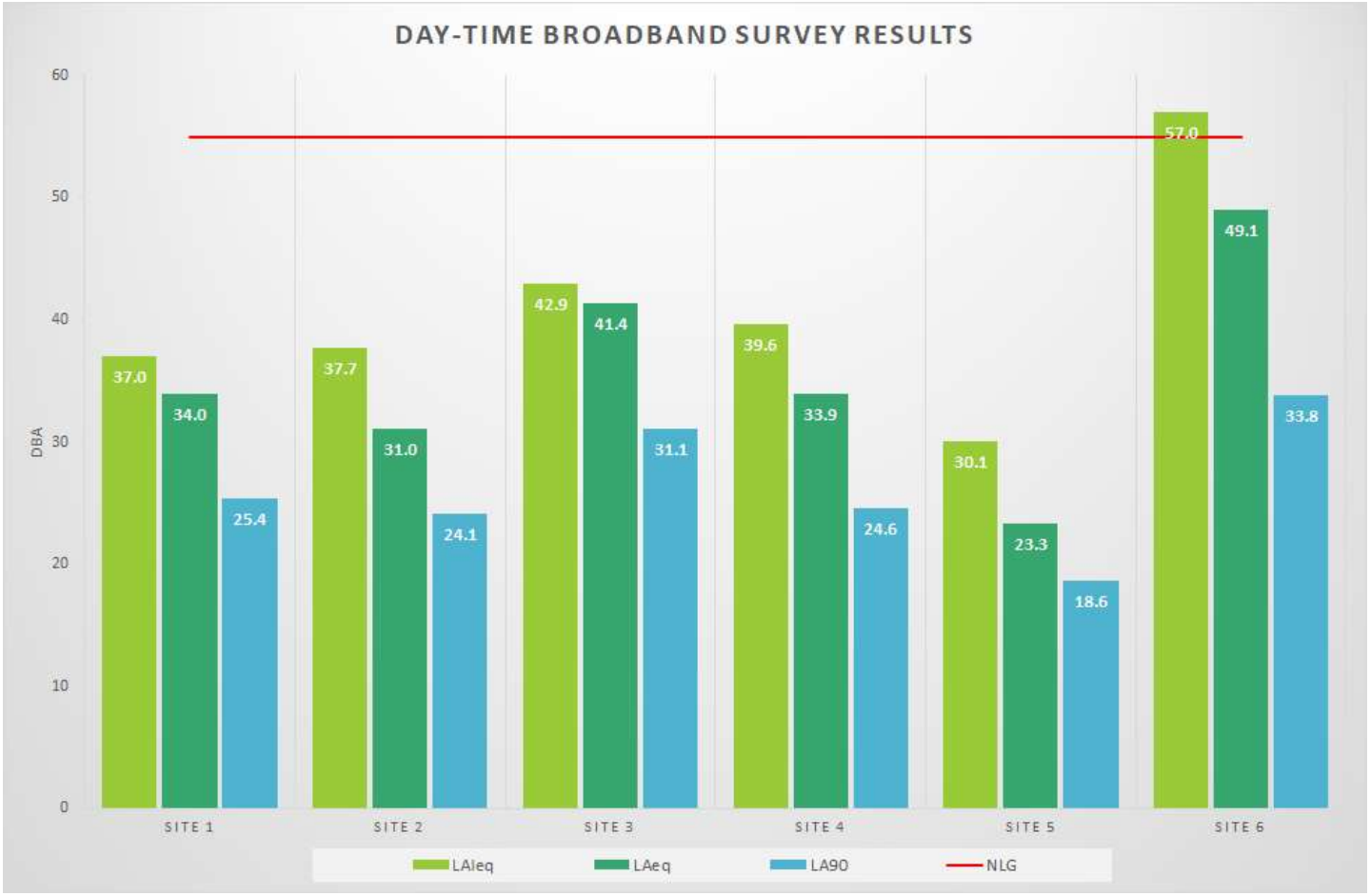


Figure 6-19: Day-Time Broadband Survey Results

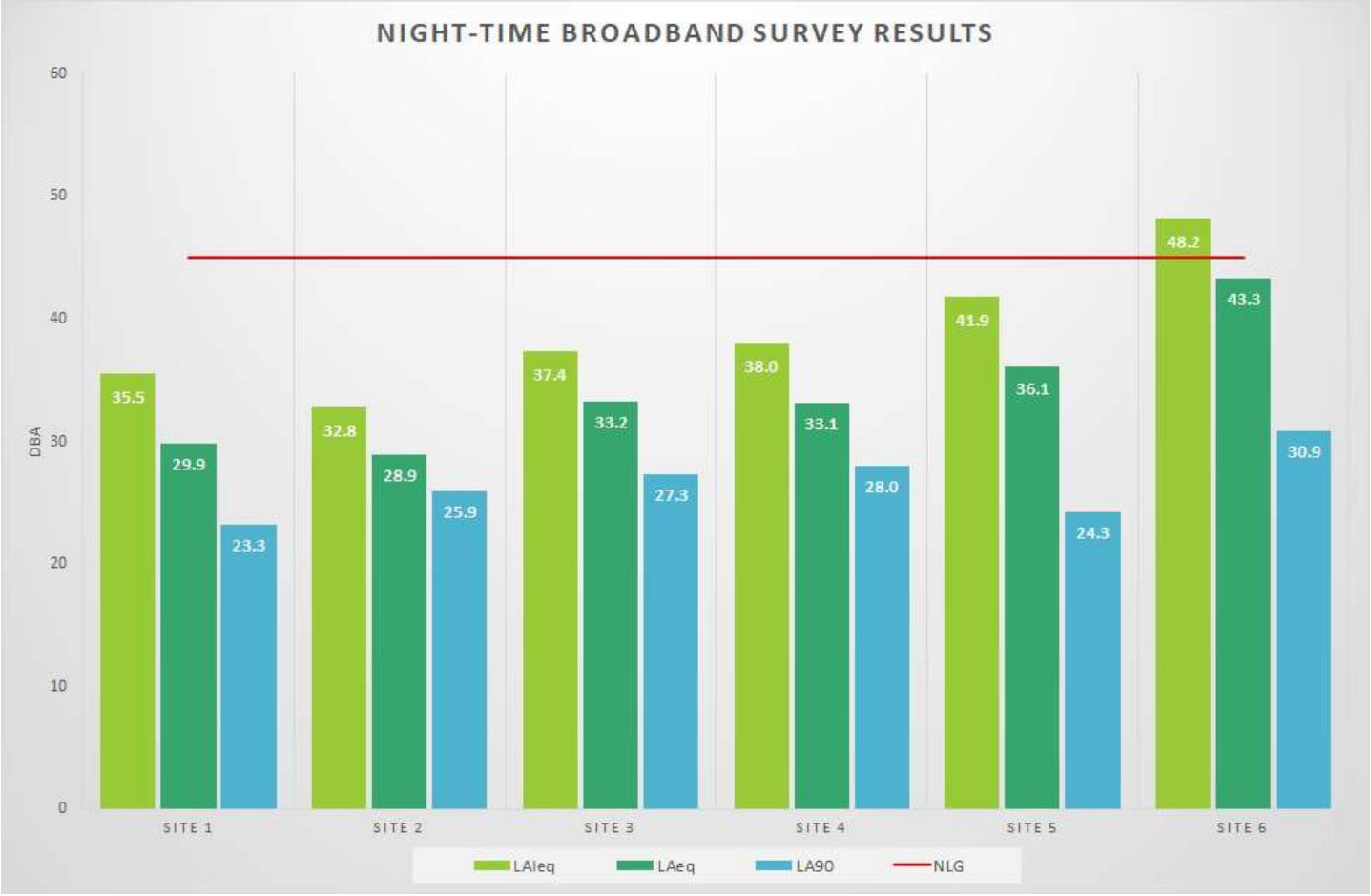


Figure 6-20: Night-Time Broadband Survey Results