APPENDIX 3: NCHWANING 2 TSF EXPANSION IMPACT ASSESSMENT

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1 INTRODUCTION

This section provides a targeted assessment of environmental impacts in respect of the proposed Nchwaning 2 tailings storage facility. Specialist assessments have been undertaken for impacts of particular potential significance, as presented in Section 2: Characterisation of Tailings and Key Environmental Impacts. All other impact assessment has been undertaken in accordance with Appendix 2 as presented in sections 3 and 4.

1.1 PROPOSED NCHWANING 2 TAILING STORAGE FACILITY (TSF)

Tailings are a fine residue derived from manganese ore crushing, washing and screening operations. The economic viability of selling or further processing the tailings is dependent on the market value of manganese. Due to market fluctuations, the material may be stored or recovered for periods of time. Recovered material can be pelletised and/or sintered, or otherwise sold in its current state.

The existing tailings storage facility (TSF) at Nchwaning II will be expanded by an area of approximately 20 ha to cater for increased production capacity from the processing plant. This will include a return water dam (RWD). The image below indicates the originally authorised facilities as well as the proposed TSF expansion.

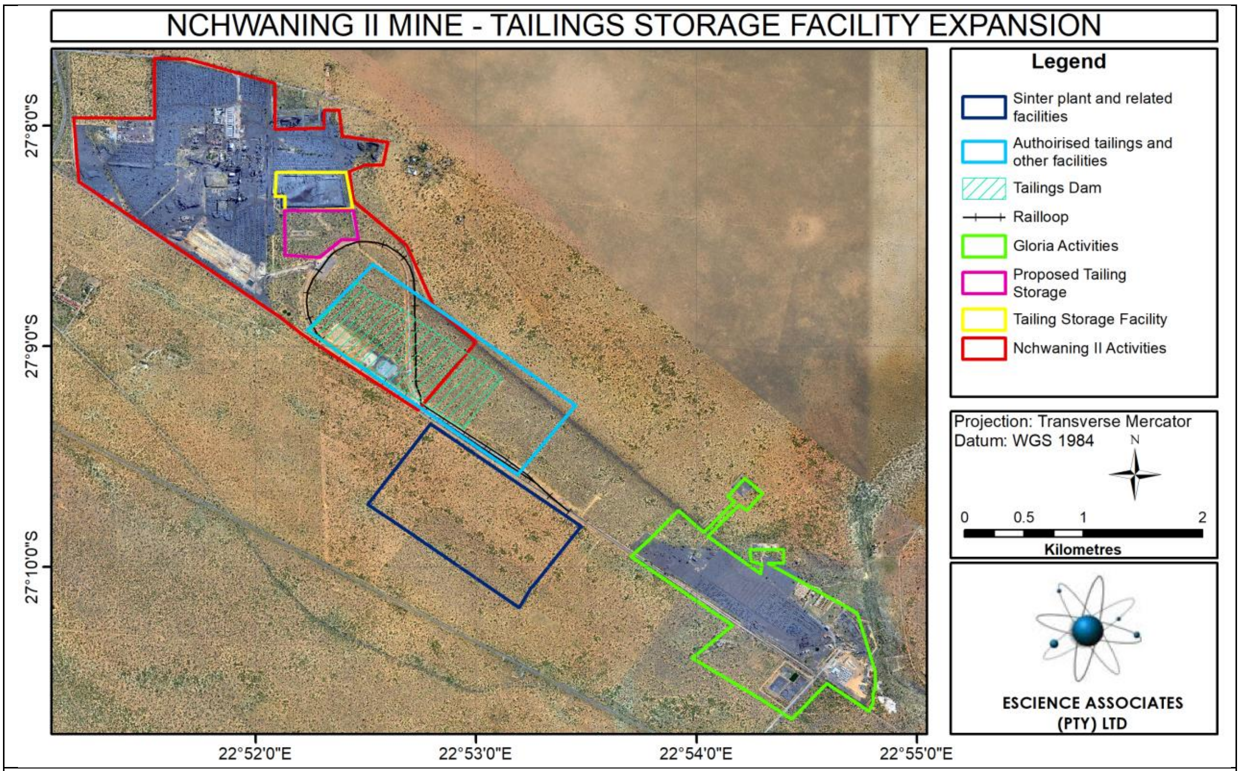

Figure 1-1: Planned Nchwaning II Tailings Expansion Location

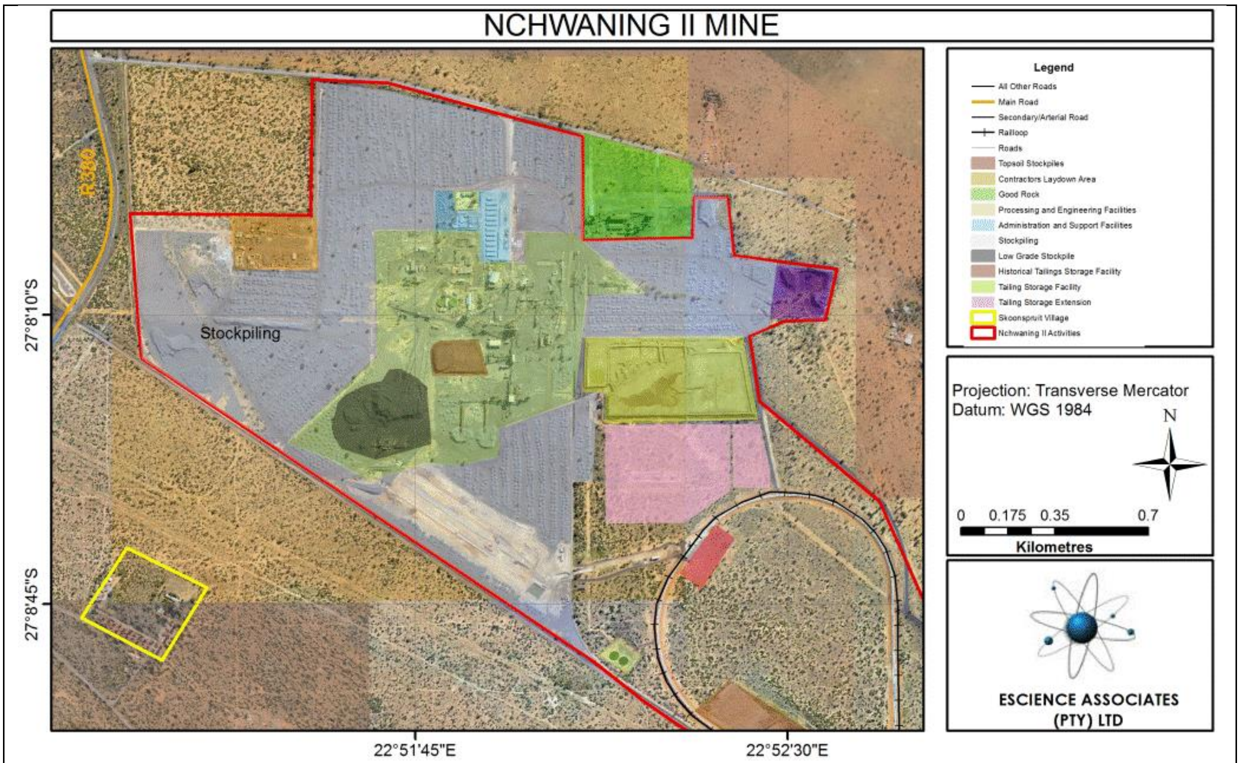

Figure 1-2: Planned Nchwaning II Tailings Expansion Outline

1.2 DESIGN

A concept design for the new Nchwaning TSF was prepared by Geo Tail (Pty) Ltd (Report no. GT/12/16 – REV 0 November 2016). The report refers to a "super fines storage facility" (SFSF), the terms "super fines" and "tailings" are used interchangeably herein.

The TSF will be developed as a single compartment ring dyke type storage facility. The TSF will have a maximum vertical height of 20 m and the total SFSF footprint is approximately 20 ha. The slurry will initially be placed behind an engineered starter embankment. The maximum height of the starter embankment is 6 m.

An upstream construction methodology will be implemented above the starter embankment crest elevation. The perimeter embankment construction material will be the segregated coarse residue material from the head of the beach. The slurry will be discharged from the perimeter embankment to form a beach that slopes downwards and away from the embankment. This will create a top surface geometry that will result in a supernatant pool that is maintained in the immediate vicinity of the decant system.
The slurry will be pumped to the SFSF basin through two slurry delivery pipelines. The design for the slurry pumping system falls outside the scope of this report.

The return water will be pumped from the return water dam to the process plant for re-use in the process.

The report further summarises environmental control measures as follows:

- In the design, the total seepage flux and, hence, the contaminant load will be minimised through:

- o Utilising the thickener at the process plant to increase the slurry density.
- o Always operating the TSF with the minimum amount of water stored on the top surface.
- o Operating the TSF in such a way that the beach angles are maximised and therefore the pool area will be kept as small as possible.
- o The fine segregated super fines in the pool area are expected to have a low permeability with the result that seepage infiltration will be low.

- The seepage will be diverted to the downstream RWD for re-use in the process.
- The storm water diversion system will divert clean precipitation run-off from the external catchment.
- The downstream side slope of the TSF will be terraced and the engineered bench will collect surface run-off and silt load. The runoff will then be diverted to the RWD through a berm penstock system that is linked to the drainage collector pipe.
- Appropriate erosion protection and energy dissipation measures will be implemented for open trenches, spillways etc.
- Deposition of the slurry will be managed during the operation phase to control dust generation.

1.2.1 SITE CLEARANCE AND PREPARATION

The site preparation will include the following activities:

- Clear and grub footprint.
- Remove topsoil (approximately 200 to 400 mm thick) and place it in dedicated stockpiles for future rehabilitation purposes. During the stripping operation, topsoil will be separated from trees and brush. The proposed topsoil stockpiles will be managed in accordance with BRMO topsoil stockpile management procedure.
- Remove unsuitable and/or construction material from the TSF and RWD basins.
- Profile and compact the SFSF and RWD basins to the required design specifications.
- Undertake a topographical survey for the final surface.

An access road will also be built around the TSF and RWD.

2 CHARACTERISATION OF TAILINGS AND KEY ENVIRONMENTAL IMPACTS

The primary potentially significant environmental impacts consist of:

- The potential for contamination of groundwater from leachate percolating through the material.
- The impact of land clearing.

Although there are various other potential environmental impacts, the two above are of particular significance and have been informed by specialist assessments.

2.1 WASTE ASSESSMENT FOR LANDFILL DISPOSAL (GN.R 635 OF 2013)

The Regulations Regarding the Planning and Management of Residue Stockpiles and residue Deposits GN.R 632 24 July 2015, require inter alia, classification of mineral residues in terms of the National Norms and Standards for the Assessment of Waste for Landfill Disposal (GN.R 635 of 2013). A classification of the tailings has been undertaken in cognisance of the requirements of GN 635:2013, and is attached hereto as well (refer to Appendix 14).

The national norms and standards for the assessment of waste for landfill disposal was published on the 23rd August 2013 in GN.R 635. These require that all wastes that are to be disposed of in landfills be assessed in terms of their composition and leaching properties. These values are then compared to threshold values indicated in GN.R 635 to determine the classification of the waste.

If any of the concentrations, total concentration (TC) or leach concentrations (LC), of the assessed compounds are higher than a given threshold, the waste is given a specific rating, the lowest waste type in the waste will be used. Type 4 wastes are the least hazardous while Type 0 wastes are the most hazardous.

Table 2-1: Summary of GN.R 635 Landfill Assessment Criteria

TCT and LCT Ranges*	Waste Type	Risk Level	Applicable Landfill Class for Disposal
LC > LCT3 TC > TCT2	Type 0	***Very High Risk*** – □ Very high potential for contaminant release. □ Requires very high level of control and ongoing management.	No disposal allowed. Waste treatment followed by reassessment is required.
LCT2 < LC ≤ LCT3 TCT1 < TC < TCT2	Type 1	***High Risk*** – □ High potential for contaminant release. □ Requires high level of control and ongoing management.	Class A.
LCT1 < LC ≤ LCT2 TCT ≤ TCT1	Type 2	***Moderate Risk*** – □ Potential for contaminant release. □ Requires proper level of control and ongoing management.	Class B.

LCT0 < LC ≤ LCT1 TCT ≤ TCT1	Type 3	***Low Risk*** – ☐ Low potential for contaminant release. ☐ Requires some level of control and ongoing management.	Class C.
LC ≤ LCT0 TC ≤ TCT0	Type 4	***Low Risk*** – ☐ Low potential for contaminant release. ☐ Requires basic level of control and ongoing management.	Class D.
*TCT - Total Concentration Threshold *LCT - Leach Concentration Threshold			

An assessment of the tailings material was undertaken by MojaTerre (Pty.) Ltd, (report reference PJ160021 of January 2017). The findings below are derived from that report. A paste pH test (1 part solid: 2 parts water) was used to determine the in-situ pH of the TSF. A leach test using normal reagent water as per the GNR635 requirements, followed by analyses of the leach solution for key species identified during the paste test leach test was undertaken.

The pH values of the physicochemical and organic compound samples during analyses ranged between 9 and 10. In terms of the different leach test scenarios, the paste leach test showed LC exceeding the relevant LCT0 values for barium (Ba), boron (B), lead (Pb) and total dissolved salts (TDS). Manganese (Mn) concentration represents the highest LC within the tested analytical suites, being recorded at a concentration exceeding the LCT1 range. The normal reagent water leach test indicated low to non-detectable concentrations of the potentially significant metals identified during the paste leach test. Refer to Table 2-2. Based on these reagent water results the tailings would be rated as type 4 waste, however the paste test results indicate a type 2 waste.

Table 2-2: Tailings Leach Test Results

Analyte	**Units**	**LCT0**	**LCT1**	**LCT2**	**LCT3**	**Paste Test Leach**	**Reagent Water Leach**
# pH at 25°C	pH units					9.7 to 10.1	9.7 to 10.1
			Metal Ions				
Arsenic, As	mg/L	0.01	0.5	1	4	0.001	BDL
Boron, B	mg/L	0.5	25	50	200	1.413	0.142
Barium, Ba	mg/L	0.7	35	70	280	0.841	0.281
Cadmium, Cd	mg/L	0.003	0.15	0.3	1.2	BDL	-
Cobalt, Co	mg/L	0.5	25	50	200	0.022	-
Chromium, Cr	mg/L	0.1	5	10	40	0.007	-
Hexavalent Chromium, Cr^{6+}	mg/L	0.05	2.5	5	20	BDL	-
Copper, Cu	mg/L	2	100	200	800	0.383	-
Mercury, Hg	mg/L	0.006	0.3	0.6	2.4	BDL	-
Manganese, Mn	mg/L	0.5	25	50	200	42	BDL
Molybdenum, Mo	mg/L	0.07	3.5	7	28	0.002	-
Nickel, Ni	mg/L	0.07	3.5	7	28	0.019	-
Lead, Pb	mg/L	0.01	0.5	1	4	0.026	BDL
Antimony, Sb	mg/L	0.02	1	2	8	BDL	-

Table 2-2: Tailings Leach Test Results

Analyte	**Units**	**LCT0**	**LCT1**	**LCT2**	**LCT3**	**Paste Test Leach**	**Reagent Water Leach**
# pH at 25°C	pH units					9.7 to 10.1	9.7 to 10.1
Selenium, Se	mg/L	0.01	0.5	1	4	0.001	BDL
Vanadium, V	mg/L	0.2	10	20	80	BDL	-
Zinc, Zn	mg/L	5	250	500	2 000	0.103	-
Iron, Fe	mg/L					0.147	-
Inorganic anions							
TDS	mg/L	1 000	12 500	25 000	100 000	4304	-
Chloride, Cl	mg/L	300	15000	30000	120000	Iron interference	-
Sulphate, SO4	mg/L	250	12 500	25 000	100 000	58	-
Nitrate as nitrogen, NO3 as N	mg/L	11	550	1 100	4 400	1.07	-
Total Fluoride	mg/L	1.5	75	150	600	0.09	-
Total Cyanide	mg/L	0.07	3.5	7	28	BDL	-
Organic species							
VOC's: Dilution x1 - μ g/L							
Benzene	mg/L		0.01	0.02	0.08	BDL	-
Carbon Tetrachloride	mg/L		0.2	0.4	1.6	BDL	-
Chlorobenzene	mg/L		5	10	40	BDL	-
Chloroform	mg/L		15	30	120	BDL	-
1,2-Dichlorobenzene	mg/L		5	10	40	BDL	-
1,4-Dichlorobenzene	mg/L		15	30	120	BDL	-
1,2-Dichloroethane	mg/L		1.5	3	12	BDL	-
Ethylbenzene	mg/L		3.5	7	28	BDL	-
Hexachlorobutadiene	mg/L		0.03	0.06	0.24	BDL	-
MTBE	mg/L		2.5	5	20	BDL	-
Naphthalene	mg/L					BDL	-
Styrene	mg/L		1	2	8	BDL	-
1,1,1,2-Tetrachloroethane	mg/L		5	10	40	BDL	-
1,1,2,2-Tetrachloroethane	mg/L		0.65	1.3	5.3	BDL	-
Toluene	mg/L		35	70	280	BDL	-
1,1,1-Trichloroethane	mg/L		15	30	120	BDL	-
1,1,2-Trichloroethane	mg/L		0.6	1	4	BDL	-
Xylenes total	mg/L		25	50	200	BDL	-
1,2,4 Trichlorobenzene	mg/L		Total of 3.5	Total of 7	Total of 28	BDL	-
1,2,3 Trichlorobenzene	mg/L					BDL	-
1,3,5 Trichlorobenzene	mg/L					BDL	-
Dichloromethane	mg/L		0.25			BDL	-
1,1-Dichloroethylene	mg/L		0.35	0.7	2.8	BDL	-
1,2-Dichloroethylene	mg/L		2.5	5	20	BDL	-
Tetrachloroethylene	mg/L		0.25	0.5	2	BDL	-
Trichloroethylene	mg/L		0.25	2	8	BDL	-
Polars Dilution: Dilution x 1- μg/L							
2-Butanone (methyl ethyl ketone)	mg/L		100	5	20	BDL	-
Vinyl Chloride	mg/L		0.015	0.03	0.12	BDL	-
Formaldehyde: Dilution x 2 - μg/L							
Formaldehyde	mg/L		25	50	200	BDL	-
SVOC's: Dilution x 1 - μg/L							

Table 2-2: Tailings Leach Test Results							
Analyte	**Units**	**LCT0**	**LCT1**	**LCT2**	**LCT3**	**Paste Test Leach**	**Reagent Water Leach**
# pH at 25°C	pH units					9.7 to 10.1	9.7 to 10.1
Benzo(a)pyrene	mg/L		0.035	0.07	0.28	BDL	-
Di (2 ethylhexyl) Phthalate	mg/L		0.5	1	4	BDL	-
Nitrobenzene	mg/L		1	2	8	BDL	-
2,4 Dinitrotoluene	mg/L		0.065	0.13	0.52	BDL	-
Total PAH's	mg/L					BDL	-
Phenols: Dilution x 1 - µg/L							
2-Chlorophenol	mg/L		15	30	120	BDL	-
2,4-Dichlorophenol	mg/L		10	20	80	BDL	-
2,4,6-Trichlorophenol	mg/L		10	20	80	BDL	-
Phenols (total, non-halogenated)	mg/L		7	14	65	BDL	-
Pesticides: Dilution x 1 - µg/L							
Aldrin	mg/L		0.015	0.03	0.03	BDL	-
Dieldrin	mg/L					BDL	-
DDT	mg/L					BDL	-
DDE	mg/L					BDL	-
DDD	mg/L		1	2	2	BDL	-
Heptachlor	mg/L		0.015	0.03	0.03	BDL	-
Chlordane	mg/L		0.05	0.1	0.1	BDL	-
2,4 Dichlorophenoxyacetic Acid	mg/L		1.5	3	3	BDL	-
PCB: Dilution x 1 - µg/L							
Polychlorinated biphenyls	mg/L		0.025	0.05	0.2	BDL	-
TPH: Dilution x 1 - µg/L							
Petroleum H/Cs,C6-C9	mg/L					BDL	-
Petroleum H/Cs,C10 to C36	mg/L					BDL	-
Waste Type Category						***Type 2***	***Type 4***

The total concentration results showed TC exceeding the relevant TCT0 values for barium (Ba), boron (B), cobalt (Co), copper (Cu) and lead (Pb). Manganese (Mn) concentration represents the highest TC being recorded at a concentration exceeding the TCT2 range. Refer to Table 2-3. Based on these results the tailings would be rated as type 0 waste, and cannot be disposed to landfill without prior treatment and re-assessment.

Table 2-3: Tailings Total Concentration Test (TCT) Results					
Constituents	**Units**	**TCT0**	**TCT1**	**TCT2**	**Tailings**
# pH at 25°C	pH units				9.1 to 10.1
Metal Ions					
Arsenic, As	mg/kg	5.8	500	2 000	2.97
Boron, B	mg/kg	150	15 000	60 000	441
Barium, Ba	mg/kg	62.5	6250	25 000	5020
Cadmium, Cd	mg/kg	7.5	260	1040	0.5
Cobalt, Co	mg/kg	50	5 000	20 000	50
Chromium, Cr	mg/kg	46 000	800 000	N/A	6.44
* Hexavalent Chromium, Cr^{6+}	mg/kg	6.5	500	2 000	BDL
Copper, Cu	mg/kg	16	19 500	78 000	65

Mercury, Hg	mg/kg	0.93	160	640	0.13
Manganese, Mn	mg/kg	1 000	25 000	100 000	211718
Molybdenum, Mo	mg/kg	40	1 000	4 000	15.66
Nickel, Ni	mg/kg	91	10 600	42 400	7.93
Lead, Pb	mg/kg	20	1 900	7 600	50
Antimony, Sb	mg/kg	10	75	300	BDL
Selenium, Se	mg/kg	10	50	200	0.09
Vanadium, V	mg/kg	150	2680	10 20	1.88
Zinc, Zn	mg/kg	240	160 000	640 000	61
Iron, Fe	mg/kg				28083
Inorganic anions					
TDS	mg/kg				
Chloride, Cl	mg/kg				
Sulphate, SO4	mg/kg				
Nitrate as nitrogen, NO3 as N	mg/kg				
Total Fluoride	mg/kg	100	10 000	40 000	3
Total Cyanide	mg/kg	14	10 500	42 000	0.1
Organic species					
VOC's: Dilution x 20 - µg/kg					
Benzene	mg/kg		10	40	BDL
Carbon Tetrachloride	mg/kg		4	16	BDL
Chlorobenzene	mg/kg		8 800	35200	BDL
Chloroform	mg/kg		700	2 800	BDL
1,2-Dichlorobenzene	mg/kg		31 900	127 600	BDL
1,4-Dichlorobenzene	mg/kg		18 400	73600	BDL
1,2-Dichloroethane	mg/kg		3.7	15 000	BDL
Ethylbenzene	mg/kg		540	2160	BDL
Hexachlorobutadiene	mg/kg		2.8	5.4	BDL
MTBE	mg/kg		1 435	5 740	BDL
Naphthalene	mg/kg				BDL
Styrene	mg/kg		120	480	BDL
1,1,1,2-Tetrachloroethane	mg/kg		400	1 600	BDL
1,1,2,2-Tetrachloroethane	mg/kg		5	20	BDL
Toluene	mg/kg		1 150	4 600	BDL
1,1,1-Trichloroethane	mg/kg		1200	4 800	BDL
1,1,2-Trichloroethane	mg/kg		48	192	BDL
Xylenes total	mg/kg		890	3 560	BDL
1,2,4 Trichlorobenzene	mg/kg		Total of 3 300	Total of 13 200	BDL
1,2,3 Trichlorobenzene	mg/kg				BDL
1,3,5 Trichlorobenzene	mg/kg				BDL
Dichloromethane	mg/kg		16	64	BDL
1,1-Dichloroethylene	mg/kg		150	600	BDL
1,2-Dichloroethylene	mg/kg		3 750	15 000	BDL
Tetrachloroethylene	mg/kg		200	800	BDL
Trichloroethylene	mg/kg		11 600	46 400	BDL
Polars Dilution: Dilution x 20 - µg/kg					
2-Butanone (methyl ethyl ketone)	mg/kg		8 000	32 000	BDL
Vinyl Chloride	mg/kg		1.5	6	BDL
Formaldehyde: Dilution x 10 - µg/kg					
Formaldehyde	mg/kg		2 000	8 000	839.28
SVOC's: Dilution x 20 - µg/kg					
Benzo(a)pyrene	mg/kg		1.7	6.8	BDL
Di (2 ethylhexyl) Phthalate	mg/kg		40	160	BDL

Nitrobenzene	mg/kg		45	180	BDL
2,4 Dinitrotoluene	mg/kg		5.2	20.8	BDL
Total PAH's	mg/kg		50	200	BDL
PHENOLS: Dilution x20 - µg/kg					
2-Chlorophenol	mg/kg		2 100	8 400	BDL
2,4-Dichlorophenol	mg/kg		800	3 200	BDL
2,4,6-Trichlorophenol	mg/kg		1 770	7 080	BDL
Phenols (total,non-halogenated)	mg/kg		560	2240	BDL
Pesticides: Dilution x20 - µg/kg					
Aldrin	mg/kg		Total of 1.2	Total of 4.8	BDL
Dieldrin	mg/kg				BDL
DDT	mg/kg		Total of 50	Total of 200	BDL
DDE	mg/kg				BDL
DDD	mg/kg				BDL
Heptachlor	mg/kg		1.2	4.8	BDL
Chlordane	mg/kg		4	16	BDL
2,4 Dichlorophenoxyacetic Acid	mg/kg		120	480	BDL
PCB: Dilution x1 - µg/kg					
Polychlorinated biphenyls	mg/kg		12	48	BDL
TPH: Dilution x1 - µg/kg					
Petroleum H/Cs,C6-C9	mg/kg		650	2 600	BDL
Petroleum H/Cs,C10 to C36	mg/kg		10 000	40 000	BDL
Waste Type Category					***Type 0***

According to the Mojatere report, the Mn within the tailings material is relatively immobile at the pH values measured during this assessment (9.1 to 9.7). This finding is also portrayed within the available water quality information which indicates low to non-detectable Mn concentrations in plant effluents and the surrounding groundwater.

Available water quality data also shows similar results to this waste assessment in terms of pH values, with higher pH values typically associated with processing areas as detected in the plant effluents. This correlation is possibly due to the basic nature of the BRMO ore, increased surface areas associated with processed ore material fines and increased contact time between ore fines and process water, which is similar to the leachate test during which milled sample material is washed in reagent water for several hours.

Available groundwater quality information for monitoring boreholes downgradient of the TSF shows low to non-detectable concentrations of dissolved Mn. This confirms, with limited information available, the immobility of Mn within the current tailings disposal facility as well as no pollution links to the receiving groundwater environment.

The immobility of Mn within the currently unlined TSF further supports MojaTerre's perception that tailings material at the BRMO can be managed as a Type 1 waste.

As indicated in the GN.R 635, the TCT values were derived from the SSV (Soil Screening Values) developed in the Framework for the Management of Contaminated Land in South Africa (DEA, 2010). The SSV consider total contaminant concentrations and are land use dependant, considering exposure to sensitive receptors through direct inhalation and ingestion as well as groundwater consumption pathways. In this regard, the detected total Mn concentration in the tailings and its immobility during disposal can be considered a greater health and environmental risk in terms of fugitive dust generation as well as material handling, rather than leachate generation and subsurface migration. On this basis, BRMO has a potential case to motivate for further relaxed requirements (management of tailings as a Type 2 waste based on predicted leachate quality) from the regulators in terms of the final TSF liner specifications (Class B liner) for future facility expansions. Such motivation should be supplemented with comprehensive H&S and material handling procedures as well as a dedicated TSF groundwater monitoring programme.

2.2 RISK TO GROUNDWATER

Due to the significantly high total Mn concentration in the tailings material, the material is categorised as a Type 0 waste in terms of the GN.R 635. However, as stipulated in the GN.R 635, Type 0 wastes may not be disposed of to landfill (or in this case TSF). Type 0 waste must be treated and reassessed in terms of the GN.R 635 before disposal of such waste can be considered. Notably, proposed amendments to GN.R 632:2015, as gazetted in GN 1440 of 2016, are intended to allow for a risk based assessment in respect of disposal requirements with the insertion of R3(5) which states:

"A competent person must recommend a pollution control barrier system suitable for a specific residue stockpile or residue deposit on the basis of a risk analysis as contemplated in regulations 4 and 5 of these Regulations.".

In addition, the proposed transitional provisions state:
"4. Any application for a waste management licence relating to the establishment or reclamation of a residue stockpile or residue deposit, which was lodged with the licensing authority before the commencement of these Regulations, must be dealt with in terms of the Regulations as amended by these regulations."

It is therefore clear that the amendments are intended to apply retrospectively to existing applications.

As noted previously, the Mn within the tailings material is relatively immobile at the pH values measured during the preliminary assessment (pH range 9.1 to 9.7). Water quality monitoring results indicate low Mn concentrations in mine process water as well as in groundwater. Available water quality data also show similar pH values results to the preliminary waste assessment, with more alkaline pH values typically associated with processing areas as detected in the plant effluents. This correlation is possibly due to increased surface areas associated with processed ore material fines and increased contact time between ore fines and process water, which is similar to the leachate test during which milled sample material is washed in reagent water for several hours.

Available groundwater quality information for monitoring boreholes downgradient of the TSF shows low to non-detectable concentrations of dissolved Mn. Refer to Figure 2-1and Figure 2-2. Note that groundwater flows in a northerly direction.

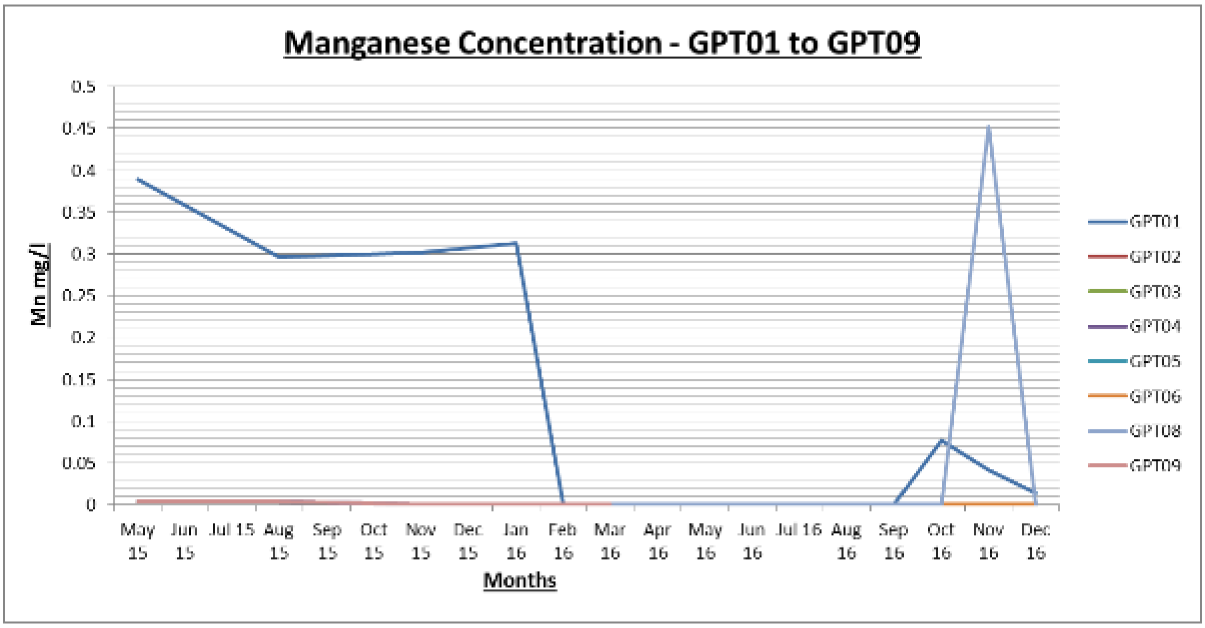

Figure 2-1: Measured Mn Concentrations in groundwater

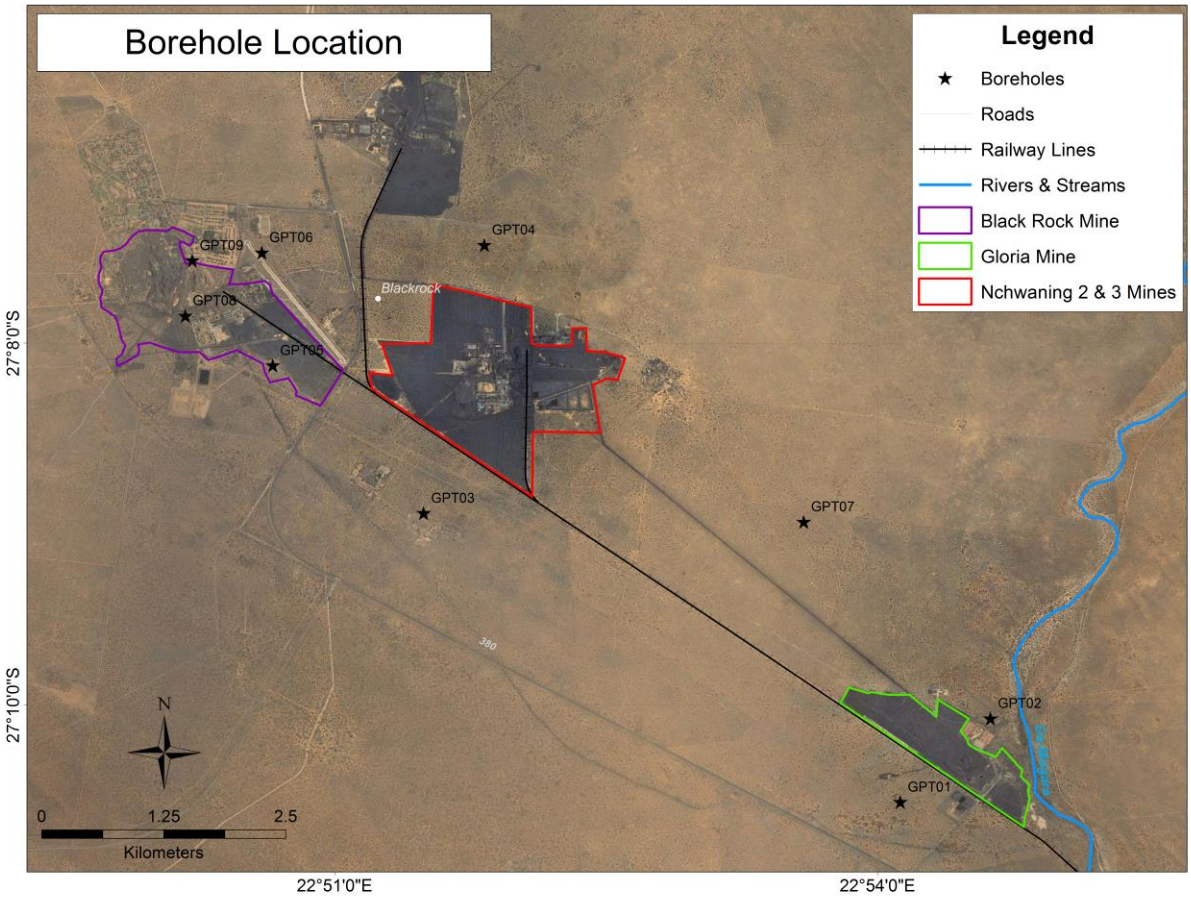

Figure 2-2: borehole locations

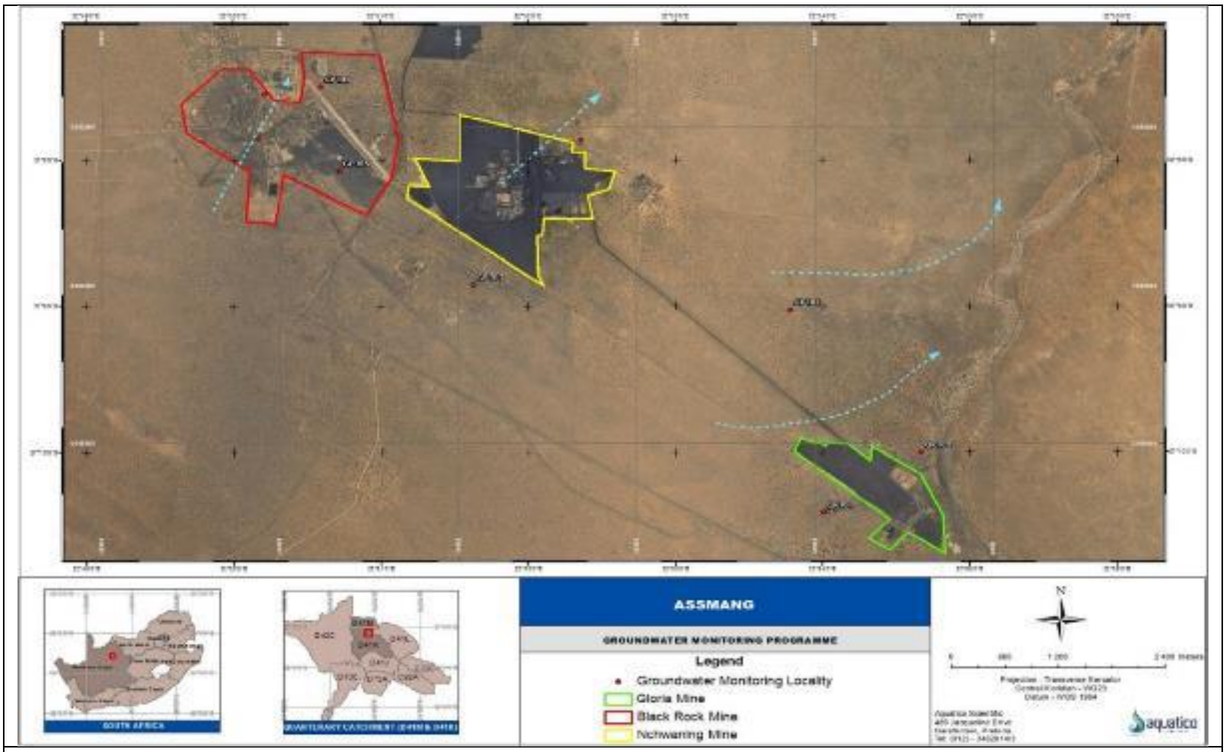

Figure 2-3: Direction of Groundwater Flow

In view of the above a specialist assessment was undertaken to inform the liner design. The assessment was undertaken by geohydrological specialists Geo Pollution Technologies (Pty) Ltd, and is attached hereto as well (refer to Appendix 14). GPT Reference Number: EEESB-17-2127, February 2017.

The risk assessment approach aims to describe and define the relationship between the cause (source) and the effect on the receptor, through the groundwater pathway. In the absence of any one of the three components, it can be concluded that groundwater risk does not exist (Framework for the Management of Contaminated Land, May 2010). The results of the risk assessment are summarised in the ensuing sub-sections, independently assessing the three components of the source-pathway-receptor model.

2.2.1 SOURCE

The source of potential contamination is the proposed extension of the existing tailings facility at the Nchwaning mine. The results of the leach testing of tailings material indicate that the discard material has a low contamination potential. Only boron, barium, manganese and lead were found in a concentration above the Leachable Concentration Threshold (LCT) limits. However, these elements are not present in the groundwater in concentrations exceeding the LCT0 concentration (with the exception of boron) thus indicating that the tailings are not currently leaching to the groundwater to any significant degree. Boron is a naturally occurring compound associated with manganese ore and can reach natural concentrations in the ore of 0.5 to 1.1% (Varentsov, 1996).

It is concluded that the source presents a low contamination risk at worst, and the concentration of contaminants in the groundwater is actually a reflection of what is already found naturally, as detected in groundwater hydraulically upgradient of the site.

2.2.2 PATHWAY

The pathway applicable to this assessment is unsaturated seepage through the Kalahari Formation to the groundwater below. The groundwater level in the area is exceptionally deep. The average depth of water below the surface was found to be about 60 m. At the site of the proposed tailings dam the groundwater is even deeper at an average of 73 m (boreholes GPT03 and GPT04). At borehole GPT03 closest to the proposed tailings, the groundwater is at 100 m below the surface. This means that the vertical thickness of the unsaturated pathway below the tailings is at least 70 m, but could well be as much as 100 m, which is immense. This also renders aquifer vulnerability very low.

During this very long pathway, there are at least three factors to consider:

- Time of travel. Recharge into the Kalahari Sands is very low, as little as 1 mm/year. Even taking extreme unsaturated flow conditions into account, the vertical velocity should not exceed 100 mm/a. It would thus take thousands of years for contamination to reach the permanent groundwater level. This slow transport velocity has also been illustrated by numerous tritium studies in the Kalahari (Xu Y., 2003).
- Diffusion during travel. During transport the water is constantly diffused by factors such as varying path lengths and retardation, for instance. The result of this diffusion is that a contamination pulse will reach the subsurface groundwater as a spread out diffuse cloud. This will inevitably reduce the contamination levels by orders of magnitude, rendering the contribution to groundwater compounds immeasurably small.
- Temporary perching: The Kalahari sands and the calcrete/clay layers form a vertically and laterally complex network of flow and perching regimes. This temporary perching before infiltration is a prominent factor in retarding vertical flow, and increases diffusion and dilution of dissolved compounds.

Another important factor to be considered is the dilution of leached source material during travel through the pathway. A previous modelling study (GPT EEESB-16-1806, 2016) has shown that a dilution factor of at least two orders of magnitude will be encountered when chemical compounds reach the aquifer below. The leaching concentrations will thus be reduced to at least a tenth of those currently measured in groundwater when the constituents reach the aquifer. This will render the concentrations well below LCT0, with the exception of manganese.

A further factor to consider is dilution over the extent of the aquifer. The area of the aquifer is about 47 000 ha. The percentage area of the proposed tailings compared to the aquifer is thus in the order of 0.03%. Thus, in the long term after mixing has occurred, the contribution of the tailings will be immeasurably small. It is thus concluded that the Kalahari Formation serves as an extensive protection for the aquifer below, and is an effective filter for contaminants. Coupled with low precipitation and high evaporation rates the transportation of dissolved contaminants from the source areas is foreseen to present a very low risk to the groundwater environment.

2.2.3 RECEPTOR(S)

Based on current available information, only proposed abstraction borehole BRMO – 23 is a possible sensitive receptor. BRMO is in the process of investigating abstraction at this point for domestic purposes. However, it has been shown in a previous investigation that the travel time to this borehole is at least five years and that the concentration will be reduced to only about 1% of the input concentration of chemical compounds that might reach the bottom of the unsaturated zone. It must thus be concluded that even if any contaminant should be able to reach the saturated aquifer, no sensitive receptors will be affected.

2.2.4 CONCLUSION

Taking into account that:

- The contribution of the new proposed tailings as a source of contamination is very unlikely and statistically insignificant;
- The pathway through the unsaturated zone is not a viable pathway on life-of-mine timescales, and is probably relatively impermeable to groundwater infiltration;
- No sensitive receptors are currently present in the area of mining; and,
- Based on a previous study, no environmental benefit is expected from installing a liner beneath a new tailings facility adjacent to an unlined tailings facility;

It is concluded that the source-receptor linkage is incomplete in the mining area, and that "(the) risk of seepage entering the groundwater environment and reaching receptors with no lining using existing leach results for Life of TSF, 20 years, 50 years and *100 years*" is indeed negligible.

2.2.5 NO-GO ALTERNATIVE

It is clear that the impacts from existing operations would continue. Based on existing water monitoring data and mine geohydrological modelling in comparison to the proposed TSF, it is also clear that the impact of the no-go alternative is not significantly different from an impact perspective.

2.3 IMPACT OF LAND CLEARING

An ecological assessment of the proposed site was undertaken, by biodiversity specialists Scientific Aquatic Services CC. Report Reference: SAS 160054, December 2016, attached hereto as well (refer to Appendix 14).

The specialist found that the majority of the study area is comprised of Open Bushveld Habitat Unit, with an overall moderate ecological sensitivity, mostly due to the high number of Vachellia erioloba and V. haematoxylon, protected under the

National Forest Act (Act 84 of 1998) present, as well as the overall moderate PES of the study area with largely intact habitat. It is however important to note that portions of the study area, particularly in the vicinity of disturbances have undergone vegetation transformation and loss of habitat structure and that the habitat type is considered well represented within the region surrounding the study area. The proposed development of a slimes dam within the study area is therefore not expected to significantly impact on floral conservation in the region. In addition, the project footprint is relatively small and is located immediately adjacent to existing mining infrastructure to the north and west.

The specialist recommended that the project be considered favourably, provided that all mitigation and management measures as outlined in this report be adhered to, with specific reference to obtaining permits under the National Forests Act (Act 84 of 1998) for the removal of V. erioloba and V. haematoxylon trees and protected floral species (Boophane disticha and Euphorbia spp.) within the study area. A summary of the assessment is presented in the ensuing subsections.

2.3.1 ASSESSMENT METHODOLOGY

The following assessment procedure/methodology was used:

- A desktop study to gain background information on the physical habitat, as well as generating potential floral biodiversity lists for the study area and surrounding region;
- Aerial photographs and digital satellite imagery were consulted prior to the field assessment to guide priority areas for ground truthing;
- The site visit was initiated by means of an initial visual, on-site assessment of the study are;
- A field assessment that identified the tree, forb, grass and alien floral species that occur within the study area;
- A description of the sensitivity of the project footprint was undertaken;
- Data analyses and reporting of all findings and impact assessment were undertaken.

2.3.2 ASSESSMENT FINDINGS

The following general conclusions were drawn upon completion of the literature review and desktop analysis:

- According to the Mining Biodiversity Guidelines (2012) the study area does not fall within an area indicated to be of increased biodiversity importance.
- According to the National List of Threatened Terrestrial Ecosystems (2011) the study area is not located within a threatened terrestrial ecosystem;
- According to the National Protected Areas Expansion Strategy (NPAES; 2008) database, the study area does not fall within an area earmarked as an NPAES area;
- According to the National Biodiversity Assessment (NBA; 2011) database, the study area is not located within a formally or informally protected

area, with the entire study area falling within an area that is currently not protected. The Land Cover data indicates that the study area largely falls within a natural area, with mining activity located to the north and west;

- According to the Northern Cape Provincial Spatial Development Framework (PSDF; 2012), the study area is located within the Griqualand West Centre of Endemism (GWC), however, the study area is not located within a Critical Biodiversity Area (CBA), within a Biodiversity Priority Area or within a protected area as identified by the PSDF (2012);
- The Municipal Biodiversity Summary (MBS; 2010) for the Kgalagadi District Municipality didn't indicate any sensitivities for this study area; and
- The study area falls within the Savanna Biome, the Eastern Kalahari Bushveld Bioregion and within the Kathu Bushveld vegetation type (Mucina & Rutherford, 2006). The study area is situated within the 2722BB Quarter Degree Square (QDS).

The following general conclusions were drawn upon completion of the field assessment:

- A single broad habitat unit was identified within the study area namely the Open Bushveld Habitat Unit, which is well represented within the region surrounding the study area;
- Although the study area is considered to be in a moderate Present Ecological Sate (PES) and having moderate ecological sensitivity due to the high number of Vachellia erioloba and V. haematoxylon trees (protected under the National Forest Act (Act 84 of 1998) within the study area, with largely intact habitat present, portions of the study area in the vicinity of disturbances have undergone vegetation transformation and loss of habitat structure;
- Due to the relatively small development footprint and the location of the proposed slimes dam adjacent to existing mining infrastructure to the north and west, which will further limit the disturbance footprint area, the proposed project is not expected to significantly impact on floral conservation in the region;
- No floral Species of Conservation Concern (SCC) listed by the International Union for the Conservation of Nature (IUCN) or listed under the National Environmental Management: Biodiversity Act (NEMBA; Act 10 of 2004) Threatened or Protected Species (TOPS; 2013) list were encountered within the study area;
- Two species listed by the South African National Biodiversity Institute (SANBI) as 'Declining' have been encountered within the study area, namely Boophane disticha and Vachellia erioloba;
- Two floral SCC listed as protected under the National Forest Act (Act 84 of 1998) were encountered within the study area, namely V. erioloba and V. haematoxylon;
- A single species protected under the Northern Cape Nature Conservation Act, 2009 (Act 9 of 2009) was encountered within the study area, namely Euphorbia duseimata and another Euphorbia species;

- A low diversity of alien species occurs within the study area. The Category 1b invasive species, Echinonopsis schickendantzii requires mandatory eradication; and,
- A relatively low abundance of medicinal species was encountered during the field assessment. Apart from Boophane disticha and V. erioloba, these medicinal species are all commonly occurring species, and are not confined to the study area.

Based on the above impact assessment it is evident that there are three possible impacts on the floral and faunal ecology respectively within the study area. The tables below summarise the findings, indicating the significance of the impacts before management takes place and the likely impact if management and mitigation takes place. From the table, it is evident that after mitigation, all potential floral impacts may be reduced from Medium-High and Medium-Low to Medium-Low and Low significance levels.

Figure 2-4: Summary of assessment of floral ecological impacts results

Impact	Unmanaged	Managed
1: Impact on habitat for floral species	Medium-Low	Low
2: Impact on floral diversity	Medium-Low	Low
3: Impact on floral SCC	Medium-High	Medium-Low

2.3.3 CUMULATIVE IMPACTS

Development of the proposed slimes dam within the study area will contribute to the cumulative loss of Kathu Bushveld within the region. However, due to the relatively small development footprint and due to the study area being located immediately adjacent to an existing slimes dam, whereby edge effects have already impacted to some degree on the ecological integrity of the northern portions of the study area, the cumulative impact of the development is not considered to be significant.

2.3.4 NO-GO ALTERNATIVE

Should the development of a slimes dam within the study area not take place, no direct loss of habitat within the study area will occur and the Vachellia erioloba and V. haematoxylon trees present will remain intact. It is however important to note, that even if no development of the study area takes place, its location immediately adjacent to existing mining activity in the north and west is likely to lead to habitat deterioration over time as a result of edge effects.

3 CONSTRUCTION PHASE IMPACT ASSESSMENT

3.1 INTRODUCTION

This phase of the project involves all those activities related to preparation of the site and subsequent construction/establishment (e.g. vegetation stripping, topsoil stripping, earthworks/levelling/excavations, construction and engineering services installations,).

In general the construction phase impacts are similar to those expected for any significant construction activities on the mine are thus reflect those indicated in Appendix 2.

3.2 AIR QUALITY

3.2.1 INTRODUCTION

During construction, the undertaking of earth and civil works leads to the generation of vehicle and wind entrained particulate matter (dust). Although the impact is likely to be localised to the site, dust suppression techniques such as wetting roads, or application of dust palliatives, are required. Other emissions, e.g. construction vehicle and machinery exhausts are not anticipated to be significant. Vegetation stripping exposes bare soils surfaces to wind action, such that dust generation may increase where development areas are stripped of vegetation. It must, however, also be noted that the extent of vegetation cover in naturally vegetated habitat of this area is low when compared to other vegetation types (i.e. % bare ground is significant for the *status quo*). Any vegetation stripping will still contribute to cumulative dust generation, particularly in windy conditions, irrespective of the nominal natural vegetation cover.

3.2.2 IMPACT DISCUSSION & SIGNIFICANCE ASSESSMENT

The impact will be of a low intensity and isolated to the site and its immediate surrounds. Effective mitigation, in the form of accepted dust suppression techniques, can be applied, but will not likely mitigate the potential occurrence of the impact in its entirety (i.e. residual impacts may be noticeable, but will be negligible relative to the original impact). The residual impacts will occur up until the point at which construction activities cease and when concurrent rehabilitation of applicable affected areas has been completed (i.e. some areas affected by vegetation clearance and topsoil stripping could feasibly be rehabilitated immediately thereafter once construction ceases).

Table 3-1: Impacts on Air Quality – Significance Rating		
Nature (N)	Negative impact on ambient air quality.	1
Extent (E)	Locally: Localised to the site and immediate surrounds	2
Duration (D)	Medium term: Construction phase (conservatively anticipated for up to a year)	3
Intensity (I)	Minor: Natural processes or functions will hardly be affected	2

Table 3-1: Impacts on Air Quality – Significance Rating			
Probability (P)	Likely: Impact will likely occur, to the extent that provisions must be made for the mitigation thereof		2
Mitigation (M)	Well mitigated: Effective dust suppression methods readily available		4
Enhancement (H)	N/A		-
Reversibility (R)	Irreversible: Not practical to reverse the impact once it has occurred		1
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Negligible**	8
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	20
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

3.2.3 MANAGEMENT ACTIONS

Assmang will institute effective dust suppression measures on all un-surfaced access and haul roads for the duration of the construction phase. Compliance thereto will be measures against the national dust control regulations and associated thresholds.

3.3 CONSTRUCTION AND INSTALLATION WASTE GENERATION (CONTRIBUTION TO LANDFILL)

3.3.1 INTRODUCTION

Waste will be generated during the construction of the proposed project structures and installation of tailings and water reticulation systems. The waste would predominantly comprise of packaging, building waste/rubble, steel and electric cabling waste. It is likely that most, if not all, of the waste generated would be non-hazardous/general waste. The generation of significant quantities of general waste could indirectly impact on the operational lifespan of the Black Rock waste disposal facility, through the permanent occupation of remaining available airspace at this facility. The same principle would apply to the applicable hazardous landfill facility/ies to which hazardous waste generated during construction will be taken for disposal. Note: Impacts of temporary onsite waste storage on surface- and ground water quality will be assessed under 'surface- and ground water quality'. Minor quantities hazardous waste in the form of used oil and oily rags from equipment maintenance is expected. General waste will deposited at the licenced Back Rock Landfill, whereas hazardous waste will have to be disposed of at licenced hazardous waste facility.

3.3.2 IMPACT DISCUSSION & SIGNIFICANCE ASSESSMENT

The impact will have National extent; where hazardous wastes are concerned (i.e. in the absence of a suitably licensed hazardous landfill facility in the Northern Cape). The intensity of the impact will, however, be low relative to cumulative National and regional waste generation volumes (general and hazardous waste generation).

<table>
<tr><th colspan="4">Table 3-2: Impacts of Construction Waste Generation – Significance Rating</th></tr>
<tr><td>Nature (N)</td><td colspan="2">Indirect negative impact on landfill airspace availability.</td><td>1</td></tr>
<tr><td>Extent (E)</td><td colspan="2">National: Use of hazardous landfill beyond the provincial boundary</td><td>5</td></tr>
<tr><td>Duration (D)</td><td colspan="2">Medium term: Construction phase (conservatively anticipated for up to a year, or possibly two)</td><td>3</td></tr>
<tr><td>Intensity (I)</td><td colspan="2">Negligible: The anticipated impact will be negligible, with no discernible effect on relative airspace availability.</td><td>1</td></tr>
<tr><td>Probability (P)</td><td colspan="2">Definite: The generated of waste during the construction phase is largely unavoidable (the amount generated can, however, be managed)</td><td>4</td></tr>
<tr><td>Mitigation (M)</td><td colspan="2">Slightly: A small reduction in the volumes of waste generated can likely be effected during construction</td><td>2</td></tr>
<tr><td>Enhancement (H)</td><td colspan="2">N/A</td><td>-</td></tr>
<tr><td>Reversibility (R)</td><td colspan="2">Moderately reversible through reuse, recovery and/or recycling initiatives: Where the impact relates to contribution to landfill, any measure implemented to reuse, recover, or recycle such waste would constitute the reversal of the impact</td><td>3</td></tr>
<tr><td>Significance Rating with Mitigation - Negative Impact (S)</td><td>N x (E+D) x I x P ÷ ½(M+R)</td><td>Low</td><td>12.8</td></tr>
<tr><td>Significance Rating without Mitigation - Negative Impact (S)</td><td>N x (E+D) x I x P ÷ ½(M+R)</td><td>Low</td><td>16</td></tr>
<tr><td>Significance Rating -Positive Impact (S)</td><td colspan="2">N x (E+D) x I x P x (H).</td><td>-</td></tr>
</table>

3.3.3 MANAGEMENT ACTIONS

Contractors will be required to provide a method statement specific to waste minimisation, reuse, recovery and recycling, as well as temporary storage and disposal; where such plans would need to be signed off by competent site environmental personnel/environmental control officer prior to the start of construction activities.

All construction and installation waste will be stored temporarily in a way that protects surface- and groundwater, and appropriately disposed of at the permitted Black Rock disposal site (i.e. where the waste in question is classified as general waste), or stored temporarily prior to collection by a suitably licensed waste disposal contractor in the event that hazardous waste is generated. Temporary waste storage areas will be sited under the guidance of site environmental personnel prior to the start of construction activities. Construction personnel will be trained in their correct use and the sites will be regularly inspected to ensure that they are being appropriately managed.

3.4 TOPOGRAPHY

3.4.1 INTRODUCTION

The primary relevance of assessing the project impacts on topography is to determine the indirect impacts thereof on site surface water run-off; where alterations to the storm water regime of the site could in turn influence soil erosion and rainwater infiltration rates (i.e. in the absence of any storm water controls). The sandy soils typical of the preferred site alternative generally do not facilitate significant surface water run-off, but rather infiltration thereof over short distances at surface following rainfall events. The flat nature of the subject terrain, furthermore, limits the extent (i.e. quantity and velocity thereof) to which significant surface storm water run-off is anticipated.

3.4.2 IMPACT DISCUSSION & SIGNIFICANCE ASSESSMENT

The projects impacts on site topography will likely be minor as the site will largely be flattened.

Table 3-3: Impacts on Topography – Significance Rating			
Nature (N)	Indirect negative impact on surface storm water regime.		1
Extent (E)	On site		1
Duration (D)	Life of Mine: Approximately 30 years		5
Intensity (I)	Minor: 'Borrow', as well as 'fill', applications will alter the environment, but natural hydrological processes are hardly affected.		2
Probability (P)	Definite: Natural site topography will be altered through proposed construction activities.		4
Mitigation (M)	Moderately mitigated: Effective mitigation can be applied to managing altered surface water run-off, but the impact may still be noticeable relative to the original impact.		3
Enhancement (H)	N/A		-
Reversibility (R)	Mostly reversible at end of life of mine through shaping and rehabilitation efforts corresponding to end land use planning at the end of life of mine		4
Significance Rating	N x (E+D) x I x P ÷	**Low**	13.7

Table 3-3: Impacts on Topography – Significance Rating			
-Negative Impact with mitigation (S)	½(M+R)		
Significance Rating -Negative Impact without mitigation (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	19.2
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

3.4.3 MANAGEMENT ACTIONS

If required, Assmang will, to the greatest extent practical and feasible, borrow material from areas where other site structures and infrastructure are proposed for establishment (i.e. if the underlying parent material at those locations is suitable for required 'fill' applications elsewhere on the project).

Furthermore, a system of storm water management will be implemented to avoid surface water run—off from the TSF to the surrounding environment.

3.5 SURFACE- AND GROUNDWATER QUALITY

The inappropriate storage, management and handling of fuel, oil and other potentially hazardous chemicals and substances during the construction period could result in potentially negative impacts on surface- and ground water quality.

3.5.1 IMPACT DISCUSSION & SIGNIFICANCE ASSESSMENT

The anticipated extent of potentially contaminated surface water run-off will be negligible. This is as a result of the sandy nature of the underlying soils; where surface water will readily infiltrate soil surfaces in close proximity to the point of contamination, as opposed to travelling any significant distance at surface. The potential for the contamination of any surface water resources through contaminated surface water flows during construction is thus deemed negligible. However infiltration may ultimately result in groundwater contamination.

Table 3-4: Impacts on Surface- and Ground Water Quality – Significance Rating		
Nature (N)	Negative impacts on surface- and ground water quality.	1
Extent (E)	Site and immediate surrounds: Ready infiltration of storm water into sandy underlying soils will limit the extent of the potential impact to the site itself (i.e. groundwater environment)	2
Duration (D)	Long term: Treatment of groundwater contamination (i.e. once occurred) is a long and arduous process	4
Intensity (I)	Major: Adjacent farmers/farming communities reliant on groundwater for their livelihood	4

Table 3-4: Impacts on Surface- and Ground Water Quality – Significance Rating			
Probability (P)	Likely: Impact likely to occur, to the extent that provisions must be made for it		2
Mitigation (M)	Well mitigated: A comprehensive range of effective mitigation measures is readily available		4
Enhancement (H)	N/A		-
Reversibility (R)	Irreversible: No amount of time or money will sustainably reverse the impact		1
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	19.2
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	48
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

3.5.2 MANAGEMENT ACTIONS

The remediation of contaminated groundwater is a long, arduous and costly process. Any such remediation efforts may also likely leave significant residual contamination, despite any such remediation attempts (dependant on the nature and extent of the contamination itself). As such, Assmang's management actions should focus on the prevention of any such potential hydrocarbon contamination, rather than post impact remediation thereof. A comprehensive range of effective, proven, mitigation measures will be implemented in this regard, which are in principle as follows:

- All hazardous substances to be stored within appropriately sized, impermeable, bund walls;
- Storm water control measures to be implemented that prevent the free movement of 'clean' storm water run-off through the aforementioned storage areas, as well as any service yards and wash bays;
- Hazardous substances spill kits to be readily available at all points where hazardous substances will be stored and/or transferred (e.g. refuelling points);
- Vehicle and plant servicing to only take place in dedicated service yards on impermeable surfaces coupled with appropriate 'dirty' water containment systems/sumps and oil/water separators; and
- Drip trays to be appropriately placed under vehicles and plant that over-night on bare soil surfaces.

3.6 BIODIVERSITY

Based on the ecological specialist's impact assessment it is evident that there are three possible impacts on the floral and faunal ecology respectively within the study area. The tables below summarise the findings, indicating the significance of the impacts before management takes place and the likely impact if management and mitigation takes place. From the table, it is evident that after mitigation, all potential floral impacts may be reduced from Medium-High and Medium-Low to Medium-Low and Low significance levels. Importantly:

- Two species listed by the South African National Biodiversity Institute (SANBI) as 'Declining' have been encountered within the study area, namely Boophane disticha and Vachellia erioloba;
- Two floral SCC listed as protected under the National Forest Act (Act 84 of 1998) were encountered within the study area, namely V. erioloba and V. haematoxylon;
- A single species protected under the Northern Cape Nature Conservation Act, 2009 (Act 9 of 2009) was encountered within the study area, namely Euphorbia duseimata and another Euphorbia species;
- A low diversity of alien species occurs within the study area. The Category 1b invasive species, Echinonopsis schickendantzii requires mandatory eradication; and,
- A relatively low abundance of medicinal species was encountered during the field assessment. Apart from Boophane disticha and V. erioloba, these medicinal species are all commonly occurring species, and are not confined to the study area.

Table 3-5: Impacts on Biodiversity – Significance Rating		
Nature (N)	Negative impacts on site biological diversity	1
Extent (E)	Nationally: Four floral species identified on site are afforded protection, in terms of law, on a National scale.	5
Duration (D)	Very long term: The impact will be largely reversed at the end of life of mine, but it may take several decades thereafter for floral species (particularly woody species) to re-establish.	5
Intensity (I)	Major: The disturbance to site flora and fauna will disrupt functions and processes at a localised level, thereby reducing diversity. Required removal of protected floral species.	3
Probability (P)	Definite: Vegetation clearance is required for the establishment of site structures and supporting infrastructure	4
Mitigation (M)	Moderately mitigated: The impact can be substantially off-set/mitigated through the establishment of an indigenous tree nursery LED project, and 'ecological off-set' area establishment, as well as concurrent rehabilitation respectively, but the residual impact will still be noticeable or significant, relative to the original impact	3
Enhancement (H)	N/A	-
Reversibility (R)	Mostly reversible: Rehabilitation efforts at closure will largely reverse the impact, although this may	4

Table 3-5: Impacts on Biodiversity – Significance Rating			
	never entirely return the site to its 'natural', pre-development, condition		
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	**17.14**
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	**30**
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

3.6.1 MANAGEMENT ACTIONS

The following actions are required:

- The boundaries of the development footprint areas are to remain as small as possible, be clearly defined and it should be ensured that all activities remain within defined footprint areas.
- Placement of temporary roads and access routes should be limited to existing roads or should be placed immediately adjacent to the proposed slimes dam footprint.
- Vehicles should be restricted to travelling only on designated and existing roadways to limit the ecological footprint of the proposed development activities.
- Edge effects of all construction activities, such as erosion and alien plant species proliferation, which may affect floral habitat, need to be strictly managed in adjacent natural areas. Alien species should be eradicated and controlled to prevent their spread beyond the mine development footprint areas. Specific mention is made of Echinopsis schickendantzii as encountered in the study area, as well as Prosopis glandulosa and Verbesina encelioides known to occur in the region, and the prevention and control Senegalia mellifera subsp detinens encroachment.
- Floral SCC encountered within the development footprint, are to be relocated as appropriate. This specifically relates to Boophane disticha, Euphorbia duseimata and another Euphorbia species which can be successfully rescued and relocated under the supervision of a qualified botanist.
- Floral SCC are to be handled with care and the relocation of these plant species to suitable similar habitat is to be overseen by a botanist.
- Permit to relocate floral SCC protected under NCNCA (Act 9 of 2009) are to be obtained from relevant departments for their removal or relocation.
- Permits are to be obtained for the destruction of approximately 1470 Vachellia erioloba and 2089 V. haematoxylon under the National Forests Act (Act 84 of 1998).

- No Vachellia erioloba or V. haematoxylon are to be needlessly destroyed and such activities must strictly be limited to specimens falling directly within the project footprint.
- It is recommended that, should such permits be obtained, the wood from felled Vachellia erioloba and V. haematoxylon be made available for use by local communities.
- Harvesting of floral species by mining and operational personnel within adjacent areas should be strictly prohibited.
- Monitoring of relocation success of Boophane disticha and Euphorbia duseimata should continue during the operational phase.

3.7 SOIL

3.7.1 INTRODUCTION

Soil is susceptible to various types of degradation brought about by mining and mine related activities, which can result in a potential decline in associated soil quality from a physical, chemical and biological perspective (Fuggle and Rabie, 2009). Topsoil conservation is of particular importance where it will be used to facilitate the rehabilitation of disturbed areas during subsequent phases of the project. Topsoil stripping and the subsequent stockpiling thereof is common-place during the construction phase mining projects; where topsoil is stripped from pre-determined surface development footprints prior to the construction/establishment of proposed mining structures and infrastructure.

The services of a specialist soil scientist (Professor Andries Claasens) were commissioned for the BRMO expansion project to assess the potential project impacts with respect to:

- establishing the appropriate depth to which the site topsoil should be stripped in preparation of construction activities, in order to ensure adequate subsequent preservation thereof for rehabilitation efforts at mine closure;
- requirements for topsoil stockpiling;
- requirements for topsoil remediation; for reuse thereof in rehabilitation after mine closure; and
- providing a broad overview of the soil types/characteristics on all the farms comprising the greater BRMO mine lease area.

3.7.2 IMPACT DISCUSSION & SIGNIFICANCE ASSESSMENT

Table 3-6: Impacts on Soils – Significance Rating		
Nature (N)	Potentially negative impacts on topsoil structure and suitability for use in rehabilitation of disturbed areas at closure.	1
Extent (E)	Site: The impact will be isolated to the development site	1
Duration (D)	Very long term: Topsoil stockpiled for the life of the mine following the stripping thereof during	5

Table 3-6: Impacts on Soils – Significance Rating			
	construction		
Intensity (I)	Minor: The stripping (i.e. during construction) and subsequent replacement thereof (i.e. at mine closure and rehabilitation) will result in alterations to the post-development environment, in terms of topsoil integrity, that will hardly effect natural processes.		2
Probability (P)	Definite: Topsoil will be stripped and stockpiled		4
Mitigation (M)	Well mitigated: Well established topsoil conservation measures readily available to Assmang for implementation		4
Enhancement (H)	N/A		-
Reversibility (R)	Mostly reversible: Any reduction in soil quality (chemical and biological) resulting from the stockpiling thereof can be easily reversed prior to replacement thereof over disturbed areas,		4
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	12
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	19.2
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

3.7.3 MANAGEMENT ACTIONS

3.7.3.1 Stripping depth:

Because the A horizon is relatively thin (20 cm), with a very low organic content, no specific recommendation are made on how deep the topsoil should be excavated prior to the commencement of construction. The excavation could be deeper than 20 cm. The normal practice is to excavate to 30 cm before the surface is prepared for construction is acceptable. A variable topsoil stripping depth of 20-30 cm is thus advocated.

3.7.3.2 Handling of stockpiled soil:

Because of the texture of the soil and the size distribution of the different sand fraction of the soil, the soil will not tend to compact and become cemented when stockpiled. No special arrangements are thus deemed necessary for stockpiling, in terms of height restrictions applicable to such. The above is true with respect to the preservation of soil structure. The degree to which naturally occurring 'seed banks' are preserved in the stockpiled material will, however, be indirectly influenced by the height of the stockpile material. As such, Assmang should aim to stockpile topsoil to within 3m above ground level as far as is practical. Appropriate storm water control measures must be implemented to minimise erosion of the stockpiles.

3.7.3.3 Soil preparation for remediation:

Although the subject topsoil is not very fertile, the stockpiled soil can be used as is to reclaim disturbed areas at mine closure. No fertilizer program is recommended, because it is assumed that the disturbed areas will be re-vegetated with naturally occurring grass species which are adapted to the local environment. Stockpiled topsoil should be replaced at closure to the depth at which it was initially stripped prior to the establishment of mine structures and infrastructure. As such, the depth to which topsoil was stripped needs to be recorded at the time of stripping and mapped accordingly for the purposes of sound rehabilitation of disturbed areas at closure.

A soil testing programme, undertaken by an appropriately qualified soil and pant nutrition specialist, will need to be instituted prior to the use of stockpiled material in rehabilitation. The study will confirm the suitability of stockpiled topsoil as medium for plant growth, as well as any potential amelioration required upon reuse thereof, in rehabilitation of disturbed areas. Preliminary specialist investigations, however, suggest that no such amelioration will be required.

3.8 HERITAGE RESOURCES

No heritage resources of significance have been identified in the area of interest nor during other construction activities on the sites surrounding the are. The impact is therefore deemed negligible.

3.9 NOISE

3.9.1 INTRODUCTION

The holder of a mining right must comply with the provisions of the Mine Health and Safety Act, 1996 (Act No. 29 of 1996), as well as any other national norms and standards regarding noise management (Fuggle and Rabie, 2009). Predominant construction related noise impacts are anticipated from the following sources:

- Heavy vehicle movement and operation associated with ground works and building activities (i.e. dump trucks, excavators, TLBs, cranes, graders, earth compacters, etc.); and
- Drilling and blasting (i.e. structural works and shaft sinking respectively).

3.9.2 IMPACT DISCUSSION & SIGNIFICANCE ASSESSMENT

General construction

Based on the fining of the BRMO expansion environmental impact assessment two aspects are important when considering the potential noise impacts of a project and these are as follows:

- The anticipated increase in the ambient noise level; and
- The overall ambient noise level produced.

The aforementioned activities will be development site specific and the construction equipment that will be used during the construction phase, as well as the anticipated line of sight noise reductions associated with each, is given in Table 3-7.

Table 3-7: Construction Vehicle Line-of-sight Estimated Noise Level Attenuation – dBA (m)

Equipment	Line-of-sight Estimated Noise Level Attenuation – dBA (m)						
	5	10	20	40	80	160	320
Cumulative distance from source	**5**	**15**	**35**	**75**	**155**	**315**	**635**
Excavator 12000	78.3	68.3	58.3	52.3	46.3	40.3	34.3
Dozer D155	83.3	73.3	63.3	57.3	51.3	45.3	39.3
Grader 140H	97.4	87.4	77.4	71.4	65.4	59.4	53.4
VolvoA40	85.6	75.6	65.6	59.6	53.6	47.6	41.6
HD 325	91.3	81.3	71.3	65.3	59.3	53.3	47.3
TLB	94.4	84.4	74.4	68.4	62.4	56.4	50.4
Lighting Plant	85.8	75.8	65.8	59.8	53.8	47.3	41.3
Bell B40	86.1	76.1	66.1	60.1	54.1	48.1	42.1

The noise reduction calculated in Table 3-7 are for direct line-of-sight and medium to hard ground conditions. The combined noise level at the distance 635 m from the source, should all the above machinery operate at one time, will be 49.4 dBA. A realistic figure will, however, be 46.8 dBA as all the machinery is not likely to operate at one time and in one area. Engineering control measures and topography can have an influence on how the noise level is perceived by the receptors in vicinity of the site.

Table 3-8: Impacts of Construction Noise – Significance Rating

Nature (N)	Negative impacts of construction related noise on sensitive receptors		1
Extent (E)	Locally: Within the vicinity of the site		2
Duration (D)	Medium term: Construction phase/shaft work conservatively anticipated for up to a year, or possibly two.		3
Intensity (I)	Minor: Sensitive receptors hardly affected		2
Probability (P)	Likely: There is a possibility that the impact will occur, to the extent that provisions must be made for it.		2
Mitigation (M)	Slightly mitigated: Limited avoidance and minimisation through design and blast criteria standards		2
Enhancement (H)	N/A		-
Reversibility (R)	Irreversible: Blast waves and noise irreversible once generated		1
Significance Rating with Mitigation -	N x (E+D) x I x P ÷ ½(M+R)	**Low**	13

Table 3-8: Impacts of Construction Noise – Significance Rating			
Negative Impact (S)			
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	20
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

3.9.3 MANAGEMENT ACTIONS

Given that construction activities will be undertaken during normal working hours, and given the impact of current activities at the processing plant and expansion project activities, it is expected that the no further management actions are required other than to ensure that vehicles and machinery have adequate silencing per general mine health safety requirements.

3.10 TRAFFIC

3.10.1 INTRODUCTION

Basd on the BRMO expansion EIA studies, the R31 between Kuruman and Hotazel has experienced significant traffic growth of between 20% and 30%, year on year, for the period 2006-2011. Heavy vehicle growth contribution to the aforementioned figures is estimated at 60-70% increases year on year. The current traffic loading on this road section far exceeds the original designed volume, which is the probable reason why the road is presently in a poor condition (Figure 3-1).

Poor road condition and user safety is attributed to varying incidences/degrees of the following road conditions along the applicable 63 km road section:

- Road edge breaks;
- Poor quality of edge break repairs;
- Block cracking;
- Dry and brittle condition of road surface;
- 'Crocodile cracks' and 'pumping';
- Rutting;
- Surface water ponding;
- Severe shoulder drop-offs;
- Poorly maintained/non-existent guard rails;
- Stray animal occurrence; and
- Narrow road width (2.8 m per lane) relative to design standard appropriate to the type of vehicles traversing the R31 (3.7 m per lane), which is further exacerbated by edge break effects.

The establishment of the structures and infrastructure proposed as part of the project would require the transport of construction materials and large pieces of equipment, pre-fabricated elsewhere, to the site. This, in addition to the daily transport of construction workers, would lead to an increase in heavy vehicle traffic to the site, although temporary in nature (i.e. during construction). The increased traffic volumes and/or slow moving heavy vehicles could cause a nuisance to other road users, as well as contributing toward further degradation of the condition of the R31 road, as well as inferred road user safety.

	
Severe edge breaks	**High shoulder drop-off**
	
Poorly maintained guardrail/s	**Crocodile cracking**

Figure 3-1: Photographic examples of deteriorated R31 road condition

3.10.2 IMPACT DISCUSSION & SIGNIFICANCE ASSESSMENT

It is evident that the present poor condition of certain sections, as well as overall inadequate design, of the R31 already impacts upon road users, and particularly their safety. Several complexities arise through out of an assessment of the individual project's impacts on traffic and road user safety during the construction period. These are detailed as follows:

- In isolation, the impacts of the project on traffic and road user safety could be seen as significant, but relative to the existing traffic volumes and present poor condition of the R31, the cumulative negative impact could be viewed as being relatively insignificant;
- There are several mines and industrial operations within a 10 km radius of BRMO that make substantial use of the R31 between Kuruman and Hotazel. Any impact of the specific project on the localised road network and users thereof thus needs to be viewed as a relative additive contribution to the impacts of other existing operations on the overall cumulative impact. Such

an approach is made cumbersome and impractical at the level of an EIA undertaken for single operation;

- Assigning responsibility, in terms of the required upgrade/repair and ongoing maintenance of the R31, cannot be laid solely at the door of any one individual mining house, or industrial operation, in the area; and
- The relevant district and local municipalities are essentially responsible for the up-keep of the R31. Any strategic initiative by private entities to upgrade the R31 needs to be done in close collaboration with, and under consent from, these municipal parties.

Table 3-9: Cumulative impact on R31 Road Condition – Significance Rating			
Nature (N)	Additive contribution to negative cumulative impact associated with increased traffic volumes (light and heavy vehicles)		1
Extent (E)	Regionally: Potential impact as far as Kuruman/Kathu		3
Duration (D)	Medium term: Construction phase/shaft sinking (bulk of work conservatively anticipated for up to a year, or possibly two)		3
Intensity (I)	Moderate: The R31 will still be available for use by other road users, albeit with increased construction related traffic thereon.		3
Probability (P)	Very likely: It is highly anticipated that existing, regular, road users will experience the increased volumes of traffic as a nuisance, but this is not certain.		3
Mitigation (M)	Slightly mitigated: Restriction of delivery times to off-peak traffic periods, as well as carpooling/bussing of construction workers to the site on a daily basis		2
Enhancement (H)	N/A		-
Reversibility (R)	Slightly reversible: With respect to R31 road condition deterioration.		2
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	27
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	36
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

3.10.3 MANAGEMENT ACTIONS

Assmang has in the past contributed to the up-keep of roads in the area and would continue to do so into the future, to an extent based on proportional road use by their vehicles. A 'Preliminary Status Quo Report' for the Kuruman-Hotazel road (i.e. R31), inclusive of a proposed upgrade strategy, was compiled in April 2011 by VELA VKE Consulting Engineers, at the request of the district municipality, BHP Billiton and Assmang Manganese Mines. The latter two being the more established mining entities in the Hotazel area.

While little project specific mitigation is proposed, or deemed feasible, Assmang should continue to seek strategic solutions to the problem in conjunction with other prominent road users and the relevant local authorities. A potential solution to alleviating the poor road condition and implementing ongoing maintenance of the R31 is put forward in terms of potential immediate (0-1 years), short (1-3 years), medium (3-10 years) and long term (10-20 years) measures in a 2011 VELA VKE road upgrade strategy. It would not be appropriate for this EIA, or associated EMPR, to commit Assmang to the sole implementation of the aforementioned plan, nor would it be appropriate (or have legal standing) to commit other mining houses to the joint implementation of the upgrade strategy. It is, however, in Assmang's and other mining houses' own interest to ensure that the condition of the R31 is upgraded in a sustainable manner that will optimise their own individual operations and improve safety for their own employees along this route.

Seeking a solution to this matter is deemed well beyond the scope of this EIA, as the route of the problem extends well beyond the battery limits of the study and involves several other parties' commitment to such. As such a strategic solution amongst all parties concerned needs to be sought, that partitions relative involvement in implementation.

4 OPERATIONAL PHASE

4.1 INTRODUCTION

The operational phase of the TSF projected to be is approximately 20 years. Potentially significant environmental issues during the operation phase will consist in the main of:

- Potential Leaching to groundwater.
- Prevention of contamination of clean storm water.
- Potential overflow from the return water dam.
- Potential for dust entrainment.
- Visual impact of the facility as it grows in height.
- Noise impact from operations.

All of the aforementioned operational activities have the potential to impact on one, or more, environmental parameters, as evaluated and described in the following sections.

4.2 AIR QUALITY

The top surface of the TSF will generally be wet, thus no significant entrainment of particulates is expected therefrom. Where fines have been deposited, at both Nchawning 2 and Gloria, the material forms a crust upon drying. There is no visible entrainment by wind and it is clear from visual inspection that crusts are well consolidated with no significant loose material that has the potential to be wind entrained.

It is therefore not expected there would be any significant emissions to atmosphere from the proposed TSF during the operational phase.

Generation of particulate emissions during the operational phase will be managed in accordance with the existing construction phase environmental management provisions. These have been proven to be effective for construction activities undertaken during the mine expansion as measured dustfall has been maintained within the requirements of the National Dust Control Regulations GN.R 827 of 2013.

Table 4-1: Impact on Air Quality – Significance Rating			
Nature (N)	Negative: Negative impacts on ambient air quality.		1
Extent (E)	Locally: Within the vicinity of the site.		2
Duration (D)	Very long-term: Impact will persist for the operational lifespan of the TSF		4
Intensity (I)	Moderate: the environment is altered, but function and process continue, albeit in a modified way;		3
Probability (P)	Unlikely: The entrainment of potentially significant amounts of particulates is unlikely.		1
Mitigation (M)	• Unmitigated: no mitigation is required.		1
Enhancement (H)	N/A		-
Reversibility (R)	Irreversible: Once emissions are emitted to the atmosphere, no amount of time or money will allow Assmang to ‘re-capture’ such.		1
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	**18**
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	**18**
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H)		-

4.3 GROUNDWATER AND SURFACE WATER

As indicated in section "2.2 Risk to Groundwater" the specialist's findings is:

- The contribution of the new proposed tailings as a source of contamination is very unlikely and statistically insignificant;
- The pathway through the unsaturated zone is not a viable pathway on life-of-mine timescales, and is probably relatively impermeable to groundwater infiltration;
- No sensitive receptors are currently present in the area of mining; and,
- Based on a previous study, no environmental benefit is expected from installing a liner beneath a new tailings facility adjacent to an unlined tailings facility;

It is concluded that the source-receptor linkage is incomplete in the mining area, and that "(the) risk of seepage entering the groundwater environment and reaching receptors with no lining using existing leach results for Life of TSF, 20 years, 50 years and *100 years"* is indeed negligible.

The surrounding topography is largely flat and composed of highly permeable Kalahari sand. In conjunction with low rainfall (300mm per annum) and high evaporation rates (as much as 3000 mm/annum), the area is arid with no evidence of surface water flow. Rainfall permeates and evaporates rapidly. There will thus be no surface water flow to the facility. Rain falling on the TSF will be captured within the TSF. Impact on surface water is thus expected to be negligible.

Table 4-2: Impacts on surface groundwater		
Nature (N)	Negative: Negative impact on the groundwater environment.	1
Extent (E)	Locally: Within the general vicinity of the site	2
Duration (D)	Very long term: For example, groundwater pollution, even if treated, will persist for a very long time – if not permanently	5
Intensity (I)	Major: The disturbance to the environment is enough to disrupt existing functions or processes (i.e. agricultural practices and human health due to borehole water ingestion), resulting in reduced diversity; the system could be damaged to the extent that it is no longer what it used to be, but there are still remaining functions; the system will probably decline further without positive intervention.	4
Probability (P)	Unlikely: the possibility of the impact occurring is very low.	1
Mitigation (M)	Well mitigated: the use of liner will significantly reduce leachate release below the TSF.	4

Table 4-2: Impacts on surface groundwater			
Enhancement (H)	N/A		-
Reversibility (R)	Slightly reversible: The pollution of groundwater is by no means easy to reverse and will require much effort, taken immediately after the impact, and even then, the final quality will not match the original environment prior to the impact.		2
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Negligible**	9.33
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	14
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

4.3.1 MANAGEMENT ACTIONS

As per the requirements of the site's WUL, a Class C liner will used unless otherwise permitted by the WUL.

4.4 POTENTIAL OVERFLOW FROM RETURN WATER DAM

The minimum freeboard target will be to accommodate the 1 in 50-year, 24-hour storm volume plus 0.8 m dry freeboard on top of the normal operating level (excluding decant return). In the unlikely event that the return water dam reaches full capacity, excess water can be directed to the BRMO process water system which has significant buffer capacity including two 25ML process water reservoirs at Nchwaning 2 plant and a 50 ML process water dam at the Black Rock clarifier complex.

Table 4-3: Potential Overflow From Return Water Dam		
Nature (N)	Negative: Negative impact on the groundwater environment.	1
Extent (E)	Locally: Within the general vicinity of the site	2
Duration (D)	Very long term: For example, groundwater pollution, even if treated, will persist for a very long time – if not permanently	5
Intensity (I)	Major: The disturbance to the environment is enough to disrupt existing functions or processes (i.e. agricultural practices and human health due to borehole water ingestion), resulting in reduced diversity; the system could be damaged to the extent that it is no longer what it used to be, but there are still remaining functions; the system will probably decline	4

Table 4-3: Potential Overflow From Return Water Dam			
	further without positive intervention.		
Probability (P)	Unlikely: the possibility of the impact occurring is very low.		1
Mitigation (M)	Well mitigated: the system is design for 1:50 rainfall event, and there is buffer capacity in the process water system.		4
Enhancement (H)	N/A		-
Reversibility (R)	Slightly reversible: The pollution of groundwater is by no means easy to reverse and will require much effort, taken immediately after the impact, and even then, the final quality will not match the original environment prior to the impact.		2
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Negligible**	9.33
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	14
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

4.4.1 MANAGEMENT ACTIONS

As per the requirements of the site's WUL, a Class C liner will used unless otherwise permitted by the WUL.

4.5 NOISE

The nature of TSF operations is such that noise generated will be negligible.

Table 4-4: Operational phase noise impacts		
Nature (N)	Negative: Potential increases to current ambient noise levels	1
Extent (E)	Locally: Within the vicinity of the site	2
Duration (D)	Long-term: Impact will persist for the operational lifespan of the TSF	4
Intensity (I)	Negligible: there is an impact on the environment, but it is negligible, having no discernible effect	1
Probability (P)	Likely: There is a possibility that noise impacts will occur even though the noise levels will be minor.	3
Mitigation (M)	Unmitigated: no mitigation is planned	1

Table 4-4: Operational phase noise impacts			
Enhancement (H)	N/A		-
Reversibility (R)	Mostly reversible: Reversible at any stage of the operational lifetime of the mine, as well as at closure; where all noise generating infrastructure will be decommissioned.		4
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Negligible**	7.2
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Negligible**	4.5
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

4.5.1 MANAGEMENT ACTIONS

Should there be complaints noise disturbance, or should noise measurements indicate noise nuisance, then the source of the noise must be investigated. Reduction of noise at the source must be implemented, at source.

4.6 VISUAL AND AESTHETIC IMPACTS

The TSF will have a maximum vertical height of 20 m, and will be located adjacent to the existing TSF to the north, processing plant and stockpiles to the west, rail loop and load out station with stacker-reclaimer to the south. Existing structures at the adjacent processing plant are well in excess of 20m. The tallest of these is a 60m high ore storage silo. The visual impact is thus expected to be negligible in the context of existing facilities.

Table 4-5: Visual and Aesthetic Impact Significance Rating			
Nature (N)	Negative impact on visual character of the area		1
Extent (E)	Locally: Within the vicinity of the site and immediate surrounds		2
Duration (D)	Permanent unless reclaimed.		5
Intensity (I)	Low: Visual and scenic resources are not affected		2
Probability (P)	Definite: Distinct possibility that the impact will occur		4
Mitigation (M)	Unmitigated: No practical mitigation possible		1
Enhancement (H)	N/A		-
Reversibility (R)	Entirely reversible at Mine Closure and Decommissioning		4
Significance Rating with Mitigation -	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	22.4

Negative Impact (S)			
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	22.4
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

4.6.1 MANAGEMENT ACTIONS

In view of the existing visual impact from much taller structures no management actions are planned.

4.7 TRAFFIC

Traffic generated during the operational phase will be negligible. The employees working on the existing TSF will be transferred to the new TSF.

4.8 SOCIO-ECONOMICS

The employees working on the existing TSF will be transferred to the new TSF, thus no new jobs will be created. In general operations relevant t the current TSF will be transferred to the new TSF, therefore there should be a negligible socio economic effect.

5 DE- COMMISSIONING AND CLOSURE PHASE IMPACT ASSESSMENT

5.1 INTRODUCTION

This phase of the project involves all those activities related to cessation of operation and subsequent closure of the site. The site may be capped and vegetated or alternatively the material may be reclaimed to be sold or processed.

5.2 AIR QUALITY

5.2.1 INTRODUCTION

During construction of the capping, the undertaking of earth and civil works leads to the generation of vehicle and wind entrained particulate matter (dust) from deposition of material on the TSF. Although the impact is likely to be localised to the site, dust suppression techniques such as wetting roads, or application of dust palliatives, are required. Other emissions, e.g. construction vehicle and machinery exhausts are not anticipated to be significant.

Once vegetated the potential for wind entrained particulates should become similar to background conditions.

Should the tailings be reclaimed then the remaining footprint will be ripped, scarified and revegetated as well.

5.2.2 IMPACT DISCUSSION & SIGNIFICANCE ASSESSMENT

The impact will be of a low intensity and isolated to the site and its immediate surrounds. Effective mitigation, in the form of accepted dust suppression techniques, can be applied, but will not likely mitigate the potential occurrence of the impact in its entirety (i.e. residual impacts may be noticeable, but will be negligible relative to the original impact). The residual impacts will occur up until the point at which closure activities cease and when rehabilitation of applicable affected areas has been completed.

Table 5-1: Impacts on Air Quality – Significance Rating		
Nature (N)	Negative impact on ambient air quality.	1
Extent (E)	Locally: Localised to the site and immediate surrounds	2
Duration (D)	Medium term: Construction phase (conservatively anticipated for up to a year)	3
Intensity (I)	Minor: Natural processes or functions will hardly be affected	2
Probability (P)	Likely: Impact will likely occur, to the extent that provisions must be made for the mitigation thereof	2
Mitigation (M)	Well mitigated: Effective dust suppression methods readily available	4
Enhancement (H)	N/A	-

Table 5-1: Impacts on Air Quality – Significance Rating			
Reversibility (R)	Irreversible: Not practical to reverse the impact once it has occurred		1
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Negligible**	8
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	20
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

5.2.3 MANAGEMENT ACTIONS

Assmang will institute effective dust suppression measures on all un-surfaced access and haul roads for the duration of the construction phase. Compliance thereto will be measures against the national dust control regulations and associated thresholds.

5.3 WASTE GENERATION (CONTRIBUTION TO LANDFILL)

5.3.1 INTRODUCTION

It is anticipated that minor volumes of waste will be generated during the closure process. The waste would predominantly comprise of general waste such as packaging. Existing equipment will be salvaged for reuse. Waste will be disposed of to the Black Rock landfill. The generation of significant quantities of general waste could indirectly impact on the operational lifespan of the Black Rock waste disposal facility, through the permanent occupation of remaining available airspace at this facility. The same principle would apply to the applicable hazardous landfill facility/ies to which hazardous waste generated during construction will be taken for disposal.

5.3.2 IMPACT DISCUSSION & SIGNIFICANCE ASSESSMENT

The impact will have National extent; where hazardous wastes are concerned (i.e. in the absence of a suitably licensed hazardous landfill facility in the Northern Cape). The intensity of the impact will, however, be low relative to cumulative National and regional waste generation volumes (general and hazardous waste generation).

Table 5-2: Impacts of Construction Waste Generation – Significance Rating		
Nature (N)	Indirect negative impact on landfill airspace availability.	1
Extent (E)	National: Use of hazardous landfill beyond the provincial boundary	5
Duration (D)	Medium term: Construction phase (conservatively anticipated for up to a year, or possibly two)	3

Table 5-2: Impacts of Construction Waste Generation – Significance Rating			
Intensity (I)	Negligible: The anticipated impact will be negligible, with no discernible effect on relative airspace availability.		1
Probability (P)	Definite: The generated of waste during the construction phase is largely unavoidable (the amount generated can, however, be managed)		4
Mitigation (M)	Slightly: A small reduction in the volumes of waste generated can likely be effected during construction		2
Enhancement (H)	N/A		-
Reversibility (R)	Moderately reversible through reuse, recovery and/or recycling initiatives: Where the impact relates to contribution to landfill, any measure implemented to reuse, recover, or recycle such waste would constitute the reversal of the impact		3
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	12.8
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	16
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

5.3.3 MANAGEMENT ACTIONS

Contractors will be required to provide a method statement specific to waste minimisation, reuse, recovery and recycling, as well as temporary storage and disposal; where such plans would need to be signed off by competent site environmental personnel/environmental control officer prior to the start of construction activities.

All waste will be stored temporarily in a way that protects surface- and groundwater, and appropriately disposed of at the permitted Black Rock disposal site (i.e. where the waste in question is classified as general waste), or stored temporarily prior to collection by a suitably licensed waste disposal contractor in the event that hazardous waste is generated. Temporary waste storage areas will be sited under the guidance of site environmental personnel prior to the start of the activities. Personnel will be trained in their correct use and the sites will be regularly inspected to ensure that they are being appropriately managed.

5.4 TOPOGRAPHY

5.4.1 INTRODUCTION

The primary relevance of assessing the project impacts on topography is to determine the indirect impacts thereof on site surface water run-off; where alterations to the storm water regime of the site could in turn influence soil erosion and rainwater infiltration rates (i.e. in the absence of any storm water controls). The sandy soils typical of the preferred site alternative generally do not facilitate significant surface water run-off, but rather infiltration thereof over short distances at surface following rainfall events. The flat nature of the subject terrain, furthermore, limits the extent (i.e. quantity and velocity thereof) to which significant surface storm water run-off is anticipated.

5.4.2 IMPACT DISCUSSION & SIGNIFICANCE ASSESSMENT

If the material is reclaimed then the site will be reshaped rehabilitated such that erosion is prevented. If the TSF is capped then the final capping design must integrate water management to ensure there is no erosion and that there is no contamination of rainwater.

Table 5-3: Impacts on Topography – Significance Rating			
Nature (N)	Indirect negative impact on surface storm water regime.		1
Extent (E)	On site		1
Duration (D)	Life of Mine: Approximately 30 years		5
Intensity (I)	Minor: 'Borrow', as well as 'fill', applications will alter the environment, but natural hydrological processes are hardly affected.		2
Probability (P)	Definite: Natural site topography will be altered through proposed construction activities.		4
Mitigation (M)	Moderately mitigated: Effective mitigation can be applied to managing altered surface water run-off, but the impact may still be noticeable relative to the original impact.		3
Enhancement (H)	N/A		-
Reversibility (R)	Mostly reversible at end of life of mine through shaping and rehabilitation efforts corresponding to end land use planning at the end of life of mine		4
Significance Rating -Negative Impact with mitigation (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	13.7
Significance Rating -Negative Impact without mitigation (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	19.2
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

5.4.3 MANAGEMENT ACTIONS

Storm water management will be implemented to avoid surface water run—off from the capped TSF to the surrounding environment. If the material is reclaimed then the site will be reshaped rehabilitated such that erosion is prevented.

5.5 SURFACE AND GROUNDWATER QUALITY

The inappropriate storage, management and handling of fuel, oil and other potentially hazardous substances during the closure activities could result in potentially negative impacts on surface- and ground water quality.

5.5.1 IMPACT DISCUSSION & SIGNIFICANCE ASSESSMENT

The anticipated extent of potentially contaminated surface water run-off will be negligible. This is as a result of the sandy nature of the underlying soils; where surface water will readily infiltrate soil surfaces in close proximity to the point of contamination, as opposed to travelling any significant distance at surface. The potential for the contamination of any surface water resources through contaminated surface water flows during construction is thus deemed negligible. However infiltration may ultimately result in groundwater contamination.

Table 5-4: Impacts on Surface- and Ground Water Quality – Significance Rating			
Nature (N)	Negative impacts on surface- and ground water quality.		1
Extent (E)	Site and immediate surrounds: Ready infiltration of storm water into sandy underlying soils will limit the extent of the potential impact to the site itself (i.e. groundwater environment)		2
Duration (D)	Long term: Treatment of groundwater contamination (i.e. once occurred) is a long and arduous process		4
Intensity (I)	Major: Adjacent farmers/farming communities reliant on groundwater for their livelihood		4
Probability (P)	Likely: Impact likely to occur, to the extent that provisions must be made for it		2
Mitigation (M)	Well mitigated: A comprehensive range of effective mitigation measures is readily available		4
Enhancement (H)	N/A		-
Reversibility (R)	Irreversible: No amount of time or money will sustainably reverse the impact		1
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	19.2
Significance Rating without Mitigation -	N x (E+D) x I x P ÷	**Moderate**	48

Table 5-4: Impacts on Surface- and Ground Water Quality – Significance Rating			
Negative Impact (S)	½(M+R)		
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

5.5.2 MANAGEMENT ACTIONS

The remediation of contaminated groundwater is a long, arduous and costly process. Any such remediation efforts may also likely leave significant residual contamination, despite any such remediation attempts (dependant on the nature and extent of the contamination itself). As such, Assmang's management actions should focus on the prevention of any such potential hydrocarbon contamination, rather than post impact remediation thereof. A comprehensive range of effective, proven, mitigation measures will be implemented in this regard, which are in principle as follows:

- All hazardous substances to be stored within appropriately sized, impermeable, bund walls;
- Storm water control measures to be implemented that prevent the free movement of 'clean' storm water run-off through the aforementioned storage areas, as well as any service yards and wash bays;
- Hazardous substances spill kits to be readily available at all points where hazardous substances will be stored and/or transferred (e.g. refuelling points);
- Vehicle and plant servicing to only take place in dedicated service yards on impermeable surfaces coupled with appropriate 'dirty' water containment systems/sumps and oil/water separators; and
- Drip trays to be appropriately placed under vehicles and plant that over-night on bare soil surfaces.

5.6 BIODIVERSITY

The capping and vegetation of the TSF, or rehabilitation of the reclaimed footprint, will result in a positive impact on biodiversity.

Table 5-5: Impacts on Biodiversity – Significance Rating		
Nature (N)	Positive impacts on site biological diversity	-0.25
Extent (E)	Nationally: Four floral species identified on site are afforded protection, in terms of law, on a National scale.	5
Duration (D)	Very long term: The impact will be permanent unless the site is disturbed in future.	5
Intensity (I)	Minor: Due to the size if the site, it is not expected that the rehabilitated area in islolation will be significant.	2
Probability (P)	Definite: Closure will be required at end of life.	4
Mitigation (M)	N/A	
Enhancement (H)	Moderately enhanced: The use of appropriate species and ensure that the rehabilitation is	3

Table 5-5: Impacts on Biodiversity – Significance Rating			
	effective.		
Reversibility (R)	N/A		-
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)		**-**
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)		**-**
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-60

5.6.1 MANAGEMENT ACTIONS

Closure and rehabilitation must be undertaken in accordance with the BRMO closure plan objectives and requirements.

5.7 HERITAGE RESOURCES

No heritage resources of significance have been identified in the area of interest nor during construction activities on the sites surrounding the area. If there are such resources discovered during the construction of the facility then clearly the impact upon closure will be negligible.

5.8 NOISE

The capping or reclaim and closure activities are expected to have similar noise impacts as with construction.

5.8.1 INTRODUCTION

The holder of a mining right must comply with the provisions of the Mine Health and Safety Act, 1996 (Act No. 29 of 1996), as well as any other national norms and standards regarding noise management (Fuggle and Rabie, 2009). Predominant construction related noise impacts are anticipated from the following sources:

- Heavy vehicle movement and operation associated with ground works and building activities (i.e. dump trucks, excavators, TLBs, cranes, graders, earth compacters, etc.); and
- Drilling and blasting (i.e. structural works and shaft sinking respectively).

5.8.2 IMPACT DISCUSSION & SIGNIFICANCE ASSESSMENT

Based on the fining of the BRMO expansion environmental impact assessment two aspects are important when considering the potential noise impacts of a project and these are as follows:

- The anticipated increase in the ambient noise level; and
- The overall ambient noise level produced.

The aforementioned activities will be site specific and the general sort of equipment that will be used during this phase, as well as the anticipated line of sight noise reductions associated with each, is given in Table 3-7.

Table 5-6: Construction Vehicle Line-of-sight Estimated Noise Level Attenuation – dBA (m)

Equipment	**Line-of-sight Estimated Noise Level Attenuation – dBA (m)**						
	5	**10**	**20**	**40**	**80**	**160**	**320**
Cumulative distance from source	**5**	**15**	**35**	**75**	**155**	**315**	**635**
Excavator 12000	78.3	68.3	58.3	52.3	46.3	40.3	34.3
Dozer D155	83.3	73.3	63.3	57.3	51.3	45.3	39.3
Grader 140H	97.4	87.4	77.4	71.4	65.4	59.4	53.4
VolvoA40	85.6	75.6	65.6	59.6	53.6	47.6	41.6
HD 325	91.3	81.3	71.3	65.3	59.3	53.3	47.3
TLB	94.4	84.4	74.4	68.4	62.4	56.4	50.4
Lighting Plant	85.8	75.8	65.8	59.8	53.8	47.3	41.3
Bell B40	86.1	76.1	66.1	60.1	54.1	48.1	42.1

The noise reduction calculated in Table 3-7 are for direct line-of-sight and medium to hard ground conditions. The combined noise level at the distance 635 m from the source, should all the above machinery operate at one time, will be 49.4 dBA. A realistic figure will, however, be 46.8 dBA as all the machinery is not likely to operate at one time and in one area. Engineering control measures and topography can have an influence on how the noise level is perceived by the receptors in vicinity of the site.

Table 5-7: Impacts of Construction Noise – Significance Rating

Nature (N)	Negative impacts of construction related noise on sensitive receptors		1
Extent (E)	Locally: Within the vicinity of the site		2
Duration (D)	Medium term: Work conservatively anticipated for up to a year, or possibly two)		3
Intensity (I)	Minor: Sensitive receptors hardly affected		2
Probability (P)	Likely: There is a possibility that the impact will occur, to the extent that provisions must be made for it.		2
Mitigation (M)	Slightly mitigated: Limited avoidance and minimisation through design and blast criteria standards		2
Enhancement (H)	N/A		-
Reversibility (R)	Irreversible: Blast waves and noise irreversible once generated		1
Significance Rating with Mitigation - Negative Impact	N x (E+D) x I x P ÷ ½(M+R)	**Low**	13

Table 5-7: Impacts of Construction Noise – Significance Rating			
(S)			
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	20
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

5.8.3 MANAGEMENT ACTIONS

Given that construction activities will be undertaken during normal working hours, and given the impact of current activities at the processing plant and expansion project activities, it is expected that the no further management actions are required other than to ensure that vehicles and machinery have adequate silencing per general mine health safety requirements.

5.9 TRAFFIC

The capping or reclaim and closure activities are expected to have similar trafiic impacts as with construction, however with a much smaller traffic volume.

5.9.1 INTRODUCTION

Based on the BRMO expansion EIA studies, it can be extrapolated that the closure phase traffic status quo will be potentially be much more significant than current. It is however not feasible to make predictions in view of the time period that must be extrapolated for. However it is expected recommended management measures as stipulated in the construction phase will still apply and be effective.

5.9.2 IMPACT DISCUSSION & SIGNIFICANCE ASSESSMENT

Table 5-8: Cumulative impact on R31 Road Condition – Significance Rating		
Nature (N)	Additive contribution to negative cumulative impact associated with increased traffic volumes (light and heavy vehicles)	1
Extent (E)	Regionally: Potential impact as far as Kuruman/Kathu	3
Duration (D)	Medium term: Work conservatively anticipated for up to a year, or possibly two.	3
Intensity (I)	Moderate: The R31 will still be available for use by other road users, albeit with increased construction related traffic thereon.	3
Probability (P)	Very likely: It is highly anticipated that existing, regular, road users will experience the increased volumes of traffic as a nuisance, but this is not certain.	3

Table 5-8: Cumulative impact on R31 Road Condition – Significance Rating			
Mitigation (M)	Slightly mitigated: Restriction of delivery times to off-peak traffic periods, as well as carpooling/bussing of construction workers to the site on a daily basis		2
Enhancement (H)	N/A		-
Reversibility (R)	Slightly reversible: With respect to R31 road condition deterioration.		2
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	27
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	36
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

5.9.3 MANAGEMENT ACTIONS

Assmang has in the past contributed to the up-keep of roads in the area and would continue to do so into the future, to an extent based on proportional road use by their vehicles. A 'Preliminary Status Quo Report' for the Kuruman-Hotazel road (i.e. R31), inclusive of a proposed upgrade strategy, was compiled in April 2011 by VELA VKE Consulting Engineers, at the request of the district municipality, BHP Billiton and Assmang Manganese Mines. The latter two being the more established mining entities in the Hotazel area.

While little project specific mitigation is proposed, or deemed feasible, Assmang should continue to seek strategic solutions to the problem in conjunction with other prominent road users and the relevant local authorities. A potential solution to alleviating the poor road condition and implementing ongoing maintenance of the R31 is put forward in terms of potential immediate (0-1 years), short (1-3 years), medium (3-10 years) and long term (10-20 years) measures in a 2011 VELA VKE road upgrade strategy. It would not be appropriate for this EIA, or associated EMPR, to commit Assmang to the sole implementation of the aforementioned plan, nor would it be appropriate (or have legal standing) to commit other mining houses to the joint implementation of the upgrade strategy. It is, however, in Assmang's and other mining houses' own interest to ensure that the condition of the R31 is upgraded in a sustainable manner that will optimise their own individual operations and improve safety for their own employees along this route.

Seeking a solution to this matter is deemed well beyond the scope of this EIA, as the route of the problem extends well beyond the battery limits of the study and involves several other parties' commitment to such. As such a strategic solution amongst all parties concerned needs to be sought, that partitions relative involvement in implementation.

6 THE NO-GO ALTERNATIVE

The no-go alternative in the context of this proposed facility will severely impact on the continued feasibility of mining at BRMO. From an operational perspective the no-go alternative is not feasible.

From an environmental perspective, the no-go alternative will avoid all the impacts noted previously. However, it must be noted that none of the negative environmental impacts are exceed a moderate rating with adequate mitigation/management in place.

From a socio-economic perspective the shutdown or severe down scaling of operations will in substantial job losses as well development and income to the area.

For these reasons the no-go alternative is clearly not preferred.