ENVIRONMENTAL PREVIEW REPORT PURSUANT TO THE NEWFOUNDLAND AND LABRADOR *ENVIRONMENTAL PROTECTION ACT*

AGS Fluorspar Project
St. Lawrence, NL
Volume 2, Appendix J-N

Submitted to:

Newfoundland and Labrador Department of Environment
and Conservation, Environmental Assessment Division

Submitted by:
Canada Fluorspar (NL) Inc.

September 2015

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APPENDIX J

Tailings Management Alternatives Analysis

September 22, 2015

GOLDER REPORT

TAILINGS MANAGEMENT FACILITY ALTERNATIVE ASSESSMENT

Submitted to:
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REPORT

Report Number: 1407707 - 0058

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1.0 INTRODUCTION

This report presents an update to the Tailings Management Facility (TMF) alternatives assessment prepared by Canada Fluorspar (NL) Inc. (CFI) and summarized in Section 3.3.1 of "*Environmental Assessment Registration Pursuant to the Newfoundland and Labrador Environmental Protection Act*" issued June 2015 (CFI 2015). This update provides an initial re-assessment of alternatives to account for the recently discovered AGS deposit and the location of a mill to process the fluorite ore.

The objective of the updated TMF alternatives assessment is to identify the most appropriate alternative for management of the tailings for the AGS deposit based on environmental, technical, economic and social considerations, in general accordance with the Environment Canada Guidelines for the Assessment of Alternatives for Mine Waste Disposal (EC 2011).

A total of five TMF locations were examined in 2010. In addition, two possible locations for dry land disposal in proximity of the AGS deposit were added, along with examining tailings disposal in the mined-out open pits. For each of these options, various tailings disposal technologies, based on different levels of dewatering, were also considered.

Based on the 10 year life of mine plan presented in the Preliminary Feasibility Study on the AGS Vein Deposit issued in May 2015, the TMF would need to contain approximately 2,800,000 tonnes of tailings from the processing of 5,916,200 tonnes of ore, of which approximately 50.5% or 2,986,000 tonnes would come from the underground operations. The remainder of the ore would be extracted from the four open pits to be operated during the life of the project (Worley Parsons 2015).

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3.0 TAILINGS DISPOSAL OPTIONS

3.1 Identification of tailings disposal locations

The first step in the alternatives assessment is to identify possible locations for the TMF. Those locations considered in 2010 were revisited, the underground disposal option was modified and new locations in the vicinity of the AGS deposit were added. The fundamental consideration for the sitting exercise was that the TMF be located within the CFI property. Each location is identified in Figure 1 and briefly described in the following sections.

3.1.1 Location 1: Shoal Cove Pond

Shoal Cove Pond is a brownfield site and has been used historically to deposit tailings. The TMF will consist of one main retaining dam with a polishing pond located immediately downstream of the facility. The dam would be systematically raised throughout the 10 year mine life and is capable of containing all of the milled tailings.

3.1.2 Location 2: Hillside

The Hillside location considers two options located on the hillside above Shoal Cove Pond. Both options are focused around Shoal Cove Pond and entail the construction of containment dams. Seepage from both options would be collected by ditches and directed into the polishing ponds prior to discharge into Shoal Cove Pond.

3.1.2.1 Hillside 1

Hillside 1 requires the construction of four smaller tailings cells on the west and east sides of Shoal Cove Pond. The tailings dams would be constructed as pervious dams. Collection ditches along the toe of each cell will be required to direct the seepage water into a polishing pond prior to discharge into Shoal Cove Pond. The cells would be constructed and raised over the course of the mine life.

3.1.2.2 Hillside 2

Hillside 2 requires the construction of two larger cells on the east and south sides of Shoal Cove Pond. The tailings dams will be constructed as pervious dams. Collection ditches along the toe of each cell will be required to direct the seepage water into a polishing pond prior to discharge into Shoal Cove Pond. The tailings cells would be raised over the course of the mine life.

3.1.3 Location 3: Clarkes Pond

Clarkes Pond is a site located northwest of the Shoal Cove Pond site. The conceptual design for Clarkes Pond involves the construction of two tailings dams (north and south) to contain all of the milled tailings. A polishing pond would be constructed downstream of the tailings pond. The dams would be raised throughout the course of the mine life.

3.1.4 Location 4: Director Watershed

Director Watershed is a site located approximately 1 kilometre (km) west of the Shoal Cove Pond site. The conceptual design for the Director Watershed involves the construction of two tailings dams (west and south) to contain all of the mill tailings. A polishing pond would be constructed west of the tailings pond. The dams would be raised throughout the course of the mine life.

3.1.5 Location 5: Underground Paste Backfill

The initial evaluation examined the potential underground (U/G) storage of a portion of the milled tailings in the Blue Beach North and Tarefare deposit. Since these deposits are not part of the current mining plan, the current evaluation is considering returning the material underground within the AGS deposit. The Central Pit South (CPS) open pit, one of the four to be mined and will be developed first as it will be the location for the portal to the underground mine. Underground mining would start in year three after the CPS open pit has been depleted.

3.1.6 Location 6: AGS Pit Dry Land West

AGS Pit Dry Land West is a greenfield site located west of the South Dump and the mill. The conceptual design involves one large cell on the side of the hill with dams on three sides and the polishing pond located downstream of the TMF.

3.1.7 Location 7: AGS Pit Dry Land East

AGS Pit Dry Land West is also a greenfield site located north of the mill and east of John Fitzpatrick Pond. The conceptual design involves one large cell with an irregular shape to avoid the surrounding water bodies. The polishing pond would be downstream of the TMF.

3.1.8 Location 8: In Pit Disposal

The last location examined for possible tailings disposal was the mined out open-pits. The disposal would involve returning the material to the voids created from the extraction of the fluorite ore.

3.2 Potential Tailings Disposal Technologies

In addition to locations, a selection of tailings waste disposal technologies have been considered for the AGS deposit. Disposal technologies vary by the degree of tailings dewatering. Typical solids densities of tailings range from 5% to 40% solids density for slurry to approximately 80% to 85% solids density for filtered tailings. Table 1 compares these tailings technologies in general terms based on laboratory testing performed on the Canada Fluorspar tailings (Golder 2014). Also included in Table 1 is an estimate of the capital cost of the tailings dewatering plant based on projects with similar tonnages that Golder has designed as part of conceptual, pre-feasibility and feasibility studies in the past. These provide an order of magnitude capital cost estimate +/- 50%. The capital costs presented do not consider tailings transport and or tailings containment structures.

Table 1: Comparison of Tailings Disposal Technologies

Technology	% Solids	Process Equipment	Transport	Deposition	Containment	Pond	CAPEX Dewatering Equipment ($)
Slurry	15	None	Centrifugal Pump/ Pipeline	Spigots	Engineered Containment Structures	Large	N/A
Thickened	65	Thickener	Centrifugal Pump/ Pipeline	Spigots	Engineered Containment Structures	Moderate	2 – 3 M
Paste	81	Thickener/ Pressure Filter	Positive Displacement Pump/ High Pressure Pipeline	Spigots	Engineered Containment Structures	Small	10 – 12 M
Filtered	87	Thickener/ Pressure Filter	Conveyor or Trucks	Bulldozer	Containment Structures may not be required	None - just runoff	12 – 16 M
Cemented Paste Backfill	81-83	Thickener/ Pressure/Filter/ Mixer/Binder Silo	Positive Displacement Pump/High Pressure Pipeline	U/G Stopes	U/G Barricades	None	12 - 15 M

N/A – not applicable

3.2.1 Underground Paste Backfill

It is important to note that the mining methods proposed by CFI do not require the use of backfill, therefore, this evaluation focuses solely on underground tailings disposal. There are three formulations of CFI tailings that could be used to dispose of tailings underground in the form of mine backfill:

- Hydraulic (sand) backfill;
- Paste backfill; and
- Filtered tailings backfill.

The degree of dewatering, complexity of the preparation process equipment and capital equipment cost increases from the top to the bottom of the list. A brief description of the characteristics of each backfill type is provided in the following subsections.

3.2.1.1 Hydraulic (sand) backfill:

- Hydro-cyclone classification is used to separate the coarse (sand) fraction from fine (slimes) fraction within the tailings stream;
- The resulting slurry has a solids content in the range of 66% to 70% by weight, meaning that large quantities of water are used to transport the tailings underground that drains into the mine's dewatering system;
- A binding agent such as normal Portland cement need not be added to the tailings if they are not to be used as a structural backfill that will be exposed in the mining process; and
- The tailings are transported underground in pipelines through the use of centrifugal pumps or via gravity.

3.2.1.2 Paste Backfill

- The entire tailings stream is processed into paste by using successive dewater processes, a combination of a thickener and filtration systems;
- In the case of the CFI tailings, the paste would have a solids content in the range of 80.6% to 81.8% by weight and little water "bleeds" from the backfill into the mine dewatering system;
- A binding agent such as normal Portland cement must be added to consume the contained pore water in the paste and thereby mitigate the possibility of remobilization of paste through liquefaction; and
- The tailings are transported underground in robust pipelines through the use of positive displacement (piston style) pumps or via gravity.

3.2.1.3 Filtered Tailings Backfill

- The use of filtered tailings as backfill is an uncommon approach and not widely practiced in the mining industry;
- The entire tailings stream is processed into filter cake by using successive dewater processes, a combination of a thickener and pressure filtration systems;
- The resulting filter cake has a solids content in the range of 87% by weight meaning that virtually no water would report to the mine's dewatering system;
- A binding agent such as normal Portland cement need not be added to the tailings and through lab testing (Golder 2014), it appears that there is insufficient water within the filter cake to allow binder hydration and

the development of backfill strength; therefore, they cannot be used as a structural backfill that will be exposed in the mining process; and

- The tailings are transported underground through the use of trucks and the entire processing and delivery system will be the most expensive of all the backfill options.

4.0 PRE-SCREENING ASSESSMENT

The pre-screening assessment is used to filter the list of potential candidates by focusing on waste disposal options that should have a reasonable likelihood of success in terms of being technically feasible to construct and operate, environmentally sound to a certain degree (no ecological “showstoppers”), and relatively economic to construct and operate.

The purpose of the pre-screening assessment was to eliminate any of the locations that had “fatal flaws” prior to completing the more detailed Multiple Accounts Analysis (MAA). Pre-screening criteria were formulated as simple “yes” or “no” answers to complete the evaluation. There were four criteria utilized as part of the pre-screening assessment which are summarized in Table 2.

Table 2: Pre-Screening Evaluation Criteria

No	Criteria	Explanation
1	Does the footprint of any greenfield location include a water body frequented by fish?	If the footprint of the greenfield location contains a water body frequented by fish, it is believed that getting approval from Fisheries and Oceans Canada (DFO) will not be possible for those sites and they should be eliminated.
2	Does the location avoid known restricted non-mitigatable sites?	If the area is an environmental protection area such an “Environmental Protection Management Unit” it is believed that getting approval will not be possible for those sites and they should be eliminated.
3	Does the increase in cost of an alternative exceed a reasonable threshold for financial liability? (An increase of 100% to the pre-production capital cost of $3.5 million for the TMF).	The feasibility of any mining project is sensitive to the effect of cost. The higher the cost, the greater the risk that the project will not proceed or that the project will not be sustainable. While higher costs may be warranted to eliminate significant adverse effects, there is no reason to investigate alternatives requiring significant additional cost unless there is a reasonable assumption of environmental gain. CFI has determined that in the absence of the identification of significant environmental improvements at the pre-screening stage, an alternative that would increase by 100% the capital cost for managing the tailings disposal has been selected as a large enough cost to compensate for any estimation errors at this level of analysis. Any alternative exceeding this threshold should be excluded at this stage unless it is determined in subsequent analysis of remaining alternatives that there is a significant environmental gain.
4	Does the alternative exceed an acceptable risk threshold for failure?	Any alternative that presents uncertainty that the storage of tailings can be stored safely should be eliminated.

4.1 Results of Pre-Screening

The pre-screening exercise reduced the number of alternatives from 34 to 8. Results are summarized in Table 3.

Table 3: Results of Pre-Screening

Location	Criteria 1		Criteria 2	Criteria 3				Criteria 4
	Greenfield	Water Body Frequented by Fish	Environmental Protection Management Unit	Tailings Disposal Technologies > $ 3.5 Million Process Equipment				High Risk
				Slurry	Thickened	Paste	Filter Cake	
Shoal Cove Pond	No	Yes	No	No	No	Yes	Yes	No
Hillside 1	Yes	No	No	No	No	Yes	Yes	No
Hillside 2	Yes	No	No	No	No	Yes	Yes	No
Clarkes Pond	Partially(1)	Yes	No	No	No	Yes	Yes	No
Director Watershed	Partially(2)	Yes	No	No	No	Yes	Yes	No
U/G Backfill	Yes	No	No	N/A	N/A	Yes	Yes	Yes
AGS Pit Dry Land West	Yes	No	Yes	No	No	Yes	Yes	No
AGS Pit Dry Land East	Yes	No	No	No	No	Yes	Yes	No
Open Pits	Yes	No	No	No	No	Yes	Yes	Yes

Notes:
(1) Water supply for previous mining operations
(2) Previous underground operation in this area

- Alternatives involving Clarkes Pond and Director Watershed failed to pass, since, while they are associated with previous mining operations, they have not been used for the placement of tailings and these locations overlap water bodies frequented by fish.

- The alternatives involving paste for surface disposal failed to pass due to the significant increase in capital. Based on the laboratory testing performed it would not be possible to achieve a paste consistency using only a thickener. It would require part of the thickener underflow to be further dewatered using pressure filters since the tailings are not amenable to vacuum filtration. If the cost associated with pumping the material was included, depending on distance, additional capital would be required.

- The alternatives involving filter cake for surface disposal failed to pass due to the significant increase in capital. This option requires that 100% of the tailings be filtered rather than only a portion for paste production. With the added pressure filtration requirements and including the cost of the equipment to transport and place the filter cake, additional capital would be required.

- The alternative considering sending the tailings underground failed to pass. There are two important physical characteristics within the mine. The mine is wet due to naturally occurring ground water inflow, and more importantly, there are a large number of interconnecting fissures and vugs (varying sized naturally occurring voids) throughout the ore body that would allow water or remobilized tailings to migrate in an uncontrollable fashion to other mine workings. For these reasons the various disposal options in the form of backfill are not recommended.

  - Hydraulic Fill: Due to the required hydro-cyclone classification process no more than 50% of the entire tailings stream would report underground, with the remaining fine material still requiring surface disposal. However, most importantly due to naturally large quantities of backfill, water would be added to the already wet mine and would consume a large amount of energy to pump it out of the mine.
  - Paste Backfill: Since it is necessary to add a binding agent such as normal Portland cement to mitigate the possibility of liquefaction, there is a significant added cost over and above just disposing of the tailings on surface. However, most importantly, the addition of binder to mitigate liquefaction creates weak bonds within the paste, and water ingress would most likely liquefy the tailings and they could flow in an uncontrolled fashion into other working areas, thereby creating the possibility of a dangerous work environment.
  - Filtered Tailings: Since these tailings are essentially dry, any form of binder addition will not develop structural integrity and cohesive properties, and as with the case of paste backfill, however, to a greater extent, water ingress would most likely liquefy the tailings and they could flow in an uncontrolled fashion into other working areas thereby creating the possibility of a dangerous work environment.

- The alternative considering the AGS Pit Dry Land West failed to pass since a large portion of the TMF and 100% of the polishing pond surface area would need to be located within an “Environmental Protection Management Unit”.

- The alternative considering the placement of the tailings within the open pit poses risk similar to those of backfilling the underground mine workings resulting in significant worker risk. There is a risk of flooding the underground mine by water contained within the tailing seeping through broken ground. The base and walls of the pit need to be as impermeable as practical to minimise risk of a pipe failure into the mine underground working. Finally, the open pits would not be able to provide sufficient storage during the operation of the mine. The Grebes Nest Pit and Central Pit North would be mined during most of the mine life and the Central Pit North would also be unavailable to serve as the portal to the U/G mine. This leaves the Open Cut Pit which has limited capacity.

5.0 MULTIPLE ACCOUNTS ANALYSIS METHOD

A multiple accounts analysis approach was used to evaluate the six alternatives that were identified following the pre-screening assessment and evaluation of tailings disposal technologies. Details of the MAA method are described in the Environment Canada 2011 Guidelines (EC 2011). The MAA assessment involved relative evaluation of alternatives for management of tailings based on environmental, technical, economic and social considerations. Evaluation criteria called sub-accounts and indicators were developed for each of these areas. The alternatives were evaluated against each criterion using a six point scale. Weightings were used to introduce a value bias between the individual criteria. The scoring and weighting were combined to calculate individual scores for each alternative to allow for relative ranking of the alternatives and determination of the preferred option.

Table 4 summarizes the sub-accounts and indicators that were developed to evaluate the alternatives with respect to environmental, technical, economic and social issues.

Table 4: Sub-accounts and Indicators

Account	Sub-Account	Indicator	Metric	Unit
Environmental	Land Use and Terrestrial Impacts	TMF infrastructure	Length of tailings pipeline	km
		TMF footprint	Area	ha
		Percentage of TMF surface area greenfield	Percent	%
	Surface Water	Number of watersheds affected	Number	#
	Aquatic Habitat	Number of stream crossings by tailings pipeline	Number	#
	Air Quality	Potential for dust generation	Length of access roads from open pits (waste rock dumps) to TMF	km
		Potential for greenhouse gas emission due to construction	Fill volume times km of haul	m^3-km
Technical	Complexity of Design and Construction	Topography containment	Qualitative Rank	-
		Pumping requirements	Difference in elevation between mill and TMF	m - m^3
		Storage/dam volume ratio	Ratio	X:Y
	Water Management	Water volume to TMF	Value	Mm^3/yr
		Water reclaim	Qualitative Rank	-
		Habitat compensation	Qualitative Rank	#
	Closure	Acid Rock Drainage	Qualitative Rank	-
		Closure/Reclamation	Qualitative Rank	-
Economics	Capital Cost	Estimated TMF capital cost	Qualitative Cost	$
		Estimated dewatering plant capital cost	Qualitative Cost	$
		Estimated slurry pumping capital costs	Qualitative Cost	$
		Estimated closure/reclamation cost	Qualitative Cost	$
Social	Visual Impacts	Maximum Height of TMF/Visual	Height	m
		Previous/Existing Land Use	Qualitative Rank	-
		Distance from Town of St. Lawrence	Distance	Km

5.1 Scoring and Weighting

Each alternative was evaluated by assigning relative scores and weightings to the sub-accounts and indicators within each of the four accounts (e.g., Environment). Judgement and perception of the individuals conducting the analyses is inevitably part of any such decision making system, both in the assignment of qualitative scores and of weighting factors. Quantitative methods were used to assign relative scores, where possible; however, some sub-accounts and indicators required the use of qualitative judgement. The following sections explain how scores and weightings were assigned and the calculations used to determine the preferred alternative.

5.1.1 Score

As suggested by the Environment Canada Guidelines (EC 2011), a six point scoring scheme was developed for each sub-account and indicator. The scores provide a relative ranking between the alternatives with the “best” (most preferred) option receiving a score of 6, and the “worst” (least preferred) a score of 1. This scoring measure was used for both quantitative and qualitative indicators.

For sub-accounts and indicators that could be quantitatively measured, the highest and lowest scale points (1 and 6) were defined based on the maximum and minimum measurements. The remaining measurements were scored using a linear interpolation rounded to the nearest whole number, between the maximum and minimum values. For sub-accounts and indicators that required qualitative evaluation, the scoring schemes were developed using the judgement.

Although a six point scoring scale was used for each sub-account or indicator, descriptions for all six points were not always defined. In some cases, it was not practical to define qualitative descriptions for all six points. In these cases, definitions were always defined for the highest and lowest scale points (i.e., 1 and 6).

5.1.2 Weighting

Accounts, sub-accounts and indicators were assigned a relative weighting (W) to introduce a value bias between the individual accounts, sub-accounts, and indicators. The weighting factors ranged from 1 to 6, following the Environment Canada Guidelines (EC 2011). The value bias is based on the relative subjective importance of one account/sub-account/indicator versus another. A higher weighting factor indicates a perceived greater relative value or importance.

5.1.3 Multiple Accounts Analysis Calculations

The MAA assessment involved taking individual scores and weightings for each indicator and sub-account within the four accounts, and converting them to a single score for each alternative. This involved several steps that are described below:

1) Sub-account merit ratings were calculated using the following steps:

    a) Calculate indicator merit scores by multiplying the score (S) by the weighting (W) for each indicator (S x W).

    b) Calculate the sub-account merit scores by summing the indicator merit scores for each sub-account ($\sum\{S \times W\}$).

    c) Calculate the sub-account merit rating (R_s) by normalizing the sub-account merit scores back to a six point scale. This was achieved by dividing the sub-account merit scores by the sum of the indicator weightings ($\sum W$) to get $R_s = \sum(S \times W)/\sum W$ to produce a value between 1 and 6 for each sub-account.

This normalization is necessary so that the number of indicators associated with each sub-account does not influence the results.

2) The same set of calculations was then conducted to obtain account merit ratings.
   a) Calculate account merit scores by summing the sub-account merit ratings multiplied by the sub-account weightings ($\sum\{R_s \text{ x } W\}$).
   b) Calculate the account merit ratings by normalizing the account merit scores by the sum of the sub-account weightings ($R_a = \sum(R_s \text{ x } W)/\sum W$).
3) Alternative merit scores were then calculated as follows:
   a) Calculate alternative merit scores by summing the account merit ratings multiplied by the account weightings ($\sum\{R_a \text{ x } W\}$).
   b) Calculate the alternative merit ratings by normalizing the alternative merit scores by the sum of the account weightings ($R_a = \sum(R_s \text{ x } W)/\sum W$).

The resulting alternative merit rating (alternative score) is a value between 1 and 6 and provides a means to evaluate the relative ranking of the various alternatives considered. The highest alternative merit rating represents the preferred alternative. In accordance with the Environment Canada Guidelines (EC 2011), this method is considered transparent, and allows stakeholders the opportunity to assess the relative weightings and scorings based on personal preference.

6.0 TAILINGS MANAGEMENT FACILITY ALTERNATIVES MULTIPLE ACCOUNTS ANALYSIS RESULTS

The results of the MAA calculations are summarized in the following sections. The analysis was split into two phases; baseline analysis and sensitivity analysis. The detailed MAA matrix tables are provided in Appendix A.

6.1 Baseline Results

The baseline results incorporate the account weightings recommended in the Environment Canada Guidelines (EC 2011). These weightings are summarized in Table 5. Results of the baseline MAA calculations are presented in Table 6.

Table 5: Baseline Account Weightings

Account	Weightings
Environment	6
Technical	3
Economic	1.5
Social	3

Table 6: Summary of Multiple Accounts Analysis Baseline Results

	Shoal Cove Pond		Hillside 1		Hillside 2		AGS Pit Dry Land East	
	Slurry	Thickened	Slurry	Thickened	Slurry	Thickened	Slurry	Thickened
Environment	5.12	5.24	4.35	4.47	4.53	4.65	3.94	4.06
Technical	3.77	4.24	3.35	3.83	3.35	3.83	3.89	4.36
Economic	5.00	3.88	3.06	1.65	4.06	2.35	4.18	2.88
Social	5.05	5.05	4.18	4.18	3.73	3.73	2.59	2.59
Overall Score	**4.79**	**4.82**	**3.95**	**3.95**	**4.04**	**4.01**	**3.66**	**3.67**

6.2 Sensitivity Analysis

As discussed previously, judgement and perceptions of the individuals conducting the MAA is inevitably part of any such decision making system, both in assignment of qualitative scores and of weighting factors. As such, a sensitivity analysis was conducted to evaluate the robustness of the baseline results.

The sensitivity analysis involved varying the account weightings to put a varying emphasis on different accounts (i.e., Environment, Technical, Economic and Social) to assess how they influence the relative ratings of the alternatives. Table 7 summarizes the account weightings that were used to define the sensitivity cases. Higher weighting values within each sensitivity case indicate an emphasis on those accounts. The results of the sensitivity analysis are summarized in Table 8.

Table 7: Summary of Sensitivity Analysis Cases

Account	Weightings			
	Case 1	Case 2	Case 3	Case 4
Environment	6	6	1	1
Technical	3	0	1	1
Economic	0	0	1	1
Social	3	3	1	1

Note (1) All weighting factors (i.e., accounts, sub-accounts, and indicators) weighted equally

Table 8: Summary Table

Sensitivity Case		Shoal Cove Pond		Hillside 1		Hillside 2		AGS - Pit Dry Land East	
		Slurry	**Thickened**	**Slurry**	**Thickened**	**Slurry**	**Thickened**	**Slurry**	**Thickened**
Base Case	Guideline recommended account weighting	4.79	**4.82**	3.95	3.95	4.04	4.01	3.66	3.67
Sensitivity Case 1	Economics removed	4.76	**4.94**	4.06	4.42	4.03	4.21	3.59	3.77
Sensitivity Case 2	Only environmental and social accounts considered	5.09	**5.17**	4.30	4.37	4.26	4.34	3.49	3.57
Sensitivity Case 3	All accounts weighted equally	**4.73**	4.60	3.74	3.53	3.92	3.64	3.65	3.47
Sensitivity Case 4	All weighting factors (i.e., accounts, sub-accounts, indicators) weighted equally	**4.52**	4.51	3.64	3.60	3.89	3.83	3.74	3.73

Note: Shaded areas represent the highest values.

7.0 SUMMARY AND CONCLUSION

This report presents the decision making process used for the preliminary selection of a TMF (i.e., location and level of tailings dewatering) for the AGS Deposit. The objective of the assessment was to revisit the work previously performed by CFI and consider additional locations to identify the preferred alternative for management of tailings based on environmental, technical, economic and social considerations, in general accordance with the Environment Canada *Guidelines for the Assessment of Alternatives for Mine Waste Disposal* (EC 2011). These guidelines recommend the use of a MMA approach, which is a well-accepted, transparent decision-making tool.

The MAA assessment process involved identifying feasible locations for the tailing management facility. A total of nine possible locations and four levels of tailings dewatering (i.e., slurry, thickened tailings, paste and filter cake) were examined based on the following fundamental considerations:

- That the footprint of the TMF of any greenfield location did not overlap a body of water frequented by fish;
- That the footprint of the TMF avoids know restricted non-mitigable sites;
- That the TMF alternative did not exceed an acceptable risk threshold for failure; and
- That the TMF alternative did not exceed a reasonable financial threshold (capital cost).

The results of the MAA, including the sensitivity analysis, indicated that the Shoal Cove Pond location was the most appropriate option for the TMF for the AGS Deposit. As for the selection of the level of tailings dewatering, both slurry and thickened tailings were similar and will therefore require further study as part of the feasibility study of the AGS Deposit to determine which technology is the most appropriate.

8.0 CLOSURE

We trust the information presented in this report meets your current requirements. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

Report Signature Page

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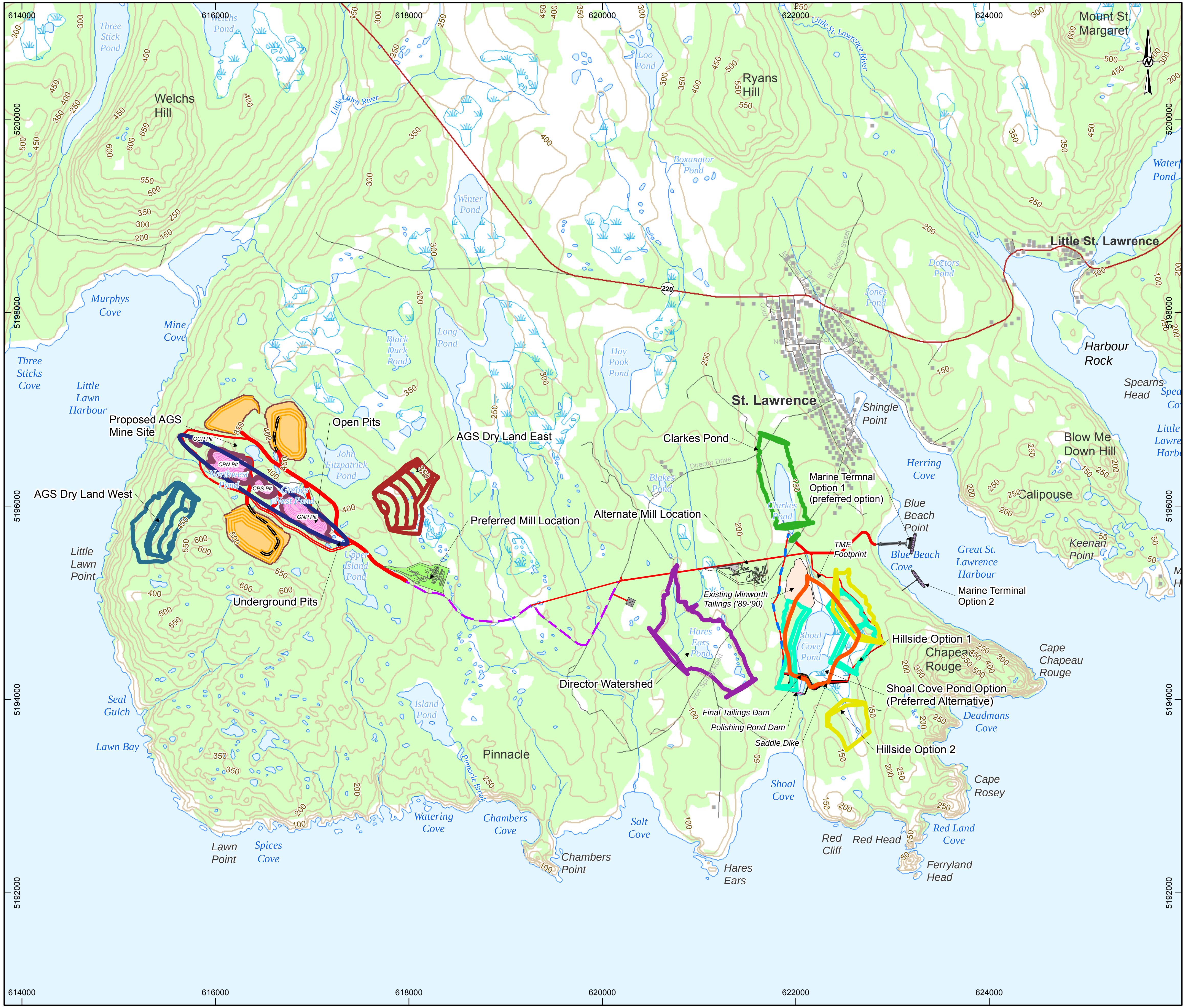

LEGEND

PROJECT COMPONENTS

- Clarkes Pond Diversion Channel
- Proposed Road
- Proposed Upgraded Road
- Final Tailings Dam
- Settling Pond Dam
- Saddle Dike
- Existing Minworth Tailings
- Mine Dump Option
- Pit

TAILINGS MANAGEMENT FACILITY ALTERNATIVES

- Shoal Cove Pond Option (Preferred Alternative)
- AGS Dry Land West
- AGS Dry Land East
- Clarkes Pond
- Director Watershed
- Hillside Option 1
- Hillside Option 2
- Open Pits
- Underground Pits

TOPOGRAPHY

- Building
- Highway
- Existing Road
- Contour Line (interval: 50 ft)
- Watercourse
- Waterbody
- Wetland

0 1 2

Kilometres

1:40,000

REFERENCE

SOURCE(S): DEVELOPMENT REGULATIONS 2011 LAND USE ZONING MAP 1, JAN. 19, 2013, TOWN OF ST. LAWRENCE; CANVEC & CANVEC+, 1: 50 000 SCALE, NRCAN.

DATUM: NAD 83. PROJECTION: UTM ZONE 21.

CLIENT

CANADA FLUORSPAR INC.

PROJECT

AGS MINE PROJECT, ST. LAWRENCE NL
ENVIRONMENTAL PREVIEW REPORT

TITLE

TAILINGS MANAGEMENT FACILITY ALTERNATIVES

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-05-13
DESIGN	CG
GIS	ED
REVIEW	EL
APPROVED	DJ

PROJECT No.	Rev.	FIGURE
14-07707	0	1

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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:

25mm

APPENDIX A

Multiple Accounts Analysis Matrix Tables

Table A1: Environmental

Indicator	Metric	Indicator Weighting	Quantitative Score	Description	Quantitative Scoring Scheme								
						Shoal Cove Pond		Hillside 1		Hillside 2		AGS - Pit Dry Land East	
						Slurry	Thickened	Slurry	Thickened	Slurry	Thickened	Slurry	Thickened
TMF infrastructure	Length of tailings pipeline	5	6	< 1 km	Alternative Parameter								
			5	1 to 3 km	Quantitative Score	2	4	1	3	1	3	4	6
			4	3 to 5 km	Distance from Mill to Shoal Cove Pond TMF Inlet ~ 6 km (slurry high flow with further dispersion in case of leak (slurry - 332 vs. thickened tails - 33 m3/hr) compared to thickened therefore add 1 higher risk slurry remove 1 for thickened tails all options)								
			3	5 to 7 km	Distance from Mill to Hillside 1 TMF Same as Shoal Cove + 2 extra km -> 1km for Cell 1&2 and 1km for Cell 3&4 = Total ~ 8 kms								
			2	7 to 9 km	Distance from Mill to Hillside 2 TMF Same as Shoal Cove + 2.5 extra km -> 1 km to reach Cell 1 and extra 1.5 km for Cell 2 = Total ~ 8.5 kms								
			1	> 9 km	Distance for Mill to AGS Pit Dry Land East - Close to Mill - Approximately 1 km								
TMF footprint	Area	6	6	< 25 ha	Alternative Parameter								
			5	25 to 40 ha	Quantitative Score	3	3	3	3	4	4	6	6
			4	40 to 55 ha	Shoal Cove Pond: Figure 1 - Worley Parsons April 2015 - TMF Footprint (Green Line) - Approximately 65 ha.								
			3	55 to 70 ha	Hillside 1: SNC Figure 2 - July 2010 - Rough Estimate 35 ha - need to raise ~ 3.1 m to get 2.8 M m3 of tailings increase to 60 ha								
			2	70 to 85 ha	Hillside 2: SNC Figure 3 - July 2010 - Rough Estimate 35 ha - need to raise ~ 2.8 m to get 2.8 M m3 of tailings increase to 55 ha								
			1	> 85 ha	AGS Pit Dry Land East - Golder Estimate 10.6 ha								
Percentage of TMF surface area greenfield	Percent	6	6	< 10%	Alternative Parameter								
			5	10 to 30%	Quantitative Score	6	6	2	2	2	2	1	1
			4	30 to 50%	Shoal Cove Pond: Rough Estimate - Between 10 to 30% since TMF will be bigger than historical footprint.								
			3	50 to 70%	Hillside 1: Rough Estimate - Between 70 to 90 % - Polishing Pond might overlap historical footprint								
			2	70 to 90%	Hillside 2: Rough Estimate - Between 70 to 90 % - Polishing Pond might overlap historical footprint								
			1	> 90%	AGS Pit Dry Land East - > 90 % would be green field								
Number of watersheds affected	Number	5	6	1	Alternative Parameter								
			5		Quantitative Score	6	6	6	6	6	6	4	4
			4	2	Shoal Cove Pond: EA June 2015 - Estimated from Figure 6.3 Number = 1 Shoal Cove Watershed								
			3		Hillside 1: EA June 2015 - Estimated from Figure 6.3 Number = 1 Shoal Cove Watershed								
			2	3	Hillside 2: EA June 2015 - Estimated from Figure 6.3 Number = 1 Shoal Cove Watershed								
			1	> 3	AGS Pit Dry Land East: EA June 2015 - Estimated from Figure 6.3 Number = 2 Grebes Nest and Salt Cove Watersheds								

Indicator	Metric	Indicator Weighting	Quantitative Score	Description	Quantitative Scoring Scheme								
						Shoal Cove Pond		Hillside 1		Hillside 2		AGS - Pit Dry Land East	
						Slurry	Thickened	Slurry	Thickened	Slurry	Thickened	Slurry	Thickened
Number of stream crossings by tailings pipeline	Number	4	6	No stream crossings	Alternative Parameter								
			5	1 and 2 stream crossings	Quantitative Score	2.5	2.5	2	2	2	2	6	6
			4	3 and 4 stream crossings	Shoal Cove Pond: EA June 2015 - Estimated from Figure 6.3 Number = 6 or 7								
			3	5 and 6 stream crossings	Hillside 1: EA June 2015 - Estimated from Figure 6.3 Number = 7 or 8								
			2	7 and 8 stream crossings	Hillside 2: EA June 2015 - Estimated from Figure 6.3 Number = 7 or 8								
			1	> 8 stream crossings	AGS Pit Dry Land East: EA June 2015 - Estimated from Figure 6.3 Number = 0								
Potential for dust generation	Length of access roads from open pits (waste rock dumps) to TMF	2	6	< 2 km	Alternative Parameter								
			5	2 to 4 km	Quantitative Score	1	1	1	1	1	1	5	5
			4	4 to 6 km	Shoal Cove Pond: EA June 2015 - Estimated from Figure 2.4 Project Site Plan - Extra 2.5 km to pipeline length (Open Pit (Waste Rock to Mill) and extra 2 km at TMF for access to dams ~ 12.5 km								
			3	6 to 8 km	Hillside 1: EA June 2015 - Estimated from Figure 2.4 Project Site Plan - Extra 2.5 km to pipeline length (Open Pit (Waste Rock) to Mill) and extra 1,5 km at TMF for access to dams ~ 12.0 km								
			2	8 to 10 km	Hillside 2: EA June 2015 - Estimated from Figure 2.4 Project Site Plan - Extra 2.5 km to pipeline length (Open Pit (Waste Rock) to Mill) and extra 2.5 km at TMF for access to dams ~ 13.5 km								
			1	> 10 km	AGS Pit Dry Land East: EA June 2015 - Estimated from Figure 2.4 Project Site Plan - Extra 2.5 km to pipeline length (Open Pit (Waste Rock) to Mill) and extra 2 km for dam length ~ 5.5 km								
Potential for greenhouse gas emission due to construction	Fill volume times km of haul	2	6	< 2000 Mm^3-m	Alternative Parameter								
			5	2000 - 4000 Mm^3-m	Quantitative Score	6	6	2	2	3	3	4	4
			4	4000 - 6000 Mm^3-m	Shoal Cove Pond: Preliminary Pre-Feasibility Study May 2015 Volume: 58,000 m3 overburden + 62,500 m3 waste rock = total 120,500 m3 * 12,500 m = ~ 1,500 Mm3-m								
			3	6000 - 8000 Mm^3-m	Hillside 1: SNC TMF Report July 2010: 157,000 m3+126,500 m3 +143,000 m3 +145,200 m3 = 571,700 m3; increase in storage capacity of 40%, 25% more material --> ~ 715,000 m3 * 12,000 m = ~ 8,600 Mm3-m								
			2	8000 - 10 000 Mm^3-m	Hillside 2: SNC TMF Report July 2010: 120,000 m3+ 138,500 m3 + 109,000 m3 = 367,500 m3; increase in storage capacity of 40%, 25% more material --> ~460,000 m3 * 13,500 m = ~ 6,200 Mm3-m								
			1	> 10 000 Mm^3-m	AGS Pit Dry Land East - Golder Estimate = 904,000 m3 * 5,500 m = 5,000 Mm3-m								

Table A2: Technical

Indicator	Metric	Indicator Weighting	Quantitative Score	Description	Quantitative Scoring Scheme								
						Shoal Cove Pond		Hillside 1		Hillside 2		AGS - Pit Dry Land East	
						Slurry	Thickened	Slurry	Thickened	Slurry	Thickened	Slurry	Thickened
Topography containment	Qualitative Rank	4	6	Complete natural topographic containment	Alternative Parameter								
			5	Good natural topographic containment	Quantitative Score	5	5	3	3	3	3	2	2
			4	Fair natural topographic containment	Shoal Cove Pond: Good natural topographic containment natural valley - volume of material to contain tailings estimated at 120,500 m3								
			3	Moderate natural topographic containment	Hillside 1: Moderate natural containment side of hill on both sides of valley - volume of material required to contain tailings estimated at 571,700 m3								
			2	Poor natural topographic containment	Hillside 2: Moderate natural containment side of hill on both sides of valley - volume of material required to contain tailings estimated at 460,000 m3								
			1	Zero natural topographic containment	AGS Pit Dry Land East - Poor natural topographic containment - site of hill - requires largest amount of material to contain tailings which is estimated at 904,000 m3								
Pumping requirements	Difference in elevation between mill and TMF	2	6	<0 m (mill is higher than TMF)	Alternative Parameter								
			5	0-15 m	Quantitative Score	6	6	6	6	6	6	5	5
			4	16-30 m	Shoal Cove Pond: EA June 2015 Figure 2.4 Mill at approximately 110 m and Main Tailings Dam (Worley Parsons April 2015) crest height 27 - difference of approximately minus 83 m								
			3	31-45 m	Hillside 1: EA June 2015 Figure 2.4 Mill at 110 m and Main Dam SNC June 2010 + 40% tailings crest estimated at around 40 m - difference of approximately minus 70 m								
			2	46-60 m	Hillside 2: EA June 2015 Figure 2.4 Mill at 110 m and Main Dam SNC June 2010 + 40% tailings crest estimated at around 40 m - difference of approximately minus 70 m								
			1	>60 m	AGS Pit Dry Land East: EA June 2015 Figure 2.4 Mill at approximately 110 m - Tailings Dam Crest estimated at around 118 m - difference of approximately plus 8 m								
Storage/dam volume ratio	Ratio	4	6	> 25	Alternative Parameter								
			5	20 to 25	Quantitative Score	5	5	2	2	2	2	1	1
			4	15 to 20	Shoal Cove Pond: Volume of material to contain tailings estimated at 120,500 m3: 2,800,000 m3 /120,500 m3 = approx. 23								
			3	10 to 15	Hillside 1: Volume of material required to contain tailings estimated at 571,700 m3: 2,800,000 m3 / 571,700 m3 = approx. 5								
			2	5 to 10	Hillside 2: Volume of material required to contain tailings estimated at 460,000 m3: 2,800,000 m3 / 460,000 m3 = approx. 6								
			1	< 5	AGS Pit Dry Land East - Volume of material to contain tailings which is estimated at 904,000 m3: 2,800,000 /904,000 m3 = approx. 3								

Indicator	Metric	Indicator Weighting	Quantitative Score	Description	Quantitative Scoring Scheme								
						Shoal Cove Pond		Hillside 1		Hillside 2		AGS - Pit Dry Land East	
						Slurry	Thickened	Slurry	Thickened	Slurry	Thickened	Slurry	Thickened
Water volume to TMF	Value	5	6	< 0.2 Mm^3/a	Alternative Parameter								
			5	0.2 - 0.7 Mm^3/a	Quantitative Score	1	2	1	2	1	2	5	6
			4	0.7 - 1.2 Mm^3/a	Slurry 232 m3/hr @ 14.23% solids for 350 operating days per year = 1.84 Mm3/yr								
			3	1.2 - 1.7 Mm^3/a	Thickened tailings 32.7 m3/hr @65 wt.% solids for 350 operating days per year = 0.16 Mm3/yr								
			2	1.7 - 2.2 Mm^3/a	Catchment area for the Shoal Cove Pond and Hillside Options would be greater than AGS Pit Dry Land which would practically be non existant subtract 1 point to all options except AGS Dry Land East								
			1	> 2.2 Mm^3/a									
Water reclaim	Qualitative Rank	6	6	No treatment required	Alternative Parameter								
			5		Quantitative Score	3	1	3	1	3	1	3	1
			4		The water leaving the mill contains small quantities of tall oil. If these are recycled directly from the thickener it could potentially interfere with the flotation process and cause grade problems in final product.								
			3	Some form of treatment required	The water, even if allowed to age in the TMF and Polishing Pond, would still need to undergo sand filtration and iron exchange resin softening for reuse								
			2										
			1	More extensive treatment required									
Habitat compensation	Qualitative Rank	4	6	< 25	Alternative Parameter								
			5	25 - 75	Quantitative Score	3	3	4	4	4	4	6	6
			4	75 - 125	Shoal Cove Pond: SNC TMF Report July 2010 - Compensation Cost / Divided by 10,000 to get a relative value for comparison ---> 155								
			3	125 - 175	Hillside 1: SNC TMF Report July 2010 - Compensation Cost / Divided by 10,000 to get a relative value for comparison ---> 105								
			2	175 - 225	Hillside 2: SNC TMF Report July 2010 - Compensation Cost / Divided by 10,000 to get a relative value for comparison ---> 105								
			1	> 225	AGS Pit Dry Land East - TMF established on dry land not requirement for habitat compensation ---> ~ 0								
Acid Rock Drainage	Qualitative Rank	5	6	Likely lowest risk of oxidation	Alternative Parameter								
			5		Quantitative Score	1	3	2	4	2	4	3	5
			4		Based on testing done to date the tailings are likely not acid generating, although additional static testing will be completed to confirm the acid generation of the combined tailings.								
			3		If material Potentially Acid Generating for slurry and thickened deposition; saturated tailings minimizes oxidation of sulphides except for exposed beaches and dedicated surfaces.								
			2		Depending on deposition scheme the TMF with larger surface area may have more beach that are not as often covered with fresh material therefore higher risk of exposed surfaces and sulfide oxidation								
			1	Likely highest risk of oxidation	Slurry would have higher level of segregation during deposition - therefore exposed beaches close to deposition spigot would be coarser and more permeable								

Indicator	Metric	Indicator Weighting	Quantitative Score	Description	Quantitative Scoring Scheme								
						Shoal Cove Pond		Hillside 1		Hillside 2		AGS - Pit Dry Land East	
						Slurry	Thickened	Slurry	Thickened	Slurry	Thickened	Slurry	Thickened
Closure / Reclamation	Qualitative Rank	6	6	Easiest to close and restore TMF	Alternative Parameter								
			5		Quantitative Score	2	3	3	4	3	4	4	5
			4		Slurry due to segregating nature of tailings, slimes take a long time to consolidate, making them difficult to reshape contour and cover.								
			3		Would likely require long time dam maintenance, long term water monitoring and possibly treatment.								
			2		Thickened tailings would have less segregation and consolidation time would be shorter making possible to put cover on tailings a lot sooner.								
			1	More difficult to close and restore TMF	Would likely require shorter or less extensive dam maintenance and shorter water monitoring and treatment								

Table A3: Economics

Indicator	Metric	Indicator Weighting	Quantitative Score	Description	Quantitative Scoring Scheme								
						Shoal Cove Pond		Hillside 1		Hillside 2		AGS - Pit Dry Land East	
						Slurry	Thickened	Slurry	Thickened	Slurry	Thickened	Slurry	Thickened
Estimated TMF capital cost	Qualitative Cost	6	6	< $5 million	Alternative Parameter								
			5	$5 to $15 millions	Quantitative Score	5	5	2	2	4	4	2	2
			4	$15 to $25 million	Shoal Cove Pond: Pre-Feasibility Study May 2015: $ 6.28 Million (Table 1.4) for 120,500 m3 of material (Table 16.6) or $52 / m3 (Number used for other locations)								
			3	$25 to $35 million	Hillside 1 From SNC TMF Report July 2010 - Estimated volume for dams = approx. 715,000 m3 * $52 /m3 = $ 37.3 Million.								
			2	$35 to $45 million	Hillside 2 From SNC TMF Report July 2010 - Estimated volume for dams = approx. 460,000 m3 * $52 /m3 = $ 24.0 Million.								
			1	>$45 million	AGS Pit Dry Land East - TMF Estimated volumes for dams 904,000 m3 *$ 52 /m3 = $47 Million (-15% for TMF being close to Waste Rock Dumps etc.) = $40 Million								
Estimated dewatering plant capital cost	Qualitative Cost	4	6	<$500,000	Alternative Parameter								
			5	$0.5 to $1 million	Quantitative Score	6	1	6	1	6	1	6	1
			4	$1 to $1.5 million	Slurry - no capital cost for the dewatering plant								
			3	$1.5 to $2.0 million	Thickened Tailings = rough estimate for thickener - flocculent systems $ 2 - 3 million (EPCM)								
			2	$2.0 to $2.5 million									
			1	>$2.5 million									
Estimated slurry pumping capital costs	Qualitative Cost	2	6	<$100,000	Alternative Parameter								
			5	$0.10 to $0.25 million	Quantitative Score	3	1	3	1	3	1	5	4
			4	$0.25 to $0.50 million	Slurry down to Shoal Cove Pond and Hillside 1 & 2 - 8" line and centrifugal pumps) = $750,000								
			3	$0.50 to $0.75 million	Thickened tailings down to Shoal Cove Pond and Hillside 1 & 2 - 3" line and PD Pumps = $1,250,000								
			2	$0.75 to $1.0 million	Slurry to AGS - Pit Dry Land East - 8" line and centrifugal pumps = $150,000								
			1	>$1.0 million	Thickened tailings to AGS - Pit Dry Land East - 3" line and PD Pumps = $500,000								
Estimated closure / reclamation cost	Qualitative Cost	5	6	<$500,000	Alternative Parameter								
			5	$0.5 to $5 million	Quantitative Score	5	6	2	2	3	2	5	5
			4	$5 to $10 million	Shoal Cove Pond: Water Cover Pre-Feasibility May 2015 - $460,000								
			3	$10 to $15 million	Hillside 1: SNC: Dry Cover Area x 0.5 m cover @ $55/m3 = 60 ha -->$18 Million (add 10% for slurry)								
			2	$15 to $20 million	Hillside 2: SNC: Dry Cover Area x 0.5 m cover @ $55/m3 = --> 55 ha --> $15 Million (add 10% for slurry)								
			1	>$20 million	AGS Pit Dry Land East - Dry Cover Area x 0.5 m cover @ 55/m3 = 11 ha --> $3.3 Million (add 10% for slurry)								

Table A4: Social

Indicator	**Metric**	**Indicator Weighting**	**Quantitative Score**	**Description**	**Quantitative Scoring Scheme**								
						Shoal Cove Pond		**Hillside 1**		**Hillside 2**		**AGS - Pit Dry Land East**	
						Slurry	**Thickened**	**Slurry**	**Thickened**	**Slurry**	**Thickened**	**Slurry**	**Thickened**
Maximum Height of TMF / Visual	Height	4	6	No visual impact	Alternative Parameter								
			5	>10 m above natural topography	Quantitative Score	6	6	5	5	4	4	3	3
			4	>20 m above natural topography	Shoal Cove Pond: Dam Crest 27 m versus Pond Lever around 18 m - dam height 9 m however within depression low visibility								
			3	>30 m above natural topography	Hillside 1: SNC: Dam Crest estimated at approximately 35 m - toe of dam around 20 m - dam height approximately 15 m mostly within depression more than likely low visibility								
			2	>40 m above natural topography	Hillside 2: SNC: Dam Crest estimated at approximately 40 m - toe of dam around 20 m - dam height approximately 20 m mostly within depression more than likely low visibility								
			1	>50 m above natural topography	AGS Pit Dry Land East - Dam crest estimated at approximately 118 m - toe of dam around 90 m dam height approximately 28 m - high point in area likely more visible								
Previous / Existing Land Use	Qualitative Rank	6	6	Affected area less frequented by public	Alternative Parameter								
			5		Quantitative Score	5	5	4	4	4	4	2	2
			4		Shoal Cove Pond: Formerly tailings area - Public Consultation, 1 Participant fishes in Shoal Cove Pond								
			3		Hillside 1 : Area adjacent to former tailings area								
			2		Hillside 2: Area adjacent to former tailings area								
			1	Greenfield area more frequented by public	AGS Pit Dry Land East - Greenfield - 3 participants indicated they fished in John Fitzpatrick Pond - However combines installation in tighter area								
Distance from Town of St-Laurence	Distance	2	6	> 9 km	Alternative Parameter								
			5	7 to 9 km	Quantitative Score	2	2	2	2	2	2	3	3
			4	5 to 7 km	Shoal Cove Pond: Approximately 1.5 to 2.0 km in straight line to town of St-Lawrence.								
			3	3 to 5 km	Hillside 1: Approximately 1.5 to 2.0 km in straight line to town of St-Lawrence.								
			2	1 to 3 km	Hillside 2: Approximately 1.5 to 2.0 km in straight line to town of St-Lawrence.								
			1	>1 km	AGS Pit Dry Land East: Approximately 4 - 5 km in straight line to town of St-Lawrence.								

Table A5: Base Case

Weightings						Scoring							
Account	**Account Weighting (W_A)**	**Sub-Account**	**Sub-Account Weighting (W_S)**	**Indicator**	**Indicator Weighting (W_I)**	**Shoal Cove Pond**		**Hillside 1**		**Hillside 2**		**AGS Dry Land East**	
						Slurry	**Thickened**	**Slurry**	**Thickened**	**Slurry**	**Thickened**	**Slurry**	**Thickened**
Environment	6	Land Use and Terrestrial Impacts	5	TMF Infrastructure	3	2	4	1	3	1	3	4	6
				TMF Footprint	6	3	3	3	3	4	4	6	6
				Percentage of TMF surface green-field	6	6	6	2	2	2	2	1	1
				Sub-Account Merit Rating		**4.00**	**4.40**	**2.20**	**2.60**	**2.60**	**3.00**	**3.60**	**4.00**
		Surface Water	6	Number of Watershed affected	5	6	6	6	6	6	6	4	4
				Sub-Account Merit Rating		**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**4.00**	**4.00**
		Aquatic Habitat	4	Number of stream crossings by tailings pipeline	4	6	6	6	6	6	6	4	4
				Sub-Account Merit Rating		**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**4.00**	**4.00**
		Air Quality	2	Potential for dust generation	2	1	1	1	1	1	1	5	5
				Potential for greenhouse gas emissions due to construction	2	6	6	2	2	3	3	4	4
				Sub-Account Merit Rating		**3.50**	**3.50**	**1.50**	**1.50**	**2.00**	**2.00**	**4.50**	**4.50**
				Account Merit Rating		**5.12**	**5.24**	**4.35**	**4.47**	**4.53**	**4.65**	**3.94**	**4.06**
Technical	3	Complexity of Design and Construction	6	Topography containment	4	5	5	3	3	3	3	2	2
				Pumping requirements	2	6	6	6	6	6	6	5	5
				Storage / dam volume ratio	4	5	5	2	2	2	2	1	1
				Sub-Account Merit Rating		**5.20**	**5.20**	**3.20**	**3.20**	**3.20**	**3.20**	**2.20**	**2.20**
		Water Management	4	Water volume to TMF	5	1	2	1	2	1	2	5	6
				Water reclaim	6	3	1	3	1	3	1	3	1
				Habitat Compensation	4	3	3	4	4	4	4	6	6
				Sub-Account Merit Rating		**2.33**	**1.87**	**2.60**	**2.13**	**2.60**	**2.13**	**4.47**	**4.00**
		Closure	3	Acid Rock Drainage	5	1	3	2	4	2	4	3	5
				Complexity of Closure	6	2	3	3	4	3	4	4	5
				Sub-Account Merit Rating		**2.83**	**5.50**	**4.67**	**7.33**	**4.67**	**7.33**	**6.50**	**9.17**
				Account Merit Rating		**3.77**	**4.24**	**3.35**	**3.83**	**3.35**	**3.83**	**3.89**	**4.36**
Economics	1.5	Capital Cost	6	Estimated TMF capital cost	6	5	5	2	2	4	4	2	2
				Estimated dewatering plant capital cost	4	6	1	6	1	6	1	6	1
				Estimated slurry pumping capital cost	2	3	1	3	1	3	1	5	4
				Estimated closure / reclamation cost	5	5	6	2	2	3	2	5	5
				Sub-Account Merit Rating		**5.00**	**3.88**	**3.06**	**1.65**	**4.06**	**2.35**	**4.18**	**2.88**
				Account Merit Rating		**5.00**	**3.88**	**3.06**	**1.65**	**4.06**	**2.35**	**4.18**	**2.88**

Weightings						Scoring							
Account	**Account Weighting (W_A)**	**Sub-Account**	**Sub-Account Weighting (W_S)**	**Indicator**	**Indicator Weighting (W_I)**	**Shoal Cove Pond**		**Hillside 1**		**Hillside 2**		**AGS Dry Land East**	
Social	3	Visual Impacts	5	Maximum Height of TMF	4	6	6	5	5	4	4	3	3
		Sub-Account Merit Rating				**6.00**	**6.00**	**5.00**	**5.00**	**4.00**	**4.00**	**3.00**	**3.00**
		Effects on Land Use	6	Previous / Existing Land Use	6	5	5	4	4	4	4	2	2
				Distance from town of St-Lawrence	2	2	2	2	2	2	2	3	3
		Sub-Account Merit Rating				**4.25**	**4.25**	**3.50**	**3.50**	**3.50**	**3.50**	**2.25**	**2.25**
	Account Merit Rating					**5.05**	**5.05**	**4.18**	**4.18**	**3.73**	**3.73**	**2.59**	**2.59**
FINAL RANKING						**4.79**	**4.82**	**3.95**	**3.95**	**4.04**	**4.01**	**3.66**	**3.67**

Table A6: Sensitivity 1

Weightings						Scoring							
Account	Account Weighting (W_A)	Sub-Account	Sub-Account Weighting (W_S)	Indicator	Indicator Weighting (W_I)	Shoal Cove Pond		Hillside 1		Hillside 2		AGS Dry Land East	
						Slurry	Thickened	Slurry	Thickened	Slurry	Thickened	Slurry	Thickened
Environment	6	Land Use and Terrestrial Impacts	5	TMF Infrastructure	3	2	4	1	3	1	3	4	6
				TMF Footprint	6	3	3	3	3	4	4	6	6
				Percentage of TMF surface green-field	6	6	6	2	2	2	2	1	1
				Sub-Account Merit Rating		**4.00**	**4.40**	**2.20**	**2.60**	**2.60**	**3.00**	**3.60**	**4.00**
		Surface Water	6	Number of Watershed affected	5	6	6	6	6	6	6	4	4
				Sub-Account Merit Rating		**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**4.00**	**4.00**
		Aquatic Habitat	4	Number of stream crossings by tailings pipeline	4	6	6	6	6	6	6	4	4
				Sub-Account Merit Rating		**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**4.00**	**4.00**
		Air Quality	2	Potential for dust generation	2	1	1	1	1	1	1	5	5
				Potential for greenhouse gas emissions due to construction	2	6	6	2	2	3	3	4	4
				Sub-Account Merit Rating		**3.50**	**3.50**	**1.50**	**1.50**	**2.00**	**2.00**	**4.50**	**4.50**
				Account Merit Rating		**5.12**	**5.24**	**4.35**	**4.47**	**4.53**	**4.65**	**3.94**	**4.06**
Technical	3	Complexity of Design and Construction	6	Topography containment	4	5	5	3	3	3	3	2	2
				Pumping requirements	2	6	6	6	6	6	6	5	5
				Storage / dam volume ratio	4	5	5	2	2	2	2	1	1
				Sub-Account Merit Rating		**5.20**	**5.20**	**3.20**	**3.20**	**3.20**	**3.20**	**2.20**	**2.20**
		Water Management	4	Water volume to TMF	5	1	2	1	2	1	2	5	6
				Water reclaim	6	3	1	3	1	3	1	3	1
				Habitat Compensation	4	3	3	4	4	4	4	6	6
				Sub-Account Merit Rating		**2.33**	**1.87**	**2.60**	**2.13**	**2.60**	**2.13**	**4.47**	**4.00**
		Closure	3	Acid Rock Drainage	5	1	3	2	4	2	4	3	5
				Complexity of Closure	6	2	3	3	4	3	4	4	5
				Sub-Account Merit Rating		**2.83**	**5.50**	**4.67**	**7.33**	**4.67**	**7.33**	**6.50**	**9.17**
				Account Merit Rating		**3.77**	**4.24**	**3.35**	**3.83**	**3.35**	**3.83**	**3.89**	**4.36**
Economics	0	Capital Cost	6	Estimated TMF capital cost	6	5	5	2	2	4	4	2	2
				Estimated dewatering plant capital cost	4	6	1	6	1	6	1	6	1
				Estimated slurry pumping capital cost	2	3	1	3	1	3	1	5	4
				Estimated closure / reclamation cost	5	5	6	2	2	3	2	5	5
				Sub-Account Merit Rating		**5.00**	**3.88**	**3.06**	**1.65**	**4.06**	**2.35**	**4.18**	**2.88**
				Account Merit Rating		**5.00**	**3.88**	**3.06**	**1.65**	**4.06**	**2.35**	**4.18**	**2.88**

Weightings						Scoring							
Account	**Account Weighting (W_A)**	**Sub-Account**	**Sub-Account Weighting (W_S)**	**Indicator**	**Indicator Weighting (W_I)**	**Shoal Cove Pond**		**Hillside 1**		**Hillside 2**		**AGS Dry Land East**	
Social	3	Visual Impacts	5	Maximum Height of TMF	4	6	6	5	5	4	4	3	3
		Sub-Account Merit Rating				**6.00**	**6.00**	**5.00**	**5.00**	**4.00**	**4.00**	**3.00**	**3.00**
		Effects on Land Use	6	Previous / Existing Land Use	6	5	5	4	4	4	4	2	2
				Distance from town of St-Lawrence	2	2	2	2	2	2	2	3	3
				Sub-Account Merit Rating		**4.25**	**4.25**	**3.50**	**3.50**	**3.50**	**3.50**	**2.25**	**2.25**
				Account Merit Rating		**5.05**	**5.05**	**4.18**	**4.18**	**3.73**	**3.73**	**2.59**	**2.59**
					FINAL RANKING	**4.76**	**4.94**	**4.06**	**4.24**	**4.03**	**4.21**	**3.59**	**3.77**

Table A7: Sensitivity 2

Weightings						Scoring							
Account	Account Weighting (W_A)	Sub-Account	Sub-Account Weighting (W_S)	Indicator	Indicator Weighting (W_I)	Shoal Cove Pond		Hillside 1		Hillside 2		AGS Dry Land East	
						Slurry	Thickened	Slurry	Thickened	Slurry	Thickened	Slurry	Thickened
Environment	6	Land Use and Terrestrial Impacts	5	TMF Infrastructure	3	2	4	1	3	1	3	4	6
				TMF Footprint	6	3	3	3	3	4	4	6	6
				Percentage of TMF surface green-field	6	6	6	2	2	2	2	1	1
				Sub-Account Merit Rating		**4.00**	**4.40**	**2.20**	**2.60**	**2.60**	**3.00**	**3.60**	**4.00**
		Surface Water	6	Number of Watershed affected	5	6	6	6	6	6	6	4	4
				Sub-Account Merit Rating		**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**4.00**	**4.00**
		Aquatic Habitat	4	Number of stream crossings by tailings pipeline	4	6	6	6	6	6	6	4	4
				Sub-Account Merit Rating		**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**4.00**	**4.00**
		Air Quality	2	Potential for dust generation	2	1	1	1	1	1	1	5	5
				Potential for greenhouse gas emissions due to construction	2	6	6	2	2	3	3	4	4
				Sub-Account Merit Rating		**3.50**	**3.50**	**1.50**	**1.50**	**2.00**	**2.00**	**4.50**	**4.50**
				Account Merit Rating		**5.12**	**5.24**	**4.35**	**4.47**	**4.53**	**4.65**	**3.94**	**4.06**
Technical	0	Complexity of Design and Construction	6	Topography containment	4	5	5	3	3	3	3	2	2
				Pumping requirements	2	6	6	6	6	6	6	5	5
				Storage / dam volume ratio	4	5	5	2	2	2	2	1	1
				Sub-Account Merit Rating		**5.20**	**5.20**	**3.20**	**3.20**	**3.20**	**3.20**	**2.20**	**2.20**
		Water Management	4	Water volume to TMF	5	1	2	1	2	1	2	5	6
				Water reclaim	6	3	1	3	1	3	1	3	1
				Habitat Compensation	4	3	3	4	4	4	4	6	6
				Sub-Account Merit Rating		**2.33**	**1.87**	**2.60**	**2.13**	**2.60**	**2.13**	**4.47**	**4.00**
		Closure	3	Acid Rock Drainage	5	1	3	2	4	2	4	3	5
				Complexity of Closure	6	2	3	3	4	3	4	4	5
				Sub-Account Merit Rating		**2.83**	**5.50**	**4.67**	**7.33**	**4.67**	**7.33**	**6.50**	**9.17**
				Account Merit Rating		**3.77**	**4.24**	**3.35**	**3.83**	**3.35**	**3.83**	**3.89**	**4.36**
Economics	0	Capital Cost	6	Estimated TMF capital cost	6	5	5	2	2	4	4	2	2
				Estimated dewatering plant capital cost	4	6	1	6	1	6	1	6	1
				Estimated slurry pumping capital cost	2	3	1	3	1	3	1	5	4
				Estimated closure / reclamation cost	5	5	6	2	2	3	2	5	5
		Sub-Account Merit Rating				**5.00**	**3.88**	**3.06**	**1.65**	**4.06**	**2.35**	**4.18**	**2.88**
				Account Merit Rating		**5.00**	**3.88**	**3.06**	**1.65**	**4.06**	**2.35**	**4.18**	**2.88**

Weightings						Scoring							
Account	**Account Weighting (W_A)**	**Sub-Account**	**Sub-Account Weighting (W_S)**	**Indicator**	**Indicator Weighting (W_I)**	**Shoal Cove Pond**		**Hillside 1**		**Hillside 2**		**AGS Dry Land East**	
Social	3	Visual Impacts	5	Maximum Height of TMF	4	6	6	5	5	4	4	3	3
		Sub-Account Merit Rating				**6.00**	**6.00**	**5.00**	**5.00**	**4.00**	**4.00**	**3.00**	**3.00**
		Effects on Land Use	6	Previous / Existing Land Use	6	5	5	4	4	4	4	2	2
				Distance from town of St-Lawrence	2	2	2	2	2	2	2	3	3
		Sub-Account Merit Rating				**4.25**	**4.25**	**3.50**	**3.50**	**3.50**	**3.50**	**2.25**	**2.25**
	Account Merit Rating					**5.05**	**5.05**	**4.18**	**4.18**	**3.73**	**3.73**	**2.59**	**2.59**
FINAL RANKING						**5.09**	**5.17**	**4.30**	**4.37**	**4.26**	**4.34**	**3.49**	**3.57**

Table A8: Sensitivity 3

Weightings						Scoring							
Account	Account Weighting (W_A)	Sub-Account	Sub-Account Weighting (W_S)	Indicator	Indicator Weighting (W_I)	Shoal Cove Pond		Hillside 1		Hillside 2		AGS Dry Land East	
						Slurry	Thickened	Slurry	Thickened	Slurry	Thickened	Slurry	Thickened
Environment	1	Land Use and Terrestrial Impacts	5	TMF Infrastructure	3	2	4	1	3	1	3	4	6
				TMF Footprint	6	3	3	3	3	4	4	6	6
				Percentage of TMF surface green-field	6	6	6	2	2	2	2	1	1
				Sub-Account Merit Rating		**4.00**	**4.40**	**2.20**	**2.60**	**2.60**	**3.00**	**3.60**	**4.00**
		Surface Water	6	Number of Watershed affected	5	6	6	6	6	6	6	4	4
				Sub-Account Merit Rating		**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**4.00**	**4.00**
		Aquatic Habitat	4	Number of stream crossings by tailings pipeline	4	6	6	6	6	6	6	4	4
				Sub-Account Merit Rating		**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**4.00**	**4.00**
		Air Quality	2	Potential for dust generation	2	1	1	1	1	1	1	5	5
				Potential for greenhouse gas emissions due to construction	2	6	6	2	2	3	3	4	4
				Sub-Account Merit Rating		**3.50**	**3.50**	**1.50**	**1.50**	**2.00**	**2.00**	**4.50**	**4.50**
				Account Merit Rating		**5.12**	**5.24**	**4.35**	**4.47**	**4.53**	**4.65**	**3.94**	**4.06**
Technical	1	Complexity of Design and Construction	6	Topography containment	4	5	5	3	3	3	3	2	2
				Pumping requirements	2	6	6	6	6	6	6	5	5
				Storage / dam volume ratio	4	5	5	2	2	2	2	1	1
		Sub-Account Merit Rating				**5.20**	**5.20**	**3.20**	**3.20**	**3.20**	**3.20**	**2.20**	**2.20**
		Water Management	4	Water volume to TMF	5	1	2	1	2	1	2	5	6
				Water reclaim	6	3	1	3	1	3	1	3	1
				Habitat Compensation	4	3	3	4	4	4	4	6	6
		Sub-Account Merit Rating				**2.33**	**1.87**	**2.60**	**2.13**	**2.60**	**2.13**	**4.47**	**4.00**
		Closure	3	Acid Rock Drainage	5	1	3	2	4	2	4	3	5
				Complexity of Closure	6	2	3	3	4	3	4	4	5
		Sub-Account Merit Rating				**2.83**	**5.50**	**4.67**	**7.33**	**4.67**	**7.33**	**6.50**	**9.17**
				Account Merit Rating		**3.77**	**4.24**	**3.35**	**3.83**	**3.35**	**3.83**	**3.89**	**4.36**
Economics	1	Capital Cost	6	Estimated TMF capital cost	6	5	5	2	2	4	4	2	2
				Estimated dewatering plant capital cost	4	6	1	6	1	6	1	6	1
				Estimated slurry pumping capital cost	2	3	1	3	1	3	1	5	4
				Estimated closure / reclamation cost	5	5	6	2	2	3	2	5	5
		Sub-Account Merit Rating				**5.00**	**3.88**	**3.06**	**1.65**	**4.06**	**2.35**	**4.18**	**2.88**
				Account Merit Rating		**5.00**	**3.88**	**3.06**	**1.65**	**4.06**	**2.35**	**4.18**	**2.88**

Weightings						Scoring							
Account	**Account Weighting (W_A)**	**Sub-Account**	**Sub-Account Weighting (W_S)**	**Indicator**	**Indicator Weighting (W_I)**	**Shoal Cove Pond**		**Hillside 1**		**Hillside 2**		**AGS Dry Land East**	
Social	1	Visual Impacts	5	Maximum Height of TMF	4	6	6	5	5	4	4	3	3
				Sub-Account Merit Rating		**6.00**	**6.00**	**5.00**	**5.00**	**4.00**	**4.00**	**3.00**	**3.00**
		Effects on Land Use	6	Previous / Existing Land Use	6	5	5	4	4	4	4	2	2
				Distance from town of St-Lawrence	2	2	2	2	2	2	2	3	3
				Sub-Account Merit Rating		**4.25**	**4.25**	**3.50**	**3.50**	**3.50**	**3.50**	**2.25**	**2.25**
				Account Merit Rating		**5.05**	**5.05**	**4.18**	**4.18**	**3.73**	**3.73**	**2.59**	**2.59**
					FINAL RANKING	**4.73**	**4.60**	**3.74**	**3.53**	**3.92**	**3.64**	**3.65**	**3.47**

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APPENDIX K

Air Emissions Inventory

September 22, 2015

AIR EMISSIONS INVENTORY REPORT

Canada Fluorspar (NL) Inc.
AGS Fluorspar Project
St. Lawrence NL

Version 2.0

Submitted to:
Newfoundland and Labrador Department of Environment
and Conservation, Environmental Assessment Division

REPORT

Report Number: 1407707-0052

Distribution:Distribution:Distribution:

1 e-copy - Newfoundland and Labrador Department of Environment and Conservation
1 copy - Golder Associates Ltd.

Golder Associates

Document Version Control

This report documents the methods, input parameters and assumptions that were used to produce emission estimates for the Canada Fluorpspar (NL) Inc. (CFI) AGS Fluorspar project (the Project). Since the original version of the Air Emissions Inventory Report was issued in July 2015, updates have been made to the emissions inventory and report to address comments from the Newfoundland and Labrador Department of Environment and Conservation, Environmental Assessment Division (NL DOEC). Therefore, it is necessary to have appropriate version control. This version control will allow CFI personnel and government regulators to track and monitor changes to this report over time.

A Modification Log documenting the changes and updates to the emissions inventory is included in Appendix A. Changes listed in the Modification Log have been incorporated into this report.

Version	Date	Revision Description	Prepared By	Reviewed By (Facility Contact)
1.0	July 2015	Original report on the construction and operation phases of CFI AGS Project	Golder Associates Ltd.	Frank Pitman
2.0	September 2015	Updates to address comments on the emissions inventory from NL DOEC	Golder Associates Ltd.	

Executive Summary

This report documents the methods, input parameters and assumptions that were used to produce emission estimates for the Canada Fluorpspar (NL) Inc. (CFI) AGS Fluorspar project (the Project). The Project will include construction, operation, rehabilitation and closure of a surface and underground mine, a mill, a Tailings Management Facility (TMF), ancillary infrastructure, and a Marine Terminal. The proposed Project will be located partly on a brownfield site used historically for mining. The site is located entirely within the municipal boundaries of the Town of St. Lawrence, on the southern tip of the Burin Peninsula in Newfoundland.

Emission inventories were developed for the Project under two separate worst-case operating scenarios: Construction Phase and Operation Phase. Emissions that were considered under each scenario are:

Scenario 1- Construction Phase

- dust emissions (suspended particulate matter, PM_{10} and $PM_{2.5}$) from various activities including overburden, waste rock and topsoil handling and bulldozing, drilling and blasting and trucks on haul roads;
- metals present in dust generated from waste rock handling and bulldozing, drilling and blasting and trucks on haul roads; and
- combustion emissions (nitrogen oxides, carbon monoxide, sulphur dioxide and diesel particulate matter) from various equipment/activities including explosives detonation, diesel dewatering pump, diesel power generation and construction vehicles.

Scenario 2- Operations Phase

- dust emissions (suspended particulate matter, PM_{10} and $PM_{2.5}$) from various equipment/activities including open pit drilling and blasting, ore and waste rock handling, ore crushing, concentrate handling, trucks on haul roads and a crushing circuit dust collector;
- metals present in dust generated from various equipment/activities including open pit drilling and blasting, ore and waste rock handling, ore crushing, trucks on haul roads and the crushing circuit dust collector;
- combustion emissions (nitrogen oxides, carbon monoxide, sulphur dioxide, and diesel particulate matter) from various equipment/activities including explosives detonation, open pit mining equipment, haul trucks, emergency diesel generators, propane fired underground mine heating equipment and marine vessel engines while docked at port; and
- volatile compound emissions (carbon disulphide and pentanol) associated with the mill and tailings pond.

Process Flow Diagrams which graphically demonstrate the assumed operating condition for each scenario are provided in Appendix B.

Potential emissions from some activities related to the Project were considered insignificant and were not included in the inventory. Emission estimates for significant activities have been developed based on an assumed operating condition for each of the above noted scenarios and calculation input parameters which were either known and provided by CFI or assumed based on similar mining and milling operations. Emission estimate sheets for each source under each scenario are provided in Appendix C. Metals emissions are summarized in Appendix D. A table summarizing all calculation input parameters along with references for each parameter is provided in Appendix E. Emission rate estimates are summarized in Table 4-2.

CFI has committed to completing a Best Available Control Technology (BACT) analysis for equipment that will be used to control emissions from material processing and handling sources, such as crushing, screening and transfer conveyors as well as fugitive dust emission sources. The results of the BACT analysis will ensure that the most effective option based on energy, environmental and economic effects will be selected for each source type. CFI will engage with NL DOEC during the preparation of the BACT analysis to ensure that it meets Section 6 of the *Air Pollution Control Regulations, 2004*.

A review and discussion of prevailing wind direction data has been completed. Data indicates that the prevailing winds at the Project site are in the direction of the town of St. Lawrence.

In addition to estimates of GHG emissions associated with the Project during construction and operations and how these emissions compare to provincial, national and global emissions, information is also provided on the predicted effect of climate change on the Project. The provincial climate change projections for St Lawrence were used in this assessment.

In addition to the BACT analysis that will be completed during the Project permitting and following detailed engineering design of the process, CFI will consult with DOECs Pollution Prevention Division regarding an ambient monitoring program for particulates in the Town of St Lawrence commencing during construction and continuing into operations. A Best Management Practices Plan to control fugitive dust emissions will also be prepared and implemented by CFI prior to start of construction and implemented throughout construction and operations.

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APPENDICES

1.0 INTRODUCTION

This Air Emissions Inventory Report was prepared by Golder Associates Ltd. (Golder) on behalf of Canada Fluorspar (NL) Inc. (CFI) and is part of the Environmental Assessment (EA) for the AGS Fluorspar Project (the Project). The Project will include construction, operation, rehabilitation and closure of a surface and underground mine, a mill, a Tailings Management Facility (TMF), ancillary infrastructure, and a Marine Terminal. The proposed Project will be located partly on a brownfield site used historically for mining. The site is located entirely within the municipal boundaries of the Town of St. Lawrence, on the southern tip of the Burin Peninsula in Newfoundland.

Emission inventories were prepared for the Project under two separate worst-case operating scenarios: Construction Phase and Operation Phase. Emissions that were considered under each scenario are as follows:

Scenario 1- Construction Phase

- dust emissions (suspended particulate matter, PM_{10} and $PM_{2.5}$) from various activities including overburden, waste rock and topsoil handling and bulldozing, drilling and blasting and trucks on haul roads;
- metals present in dust generated from waste rock handling and bulldozing, drilling and blasting and trucks on haul roads; and
- combustion emissions (nitrogen oxides, carbon monoxide, sulphur dioxide and diesel particulate matter) from various equipment/activities including explosives detonation, diesel dewatering pump, diesel power generation and construction vehicles.

Scenario 2- Operations Phase

- dust emissions (suspended particulate matter, PM_{10} and $PM_{2.5}$) from various equipment/activities including open pit drilling and blasting, ore and waste rock handling, ore crushing, concentrate handling, trucks on haul roads and a crushing circuit dust collector;
- metals present in dust generated from various equipment/activities including open pit drilling and blasting, ore and waste rock handling, ore crushing, trucks on haul roads and the crushing circuit dust collector;
- combustion emissions (nitrogen oxides, carbon monoxide, sulphur dioxide, and diesel particulate matter) from various equipment/activities including explosives detonation, open pit mining equipment, haul trucks, emergency diesel generators, propane fired underground mine heating equipment and marine vessel engines while docked at port; and
- volatile compound emissions (carbon disulphide and pentanol) associated with the mill and tailings pond.

More detailed descriptions of each of the operation scenarios is presented in Section 2.0. Section 3.0 summarizes the sources and associated compounds that are emitted for each scenario as well as which sources were not considered to be significant, and therefore, were not included in the inventory. Discussions of the emissions estimation methodology and all input parameters are provided in Section 4.0. Emission rate estimates are summarized in Table 4-2 and Table 4-3.

2.0 DESCRIPTION OF OPERATING SCENARIOS

The Project will include construction, operation, rehabilitation and closure of a surface and underground mine, a mill, a TMF, ancillary infrastructure, and a Marine Terminal. The phases that include activities with the potential to generate emissions to air are the construction phase and the operations phase. Significantly less emissions will be generated during the rehabilitation and closure phases. For this reason, emissions inventories were developed for two operating scenarios, the Construction Phase and the Operations Phase.

The life-cycle of the Project evolves from year to year as construction activities peak and extraction rates fluctuate during operations. To inventory the air emissions associated with the Project at some defined point in time, “worst case” operating scenarios were created for the Construction Phase and for the Operations Phase. By creating these scenarios, the inventory is documenting a case, which may not be realistically achievable but, that includes maximum emissions from the Project without having to inventory multiple years within each Project phase.

The following are descriptions of each of the scenarios. Process Flow Diagrams which graphically demonstrate the activities for each scenario are provided in Appendix B.

2.1 Scenario 1 – Construction Phase

During the Construction Phase of the Project, bulldozing will occur in the overburden dump, waste rock dump and topsoil storage areas to prepare the sites for material storage. Material will be loaded into the overburden, waste rock and topsoil stockpiles, as areas are cleared for infrastructure construction and portal and pit development to occur. During the site preparation and construction phase, fugitive dust, metals and vehicle exhaust emissions will occur as equipment and personnel are transported around the site on unpaved roadways.

Drilling and blasting activities will occur at the open pits and portal locations to support pit and portal development. There will be emissions from the portal openings and the surface of the pits.

Grebes Nest Pond will be dewatered to allow for the excavation of a portion of Grebes Nest Pit during construction. A 150 horsepower (hp) diesel pump has been assumed for pit dewatering.

During the first six months of construction, 1 MW of power will be supplied by three diesel-fired portable generators while connections to the provincial grid are developed. Thereafter, electricity from the provincial grid will provide main power to the site.

CFI plans to begin mining small quantities of ore towards the end of pit construction in 2017 to support commissioning of the mill. Therefore, as per data provided by CFI for the Construction Phase, some emissions from drilling and blasting of ore were estimated, in addition to waste rock, to avoid having to quantify multiple construction years.

CFI will develop and implement a Fugitive Dust Best Management Practices Plan (Fugitive Dust BMPP) for the control of fugitive dust emissions to provide reasonable dust suppression measures for activities that generate fugitive dust during the Construction Phase.

2.2 Scenario 2 – Operations Phase

Drilling and blasting activities will occur within the open pits during the Operations Phase of the Project to support ore mining activities and develop the pits. The operating schedule for pit mining equipment and personnel will be two 10-hour shifts per day (resulting in 20 hours of operation in a 24-hour period) for 350 days per year. Both ore and waste rock material will be blasted. The worst-case scenario was assumed to be production planned for year 2019 at which time 100% of ore extraction is occurring from the Grebes Nest Pit. This production year was selected to be inventoried because it is expected to produce the highest volume of ore extracted via open pit mining. Open pit mining typically requires larger extraction and hauling equipment (i.e. vehicle size and engine HP) and a larger fleet which in turn generates more tailpipe combustion emissions than mining a similar amount of ore underground. Larger amounts of waste materials are typically moved or extracted during open pit mining which results in higher fugitive emissions in comparison to underground mining where it's more cost effective to leave the waste materials underground. Although the underground mining emissions are released in a smaller concentrated area (the mine ventilation exhaust) the actual mass amount of compound emitted to atmosphere from the entire site is typically considerably larger in open pit mining per tonne of ore extracted.

Although the worst case scenario has been assumed to occur at a time where all mining is occurring in an open pit, emissions from the underground mine air heaters and an emergency generator have been conservatively included in this assessment since these types of emissions would not be accounted for during the open pit mining phase. This conservative assumption allows for an Operations Phase "worst case" scenario to be inventoried without having to compare actual emissions from multiple production years as the Project progresses.

An open pit mining diesel equipment fleet has been assumed for the Operations Phase based on the Preliminary Feasibility Study for the Project. This fleet includes a variety of different pieces of equipment, all of which have been assumed to be operating simultaneously during the Operations Phase.

Ore and waste rock from mining operations will be stockpiled on the surface at designated stockpile areas and the waste rock dump. There will also be various transfer points where ore or fluorspar concentrate will be transferred via conveyors or loaded into product stockpiles in the concentrate storage building. Fugitive dust emissions will occur from haulage on unpaved roadways as ore is hauled out of the pits to the mill, as waste rock and overburden is hauled from the mines to the dumps, and as fluorspar concentrate and dense media separation (DMS) float products are hauled from the mill site to the Marine Terminal, where they are loaded onto ships. Fluorspar concentrate and DMS float products will be stored at the mill site until transport; therefore, there will be no stockpiling of materials at the Marine Terminal. There will only be 40 days during one calendar year where material will be hauled to the terminal and loaded to ships, 20 days for concentrate and 20 days for DMS float products. Maximum throughputs for each individual material handling activity during the Project lifecycle have conservatively been assumed for the purpose of this inventory.

Emissions from the auxiliary engines of ships docked at the Marine Terminal have also been accounted for in this assessment, based on data provided by CFI.

CFI will develop and implement a Fugitive Dust BMPP for the control of fugitive dust emissions to provide reasonable dust suppression measures for activities that generate fugitive dust during the Operations Phase.

A baghouse dust collection system will serve the crushing circuit and collect dust from: the primary, secondary and tertiary crushers; screening; transfer points; and fine ore bin loading.

After ore is crushed in the crushing circuit, the material will be screened and washed. Hydrocyclones will de-slime and further separate materials by particle size, with oversize particles undergoing further grinding in a ball mill. Ball mill hydrocyclones will separate the re-ground products, with undersize material proceeding to the sulphides/slimes flotation circuit to remove sulphides from the ore prior to fluorspar concentrating. Material will flow through a series of flotation cells, with a 10% potassium amyl xanthate solution as the flotation collector. The use of the potassium amyl xanthate product in the flotation circuit has been assumed to result in emissions to air of carbon disulphide and pentanol.

Flotation tailings generated at the mill will be discharged into a TMF centred on Shoal Cove Pond, where tailings were disposed of historically. Material will be conveyed as a slurry by pipeline. The pond liquor may contain residual potassium amyl xanthate from the flotation processes, which has been assumed to have the potential to result in further carbon disulphide and pentanol emissions.

3.0 ASSESSMENT OF COMPOUNDS AND ACTIVITIES

Emissions were estimated using activity and equipment specifications provided in the Environmental Registration Report for the Project (CFI 2015a), in the Preliminary Feasibility Study on the AGS Vein Deposit (CFI 2015b), and information provided by CFI. As the Project is in the design phase, some details required to estimate emissions, such as specific manufacturer data as well as precise material usage rates, are not known at this time. For these types of unknowns, estimates derived from similar mining and milling operations were provided to CFI and confirmed to be reasonable estimates for the Project. Internationally accepted emission factors, most notably AP-42 (U.S. EPA 1995) were also used.

There may be general ventilation from some buildings related to the Project that only discharge uncontaminated air from the workspaces or air from the workspace that may include compounds that will come from commercial office supplies, building maintenance products or supplies and activities. These types of ventilation sources are considered to be negligible and were not identified as sources for the Project. General ventilation located in the process area that does not vent process emissions is also considered to be negligible and is therefore, not included in this assessment.

Compounds that are discharged from sources in negligible amounts and/or activities that discharge a compound in a negligible amount were not included in the inventory. The rationale for these exclusions is provided in Section 3.1. Table 3-1 provides a summary of the activities related to the Project for which emissions were estimated as well as a summary of the compounds released. A surrogate compound denoted as “Metals” in the table represents dust that contains metals. Section 4.2 provides an explanation as to how dust containing metals was inventoried.

Table 3-1: Activities and Compounds Released Associated with the Project

Source Information			**Compounds Released**									
Scenario 1 – Construction Phase												
Source ID	**Source Description or Title**	**General Location**	**PM**	**DPM**	**PM_{10}**	**$PM_{2.5}$**	**CO**	**NO_X**	**SO_2**	**CS_2**	**Pentanol**	**Metals**
OB_MH	Overburden Material Handling	Overburden Dump	✓	-	✓	✓	-	-	-	-	-	-
OB_BD	Overburden Dump Bulldozing	Overburden Dump	✓	-	✓	✓	-	-	-	-	-	-
C_WR	Waste Rock Material Handling	Waste Rock Dump	✓	-	✓	✓	-	-	-	-	-	✓
WR_BD	Waste Rock Dump Bulldozing	Waste Rock Dump	✓	-	✓	✓	-	-	-	-	-	✓
TP_BD	Topsoil Bulldozing	Open Pits, Mill Site, Tailings Management Facility Site	✓	-	✓	✓	-	-	-	-	-	-
TP_MH	Topsoil Material Handling	Various Topsoil Storage Areas	✓	-	✓	✓	-	-	-	-	-	-
P_DEV	Surface Drilling and Blasting (Portal Development)	Underground Mine Portal Area	✓	-	✓	✓	✓	✓	-	-	-	✓
PIT_DEV	Surface Drilling and Blasting (Open Pit Development)	Open Pits	✓	-	✓	✓	✓	✓	-	-	-	✓
GNP_DWP	Diesel Powered Dewatering Pump	Grebes Nest Pond	✓	✓	✓	✓	✓	✓	✓	-	-	-
C_GEN	Portable Diesel Powered Generators (3 units total)	Various Locations On Site (portable generators)	✓	✓	✓	✓	✓	✓	✓	-	-	-
C_UPR	Construction Phase Traffic on Unpaved Haul Roads	Throughout the Site	✓	-	✓	✓	-	-	-	-	-	✓
C_TP	Construction Phase Vehicle Tailpipe Emissions	Throughout the Site	✓	✓	✓	✓	✓	✓	✓	-	-	-
Scenario 2 – Operation Phase												
PIT_DB	Open Pit Drilling and Blasting	Open Pits	✓	-	✓	✓	-	-	-	-	-	✓
PIT_EQUIP	Open Pit Mining Equipment Tailpipe Emissions	Open Pits	✓	✓	✓	✓	✓	✓	✓	-	-	-
U_PH	Propane-fired Underground Mine Heating	Underground Mine	✓	-	✓	✓	✓	✓	✓	-	-	-
U_EPG	Underground Mine Standby Diesel Generator	Underground Mine	✓	✓	✓	✓	-	-	-	-	-	-
ORE_MH	Above-Ground Ore Material Handling	Above-Ground Ore Stockpiles	✓	-	✓	✓	-	-	-	-	-	✓

Source ID	Source Description or Title	General Location	PM	DPM	PM_{10}	$PM_{2.5}$	CO	NO_X	SO_2	CS_2	Pentanol	Metals
OP_WR	Waste Rock Material Handling	Waste Rock Dump	✓	-	✓	✓	-	-	-	-	-	✓
ROM	Run-Of-Mine Ore Transfer to Stationary Grizzly	Mill	✓	-	✓	✓	-	-	-	-	-	✓
DC	Crushing Circuit Dust Collector	Mill	✓	-	✓	✓	-	-	-	-	-	✓
FINE	Fine Ore Transfer from Storage Bin to Feed Conveyor for Dense Media Separator	Mill	✓	-	✓	✓	-	-	-	-	-	✓
SULPH	Sink Product Sulphide Flotation	Mill	-	-	-	-	-	-	-	✓	✓	-
ONSPEC	On-spec Concentrate Stockpile Loading	Concentrate Storage Building	✓	-	✓	✓	-	-	-	-	-	-
OFFSPEC	Off-spec Concentrate Stockpile Loading	Concentrate Storage Building	✓	-	✓	✓	-	-	-	-	-	-
TL	Haul Truck Loading for Concentrate Transport to Marine Terminal	Concentrate Storage Building	✓	-	✓	✓	-	-	-	-	-	-
MAR_TD	Concentrate Transfer from Trucks into Ship Feeder	Marine Terminal	✓	-	✓	✓	-	-	-	-	-	-
MAR_CONV	Concentrate Loading onto Ship via Covered Conveyor	Marine Terminal	✓	-	✓	✓	-	-	-	-	-	-
CONC_LD	Concentrate Loading onto Ships for Transport	Marine Terminal	✓	-	✓	✓	-	-	-	-	-	-
MILL_EPG	Emergency Diesel Generator at Mill	Mill	✓	✓	✓	✓	-	-	-	-	-	-
UPR1 - UPR4	Operations Phase Unpaved Haul Roads Fugitive Dust	Throughout the Site	✓	-	✓	✓	-	-	-	-	-	✓ (except UPR4)
TAILS	Tailings Pond	Tailings Management Facility	-	-	-	-	-	-	-	✓	✓	-
SHIP_1	Ship Auxiliary Engine 1	Marine Terminal	✓	✓	✓	✓	✓	✓	✓	-	-	-
SHIP_2	Ship Auxiliary Engine 2	Marine Terminal	✓	✓	✓	✓	✓	✓	✓	-	-	-
SHIP_3	Ship Auxiliary Engine 3	Marine Terminal	✓	✓	✓	✓	✓	✓	✓	-	-	-

Notes:

CS_2 = Carbon Disulphide

DPM = Diesel Particulate Matter, which can be further speciated into various compounds.

3.1 Activities Not Considered in the Assessment

There are many activities associated with the Project that may produce emissions; however, some activities either produce little to no emissions at all, or produce emissions that are not significant in comparison to the overall emissions of relevant compounds from the Project.

Table 3.1-1 lists the activities and/or equipment that were not assessed and the accompanying rationale.

Table 3.1-1: Insignificant Emissions Associated with the Project

Activity/Equipment	Rationale for Excluding from the Assessment
Scenario 1 –Construction Phase	
Emergency Diesel Power for Construction Phase	No emergency diesel power is anticipated during the Project Construction Phase
Temporary Oil and Fuel Storage Tanks	Potential emissions from these types of sources are negligible
Temporary Portable Office/Dining Trailers Comfort Heating	Trailers will be heated by electric heaters
Scenario 2 –Operation Phase	
DMS Feed Prep Screen, De-Sliming Process, Transfer to Dense Media Separator	No emissions – feed is wet
De-Sliming Hydrocyclones	No emissions - material is fed as a slurry
Dense Media Separator	Closed process. Also, ore is fed with a stream of slurried ferrosilicon, therefore, feed is wet.
DMS Sink and Float Wash Screens	No emissions - products are washed with process water, and therefore, it is wet
Screened Float Product Stockpiling	No emissions - products are washed with process water, and therefore, it is wet
Sink Product Ball Mill Grinding and Ball Mill Hydrocyclones	Closed circuit, material processed as pulp or slurry
Pulp Thickening and Conditioning	No emissions associated with this process
Rougher and Scavenger Flotation, Flotation Cleaner Circuit	No emissions associated with this process
Final Concentrate Thickening and Filtration	No emissions associated with this process
Concentrate Stockpile Conveyor Transfers	No emissions - high moisture content in concentrate
Comfort Heating	Operational heating will be electric

4.0 EMISSION ESTIMATES AND INPUT PARAMETERS

As described in Section 2.0, to inventory the air emissions associated with the Project at some defined point in time, “worst case” operating scenarios were created for the Construction Phase and for the Operations Phase. The throughputs and details provided as inputs to estimate the emissions may not be the final design values; however, they were chosen so that the emissions estimated will be conservative and likely will not have to be modified if reasonable design changes are made to the Project.

4.1 Emission Estimates

Emission estimate sheets for each source that was considered under each operating scenario are provided in Appendix C. The emissions estimate sheets provide the following information:

- a source identifier (Source ID);
- a description of the emission source;
- an explanation of the estimation methods used to estimate emissions from the source, including references to any emission factor documents that have been used to develop the estimation technique;
- input parameters used in the calculation (see Section 4.2);
- sample calculations; and
- emission estimates in various units.

4.2 Metals Speciation

In any activities where metals may be present in the dust generated, “Metals” was identified as a compound in Table 3-1. Two speciation profiles were applied to Metals depending on which source was generating the dust. For sources that involved ore and waste rock, the maximum concentration of each metal of all ore and waste rock assay data provided by CFI was used to speciate the dust. For sources where only waste rock was involved, the maximum concentration of the waste rock assays was taken to speciate. These profiles were applied to the PM emissions documented on the emissions estimation sheets provided in Appendix C according to the following table.

Table 4-1: Metals Speciation Profiles

Speciation Profile	Max % in Ore and Waste Rock		Max % in Waste Rock	
Compound	Concentration in PM (%)	Emission Sources to which Speciation Profile has Been Applied	Concentration in PM (%)	Emission Sources to which Speciation Profile has Been Applied
Antimony	0.00046	Construction Phase:	0.00046	Construction Phase:
Arsenic	0.013		0.013	

Speciation Profile	Max % in Ore and Waste Rock		Max % in Waste Rock	
Compound	Concentration in PM (%)	Emission Sources to which Speciation Profile has Been Applied	Concentration in PM (%)	Emission Sources to which Speciation Profile has Been Applied
Barium	0.095	C_WR, WR_BD, P_DEV, PIT_DEV Operations Phase: PIT_DB, ORE_MH, OP_WR, ROM, DC, FINE	0.095	C_UPR Operations Phase: UPR1, UPR2, UPR3
Beryllium	0.0018		0.0018	
Cadmium	0.0025		0.0025	
Chromium	0.011		0.011	
Cobalt	0.002		0.002	
Lithium	0.028		0.028	
Copper	0.016		0.016	
Lead	0.15		0.023	
Manganese	0.14		0.14	
Mercury	0.00005		0.00005	
Nickel	0.0044		0.0044	
Selenium	0.0001		0.0001	
Silver	0.000069		0.000069	
Vanadium	0.0097		0.0097	
Zinc	0.5		0.16	

Appendix D contains the metals emission estimates for all sources that generate dust that may contain metals.

4.3 Input Parameters

A table summarizing all calculation input parameters along with references for each parameter is provided in Appendix E. Where possible, calculation input parameters have been selected based on design specifications provided by CFI; however, in the absence of known values, estimates derived from similar mining and milling operations were provided to CFI and confirmed to be reasonable estimates for the Project. The table provided in Appendix E indicates which calculation input parameters are based on known data and which input parameters are based on reasonable estimates.

4.4 Emission Estimate Summary

Using the operating conditions and input parameters described above, emission estimates have been prepared in various units and averaging periods. Grams-per-second (g/s) emission estimates have been prepared for 1-hour, 24-hour and annual averaging periods. In addition, emissions estimates have been prepared in kilograms-per-day and kilograms-per-year.

All compound emission estimates, along with each source's percentage contribution to the overall Project-wide emissions for each compound, are provided in Appendix F.

Table 4-3 summarizes the total annual emissions for each compound for each scenario. Emissions from stationary sources for the Operations Phase were presented separately so that comparison can be made with releases reported by other similarly sized mining operations under Environment Canada’s National Pollutant Release Inventory (NPRI). The total annual emissions from stationary sources during operations from the Project are comparable with other mining operations reporting to NPRI.

Table 4-3: Summary of Total Annual Project Emissions

Compound	Total Annual Releases (kg/year)		Total Annual Releases (Stationary Only) (kg/year)
	Construction Phase	Operations Phase	Operations Phase
PM	67,501	139,609	133,517
PM_{10}	36,709	47,434	41,342
$PM_{2.5}$	27,038	12,623	6,714
DPM	22,579	6,752	660
CO	127,096	46,571	8,990
NO_X	386,679	158,458	37,176
SO_2	699	9,879	9,683
Carbon Disulphide	—	1,525	1,525
Pentanol	—	1,769	1,769
Antimony	< 1	< 1	< 1
Arsenic	4	9	9
Barium	33	64	64
Beryllium	0.6	1.2	1.2
Cadmium	0.9	1.7	1.7
Chromium	3.8	7	7
Cobalt	0.7	1.3	1.3
Lithium	10	19	19
Copper	6	11	11
Lead	31	31	31
Manganese	48	94	94
Mercury	< 1	< 1	< 1
Nickel	2	3	3
Selenium	< 1	< 1	< 1
Silver	< 1	< 1	< 1
Vanadium	3	6	6
Zinc	118	150	150

Note:
DPM = Diesel Particulate Matter, which can be further speciated into various compounds.

5.0 CONSERVATISM OF OPERATING CONDITION AND EMISSION ESTIMATES

The following table outlines the areas where conservatism was assumed in the operating condition inventoried or emission estimates for each scenario, which result in estimates that are not likely to under-predict the actual emissions associated with the Project.

Table 5-1: Areas of Conservatism in the Operating Condition and Emission Estimates

Scenario	Project Aspect	Conservative Assumption
1 – Construction Phase	Pit and Portal Development	■ Operating Condition assumes that pit and portal development occur simultaneously, which is not likely to occur based on the Project Schedule.
2 – Operations Phase	Underground/ Open Pit Mining	■ Operating Condition assumes the worst case open pit mining stage of the Project (as described in s.2.2); however, it also considers emissions from underground mining equipment, including underground mine air heater and emergency generator. This is conservative because the open pit mining scenario assumed is not scheduled to occur at the same time as underground mining.
	Ore Crushing and Screening	■ The emission calculations are based on the maximum material throughput occurring every day of operation.
Both Scenarios 1 and 2	Blasting	■ Emission estimates are based on the largest blast possible occurring every day of operation.
	Mobile Vehicle Exhaust	■ It is assumed that all off-road vehicles are operating at the same time, for 20 hours per day (Scenario 2) or 24 hours per day (Scenario 1). This situation is not likely to occur.
	Metals in Dusts/ Particulate Matter	■ Relevant particulate matter emissions were scaled to estimate metal emission rates from all sources where metals emissions may be expected. The scaling assumed the maximum observed metal concentrations from assays of ore and waste rock. This is a conservative assumption as it is not likely that the metals would be present at the maximum concentrations at all times for all potentially emitted materials to which this assumption has been applied. Appendix E provides the metals assay data.
	Fugitive Dust Emissions from Unpaved Roadways	■ The emission estimation methods applied were developed from measured emissions from public roadways and, as a result, will tend to over-estimate low speed vehicle traffic from construction or mine sites. ■ The assumed silt loading used to calculate emission rates are based on conservative default values. As the best management practices implemented at the site are revised through continuous improvements, silt loadings and consequent emissions from the on-site roadways are likely to decrease.

6.0 BEST AVAILABLE CONTROL TECHNOLOGY

During the detailed engineering design phase, CFI will complete a Best Available Control Technology (BACT) analysis for equipment that will be used to control emissions from material processing and handling sources, such as crushing, screening and transfer conveyors as well as fugitive dust emission sources.

The draft "*Top-Down" Best Available Control Technology Guidance Document* published by the US Environmental Protection Agency (EPA) will be considered in the BACT analysis and the PPD will be consulted on the proposed approach for the analysis to ensure that it meets Section 6 of the *Air Pollution Control Regulations, 2004*. The analysis shall include a review of all potential control technologies for each source type. Technologies will be eliminated based on technical infeasibility. The remaining technologies will be ranked according to effectiveness. The most effective option based on energy, environmental and economic effects will be selected for each source type. The process will be document in a BACT report which will be updated as new sources are added at the site or existing sources are modified.

7.0 REVIEW OF PREVAILING WIND DIRECTION DATA

At the request of the NL DOEC (Personal Communication) meteorological data from the Environment Canada climate station at St. Lawrence has been reviewed and summarized with respect to winds and data availability. The pertinent physical details for this station are:

Station Name:	St. Lawrence
EC Station ID:	8403619
WMO Identifier:	71110
Latitude:	46.92 N
Longitude:	55.38 W
Elevation:	48.5 metres above sea level (masl)
Station Type:	Hourly
Data Availability:	January 2006 to present

Publicly available data (from the Environment Canada climate data website) includes hourly temperature, dewpoint, relative humidity, wind direction, wind speed, station pressure and wind chill. Station reliability appears to be high, with better than 99% data availability for the 2010 to 2014 period (the most recent five full years of data).

Figure 7.1-1 shows the 5-year wind rose for this station.

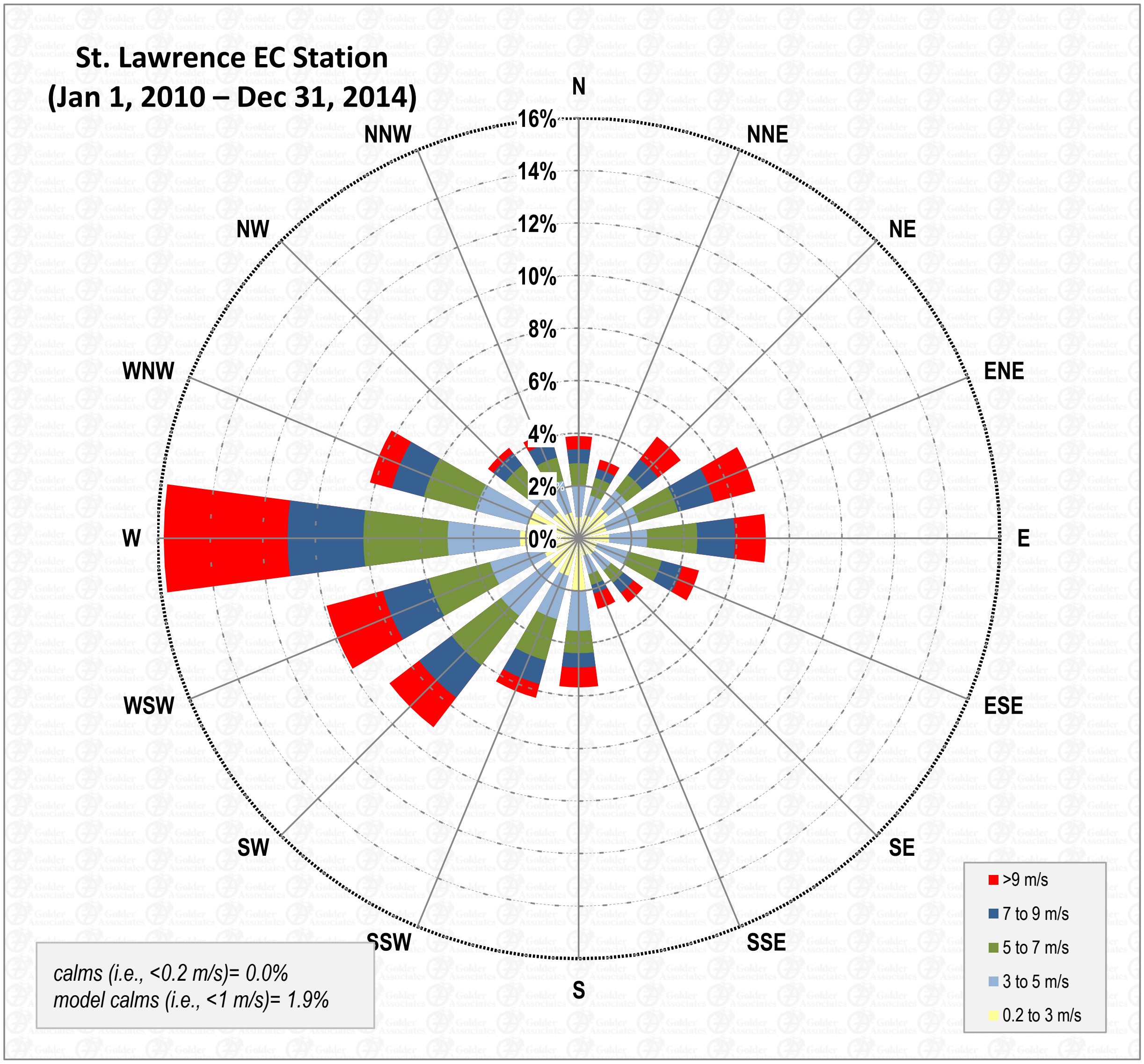

Figure 7-1: 5-year wind rose from the Environment Canada St. Lawrence climate station

Prevailing winds at the Environment Canada St. Lawrence station, located on the east side of the Great St. Lawrence Harbour are westerly, with strong contributions from southwest through west-northwest. Seasonally, winds are primarily from the west in winter, shifting to a westerly with a secondary east-north-easterly component in spring, southwesterly and west-southwesterly in summer, and back to westerly in autumn. Winds are strongest in daytime, averaging 6.5 metres per second (m/s) and somewhat lower at night, averaging 5.4 m/s. Overall, winds at this station average 5.9 m/s.

Considering the above information and the fact that the Project site is located to the west of the town of St. Lawrence, it is reasonable to state that the prevailing winds at the Project site will be in the direction of the town of St. Lawrence.

8.0 CLIMATE CHANGE

Greenhouse gas emissions from the Project can be used to assess the potential adverse effect the Project may have on global climate change. On the other hand, climate change should be considered during the Project design in order to adequately mitigate the potential adverse effect climate change may have on the Project over the duration of its life.

8.1 Greenhouse Gas Emissions

Estimates of fuel consumption and GHG emissions have been provided for each of the assumed worst case operating scenarios for the Construction Phase and Operations Phase of the Project. Details of these operating scenarios are provided in Section 2.0.

8.1.1 Estimates of Fuel Consumption for the Project

Based on the equipment and operating assumptions included in each of the maximum operating scenarios assumed for the Construction Phase and Operations Phase of the Project, the worst case annual fuel consumption has been estimated. Table 8-1 provides a summary of the activities and associated fuel consumption estimates.

Table 8-1: Fuel Consumption Estimates for the Project

Activity	Fuel Type	Annual Consumption Estimate Unit	Annual Consumption Estimate
Construction Phase			
Combustion in Stationary Sources	Diesel	L	505,122
On-Site Transportation	Diesel	L	27,016,290
Purchased Electricity	Electricity Consumption	MWh	4,392
Operation Phase			
Combustion in Stationary Sources	Propane	L	2,446,447
Combustion in Stationary Sources	Diesel	L	1,580,876
Combustion in Stationary Sources	Marine Gas Oil	L	241,379
On-Site Transportation	Diesel	L	6,183,800
Purchased Electricity	Electricity Consumption	MWh	48,180

It should be noted that since the estimates in the above table are based on the maximum operating scenarios described in Section 2.0, they also incorporate the conservative assumptions which are outlined in Section 5.0 and are thus likely an over-prediction of fuel consumption for the project.

Calculations sheets for fuel consumption estimates, which include calculation inputs and sample calculations are provided in Attachment G.

The above fuel consumption estimates have been used as calculations inputs for the GHG release estimates which are described in the following section.

8.1.2 Estimates of Greenhouse Gas Releases for the Project

The potential annual GHG emissions associated with the Project during the Construction Phase and Operation Phase have been estimated and then put in the context of the annual GHGs emitted provincially, nationally and globally.

The emissions estimation methods used to quantify annual GHG releases follow generally accepted practices for conducting Environmental Assessments (EAs) in Canada and, where applicable, the Government of Canada's GHG Emissions Reporting Program (the GHGRP) guidance document.

The Greenhouse Gas Protocol (GHG Protocol) provided by the World Business Council for Sustainable Development/ World Resources Institute (WBCSD/WRI, 2004) outlines guidance for preparing corporate GHG emission inventories, and introduces the concept of direct and indirect emissions and scopes for the inventory under three broad categories, as follows:

- **Scope 1** **–** Direct GHG emissions:

  Carbon emissions occurring from sources that are owned or controlled by the company (e.g. emissions from combustion in owned or controlled boilers, furnaces and vehicles, process and fugitive emissions).

- **Scope 2** **–** Electricity indirect GHG emissions:

  Carbon emissions from the generation of purchased electricity, heat or steam consumed by the company.

- **Scope 3** **–** Other indirect GHG emissions:

The sources of GHGs from the Project are listed in the table below.

Table 8-2: Sources of GHG releases from the Project

Source Type	Source	GHG Emissions
Construction Phase		
Stationary Fuel Combustion (Scope 1)	Stationary Diesel Combustion	Emissions from diesel powered dewatering pump and diesel power generators
Mobile Fuel Combustion Sources (Scope 1)	On-Site Transportation	On-site vehicle tailpipe emissions, due to diesel combustion
Process-Related Sources (Scope 1)	Blasting	Emissions from blasting surface materials using explosives
Purchased Electricity (Scope 2)	Purchased electricity	Indirect emissions from electricity purchase
Operation Phase		
Stationary Fuel Combustion (Scope 1)	Stationary Propane Combustion	Emissions from propane-fired underground mine air heater

	Stationary Diesel Combustion	Emissions from emergency generators and dewatering pump
	Stationary Marine Gas Oil Combustion (in Ships)	Emissions from marine vessel auxiliary engines while ship is docked at port
Mobile Fuel Combustion Sources (Scope 1)	Mining fleet	On-site vehicle tailpipe emissions, due to diesel combustion
Process-Related Sources (Scope 1)	Blasting	Emissions from blasting ore and waste rock using explosives
Purchased Electricity (Scope 2)	Purchased electricity	Indirect emissions from electricity purchase

The Environment Canada Document entitled *Technical Guidance on Reporting Greenhouse Gas Emissions* (dated October 2014; the GHGRP Guidance Document) provides direction in assessing if facilities are required to submit a GHG report to Environment Canada, an overview of the reporting process, as well as technical information related to GHG emissions estimations. Technical information includes GHG emission sources subject to reporting and information on emission estimation methodologies.

Given the nature of the Project operations, the most significant emissions in both operating phases will be Scope 1, which are direct GHG emissions occurring from sources that are owned or controlled by the Project (e.g. emissions from combustion in heaters and vehicles, process and fugitive emissions). However, for the purposes of comparing Project GHGs to provincial, national, and global emissions, Scope 2 emissions associated with consumption of purchased electricity were also assessed. Scope 3 emissions are beyond the scope of this assessment and therefore have not been included.

Direct Greenhouse Gas Emissions

Maximum annual direct GHG releases were estimated for the maximum operating scenarios for each phase considered in the Air Emissions Inventory Report and the fuel consumption estimates outlined above. Emission estimates have been prepared according to the GHGRP Guidance Document and emission factors obtained from Environment Canada (http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=AC2B7641-1). The GHG release estimates rely on the fuel consumption estimates described above, and therefore these estimates also incorporate the conservative assumptions which are outlined in s.5.0 of the *Air Emissions Inventory Report* and are thus likely an over-prediction GHG releases for the project.

Detailed GHG release estimates including calculation inputs and emission factors are provided in Appendix G. The direct annual GHG release estimates from each phase of the Project are presented in Table below.

Table 8-3: Annual Direct GHG Release Estimates

Source Type	Annual Emissions (tonnes)				
	CO_2	CH_4	N_2O	CO_2e	% of Project Total Direct GHG Emissions (in t of CO_2e)
Construction Phase					
Stationary Fuel Combustion	1,345	0.07	0.20	1,407	2%
Mobile Fuel Combustion	71,944	4.05	29.72	80,902	98%
Process Related Sources	383	—	—	383	< 1%
Operation Phase					
Stationary Fuel Combustion	8,658	0.34	0.91	8,938	32%
Mobile Fuel Combustion	16,467	0.93	6.80	18,518	67%
Process Related Sources	353	—	—	353	1%

As indicated in the above table, GHG releases from mobile fuel combustion (haul trucks, construction equipment fleet and mining equipment fleet) are likely to be the dominant direct GHG emission source from the Project in both phases.

Once approved, the Project will be required to assess GHG reporting responsibilities under the Environment Canada GHG Reporting Program (GHGRP). Table 8-4 compares the applicable annual direct GHG release estimates for each Project phase to the GHGRP reporting threshold.

Table 8-4: Environment Canada Greenhouse Gas Reporting Program Screening Level Assessment

Greenhouse Gas	Formula	CAS No.	100-year GWP	Construction Phase		Operations Phase	
				Aggregate Source Emissions (tonnes/yr)	**Subtotal Emissions (kt/yr)**	**Aggregate Source Emissions (tonnes/yr)**	**Subtotal Emissions (kt/yr)**
Carbon Dioxide (Combustion in Stationary Sources)	CO_2	124-38-9	1	1,345	1.345	8,658	8.658
Carbon Dioxide (On-Site Transportation)				71,944	71.944	16,467	16.467
Carbon Dioxide (Industrial Process)				383	0.383	353	0.353
Methane (Combustion in Stationary Sources)	CH_4	74-82-8	25	0.07	0.0017	0.34	0.008
Methane (On-Site Transportation)				4.05	0.101	0.928	0.023
Methane (Industrial Process)				NO DATA	NO ESTIMATE	NO DATA	NO ESTIMATE
Nitrous Oxide (Combustion in Stationary Sources)	N_2O	10024-97-2	298	0.20	0.060	0.91	0.272
Nitrous Oxide (Combustion in Non-Stationary Sources)				29.718	8.856	6.802	2.027
Nitrous Oxide (Process Related)				NO DATA	NO ESTIMATE	NO DATA	NO ESTIMATE
Screening Level GHG Emission Estimate [kt CO_2e]				-	**82.691**	-	**27.809**
Program Reporting Threshold [kt CO2e]				-	**50**	-	**50**
ARE SCREENING LEVEL GHG EMISSION ESTIMATES ABOVE THE PROGRAM REPORTING THRESHOLD?				-	**YES**	-	**NO***

As indicated in the above table, the Project may exceed the release-based threshold for the GHGRP based on the maximum operating scenario for the Construction Phase described in the Air Emissions Inventory Report. It should be noted that once the Project commences, under Section 46 of *Canadian Environmental Protection Act* (CEPA) GHG estimates will have to be recalculated annually based on actual consumption data, and estimates must subsequently be compared to the reporting thresholds to determine if reporting is required.

Indirect Greenhouse Gas Emissions

The indirect GHG releases associated with purchased electricity are included for the purpose of comparing Project GHG emissions to provincial, national and global emissions. The emissions provided in Table 8-5 are those resulting from the amount of electricity required to be purchased from the Newfoundland-Labrador grid, and reflects the estimated maximum electricity requirement for the Project in the Construction Phase and Operation Phase.

The GHG emissions from purchased electricity are calculated based on an annual average emission factor for the Newfoundland-Labrador grid, published in the National Inventory Report 1990-2012 by Environment Canada (Environment Canada, 2014). Total emissions are presented as CO_2 equivalent (CO_2e), as separate emission factors for CO_2, CH_4 and N_2O were not published. Emissions are presented for electricity consumption based on the maximum power needs of the Project as described in Section 2.4.6 of EA Registration (dated June 2015).

The indirect GHG release estimates for the Construction and Operation Phases of the Project are presented in Table 8-5.

Table 8-5: Annual Indirect GHG Release Estimates

Activity	**Emissions (tonnes)**	
	CO_2e	**% of Project Phase Total GHG Emissions (in tCO_2e)**
Purchased Electricity (Construction Phase)	88	0.1%
Purchased Electricity (Operation Phase)	964	3.3%

Comparison of Project Greenhouse Gas Emissions to Canadian and Global Emissions

A comparison of the GHG emissions from the Project to the annual GHG emissions (in CO2e) for Newfoundland-Labrador, Canada and globally is provided in Table 8-6. Data for Newfoundland-Labrador and Canada GHG releases are provided by Environment Canada (Environment Canada, 2014). The global baseline emissions for 2011 were obtained from the World Resources Institute (WRI, 2014). The GHG emissions from the Project would be a very minor contribution to the jurisdictional totals.

Table 8-6: Comparison of the Project Greenhouse Gas Emissions to Newfoundland-Labrador, Canadian and Global Totals

Source	Construction Phase		Operations Phase	
	Annual GHG Emissions (kt CO_2e/yr)	Project Emissions as a Relative Percentage of Listed Totals	Annual GHG Emissions (kt CO_2e/yr)	Project Emissions as a Relative Percentage of Listed Totals
Project Total Emissions (Direct and Indirect)	82.779	—		—
Newfoundland Labrador (2012)	8740	0.95%	8740	0.3%
Canada (2012)	699,000	0.012%	699,000	0.004%
Global (2011)	43,816,734	0.0002%	43,816,734	0.0001%

Source: Data for Newfoundland/Labrador and Canada-wide GHG emissions were obtained from the National Inventory Report (Environment Canada 2014a). Data for global GHG emissions were obtained from the WRI (2014).

8.1.3 Potential Project Effects on Climate Change

It is widely accepted that increased anthropogenic GHG emissions are contributing to climate change. As outlined in the previous sections, maximum GHG releases from the Project are likely to result in very minor increases to provincial, national and global GHG emissions.

When considering the effects of Project GHG emissions on climate change, the level of confidence is considered high and the level of risk is considered low. The Project-related GHG emissions, as shown in Table 8-6, are of sufficiently low magnitude that their effect on climate change cannot be measured; this is supported by the federal guidance, which states that the contribution of an individual project to climate change cannot be measured (FPTCCCEA 2003). As a result, individual effects that are not measurable are, by definition, considered negligible. Likewise, the level of risk is considered low if the federal guidance acknowledges that the contribution of an individual Project to climate change cannot be measured, and is thus considered negligible.

Based on this, it is reasonable to assume that the contribution of the Project to climate change will be immeasurable.

8.2 Potential Effects of Climate Change on the Project

A discussion on the potential effects of a changing climate on the mine components of the AGS Fluorspar Project (the Project) is provided in the following subsections.

8.2.1 Project Climate Change for St. Lawrence, Newfoundland

Future climate projections for St. Lawrence were based on *Projected Impacts of Climate Change for the Province of Newfoundland and Labrador* (Office of Climate Change, Energy Efficiency and Emissions Trading, 2013a) and *Climate Change Projections for Newfoundland and Labrador Late 20th Century to Mid 21st Century Summary Presentation* (Office of Climate Change, Energy Efficiency and Emissions Trading, 2013b). Projections in these documents are derived from seven regional climate models simulations produced for the North American Regional Climate Change Assessment Project. The current climate baseline was taken as 1968 to 2000, with projections for the mid-21st century described. Details on the projection data sets and the models used to create them are provided in Office of Climate Change, Energy Efficiency and Emissions Trading (2013a).

Climate change can affect long term climate normals (typically defined as 30-year averages), such as daily mean temperatures, and extreme events such as extra-tropical storms.

With regard to changes to the mean, in general for Newfoundland, the climate is projected to be warmer and wetter. The daily mean temperatures are projected to increase by approximately 2 to 3°C, with the largest changes observed in winter. With the increase in temperature, fewer days with frost are projected, indicating the potential for shorter winter seasons.

The amount of precipitation per precipitation event is projected to increase by approximately 5% over all seasons; however, the absolute level of precipitation is expected to increase the most during fall and winter. More days with high levels of precipitation (10 mm or more) lead to increased risk of flooding and erosion. Over a three day period, the maximum precipitation is also projected to increase over all seasons.

With regard to changes to extreme events, the Office of Climate Change, Energy Efficiency and Emissions Trading (2013b) provides projections of changes in extreme precipitation events for St. Lawrence. Extreme precipitation events are projected to increase in frequency, with the amount of precipitation associated with each time period of storm (e.g. 1-in-100 year) also projected to increase. The amount of precipitation in a current 1-in-100 year storm is projected to occur in a 1-in-50 year storm by the mid-century for St. Lawrence. More frequent and intense precipitation events are projected for the St. Lawrence area.

8.2.2 Potential Climate-Infrastructure Interactions

Changes in future climate have the potential to affect the Project-specific infrastructure components if appropriate mitigation measures are not included as part of the Project. Interactions between the proposed infrastructure and selected climate factors were identified in a climate infrastructure matrix. Any potential risks identified will be avoided or managed through project design elements or adaptive management strategies.

With the exception of the long-term management of the Project during the closure/reclamation phase, most facilities and infrastructure have an estimated lifecycle less than 15 years. The effects of climate change are typically measured over 50 to 100 year periods, therefore, there is lower potential for climate change adverse effects during the construction and operation phase.

The construction period is too short for any meaningful change to either the means or extreme events (e.g. storms). Extreme events may result in a potential interaction with construction but this is no different than any current construction activity and will be addressed if these events occur.

There is a potential for small changes in both the mean and extreme events during the operations phase which may cause interactions with the water management infrastructure.

As part of the closure phase, all buildings, structures, and ancillary facilities will be removed; the mine site area will be regraded; the waste rock storage facilities will be graded to prevent erosion for long-term stability; the tailings management facility will be covered with a pond surrounded by a vegetated surface; disturbed areas will be revegetated and all the pits will naturally fill with water. Consequently, the only environmental components that may be affected by a changing climate are hydrology, soil, flora and fauna, and natural and industrial hazards. These interactions will have to be handled and assessed by the relevant disciplines.

Table 8-7 presents a summary of the potential climate-facility/infrastructure interactions by physical work or activity. Potential interactions for the mine operations (surface and Underground Mine, a Mill, a TMF and ancillary infrastructure) that have been assessed at a regional scale, in the context of the Project, are indicated in the last column.

Table 8-7: Potential Climate-Infrastructure Interactions

Physical Work or Activity	Project Subcomponent(s)	Potential Interaction	Rational
Construction Phase (2 years)			
All activities in the construction phase	mining subcomponents in the construction phase	N	Timescale of activities is too short for considerable climate change related effects (less than 50 years).
Operation Phase (10 years)			
All activities in the operation phase	mining subcomponents in the operation phase	Y	Timescale of activities is too short for considerable climate change related effects. Extreme events (e.g. storms) may result in a potential interaction with operation (e.g. flooding)
Closure/Reclamation Phase (2 years/Ongoing)			
Re-grading of slopes for long-term stability and safety	- Waste rock dumps - Overburden dumps	Y	Increased heavy rain events could impact the slope stability.
Refilling the four open pits and underground mine with water	- Closure and reclamation of pits	Y	Changes in temperature, precipitation and extreme events (e.g., storms) may affect the rate at which the pit refills with water.
Tailings Management Facility	- Closure of the tailings management facility - Pond and spillway	Y	Changes to climate may affect the flora and fauna species previously found in

Physical Work or Activity	Project Subcomponent(s)	Potential Interaction	Rational
			the area. Changes in precipitation and extreme events may affect the water management of the permanent pond
Rehabilitation of the mine site area	- Closure and reclamation of the mine site area	Y	Changes to climate may affect the flora and fauna species previously found in the area.

8.2.3 Recommended Mitigation Measures

As discussed in Table 8-7, the duration of the construction phase of the Project is too short to be directly effected by any long-term (50 years or more) changes in climate and the project has been designed for extreme events.

Nonetheless, it is possible that even small changes to the precipitation trends may affect the water management of the Project; therefore, such changes as well as built-in levels of conservatism should be incorporated into the project design. Changes in the extreme events may affect the Project during the operational phase; however, extreme events have already been considered on water management for the Project by designing to beyond the 1 in 100 year storm, depending on the volume of water proposed to be captured.

A draft closure and reclamation plan (which also includes revegetation), has been developed as part of the Project. The intention is for this document to be an evolutionary piece that continues to be refined throughout the life of the Project. The intention is to revisit the plan, prior to implementation such that changes in conditions; improved technologies; confirmation of predicted effects; and adaptive management can be integrated. As a mitigation measure for climate change, the potential adverse effects of a changing climate should be considered as part of the re-evaluation of the plan.

Table 8-8 presents a summary of the recommended mitigation measure and adaptive management by physical work or activity.

Table 8-8: Recommended Mitigation Measures and Adaptive Management

Physical Work or Activity	Project Subcomponent(s)	Recommendation
Construction Phase (2 years)		
All activities in the construction phase	mining subcomponents in the construction phase	No mitigation measures or adaptive management required
Operation Phase (10 years)		
All activities in the operation phase	mining subcomponents in the operation phase	The infrastructure should be designed to accommodate beyond a 1-in-100 year storm.
Closure/Reclamation Phase (2 years/Ongoing)		

Physical Work or Activity	Project Subcomponent(s)	Recommendation
Re-grading of slopes for long-term stability and safety	- Waste rock dumps - Overburden dumps	Design the slope for future extreme events.
Refilling the four open pits and underground mine with water	- Closure and reclamation of pits	Not required as increase pit filling does not affect closing
Tailings Management Facility	- Closure of the tailings management facility - Pond and spillway	Changes to climate may affect the flora and fauna species previously found in the area but can be addressed through adaptive management plans which consider projected changes in climate relevant to the local flora and fauna. Permanent pond, if required, should be designed for changes in precipitation and extreme events, which may impact water management.
Rehabilitation of the mine site area	- Closure and reclamation of the mine site area	Changes to climate may affect the flora and fauna species previously found in the area but can be addressed through adaptive management plans which consider projected changes in climate relevant to the local flora and fauna.

9.0 COMMITMENTS

In addition to the BACT analysis which will be completed during the Project permitting and following detailed engineering design of the process, CFI will consult with DOECs Pollution Prevention Division regarding an ambient air monitoring program for particulates in the Town of St Lawrence commencing during construction and continuing into operations.

A Best Management Practices Plan to control fugitive dust emissions will also be prepared and implemented by CFI prior to start of construction. This plan will characterize the existing fugitive dust sources at the site, rank them according to relative risk and provide reasonable control measures to be followed by the site to minimize the dust emissions. The plan will also include frequency for inspection of the fugitive sources and procedures for implementation of adaptive management measures following inspection. The plan will be kept up to date and revised accordingly throughout the various Project phases.

Collectively, these measures comprise the Project's commitment to responsible environmental management of the Project, and an approach to avoid or minimize potential effects on air quality.

10.0 REFERENCES

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11.0 CONCLUSIONS

This report documents the methods, input parameters and assumptions that were used to produce emission estimates for the Construction and Operations Phases of the Project. The emissions were summarized by source using various units of measure and averaging periods. Total annual emissions for each compound are also presented and can be compared to NPRI releases of other similarly sized mining operations in Canada.

CFI has committed to completing a BACT analysis for equipment that will be used to control emissions from material processing and handling sources, such as crushing, screening and transfer conveyors as well as fugitive dust emission sources. The results of the BACT analysis will ensure that the most effective option based on energy, environmental and economic effects will be selected for each source type. CFI will engage with NL DOEC during the preparation of the BACT analysis to ensure that it meets Section 6 of the *Air Pollution Control Regulations, 2004*.

A review and discussion of prevailing wind direction data has been completed. Data indicates that it is reasonable to state that the prevailing winds at the site are in the direction of the town of St. Lawrence.

In addition to estimates of GHG emissions associated with the Project during construction and operations and how these emissions compare to provincial, national and global emissions, information is provided on the predicted effect of climate change on the Project. The provincial climate change projects for St. Lawrence were used in this assessment.

In addition to the BACT analysis which will be completed during the Project permitting and following detailed engineering design of the process, CFI will consult with DOECs Pollution Prevention Divison regarding an ambient air monitoring program for particulates in the Town of St Lawrence commencing during construction and continuing into operations. A BMPP to control fugitive dust emissions will also be prepared and implemented by CFI prior to start of construction and implemented throughout construction and operations.

Report Signature Page

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APPENDIX A

Modification Log

AIR EMISSIONS INVENTORY REPORT – AGS FLUORSPAR PROJECT
MODIFICATION LOG

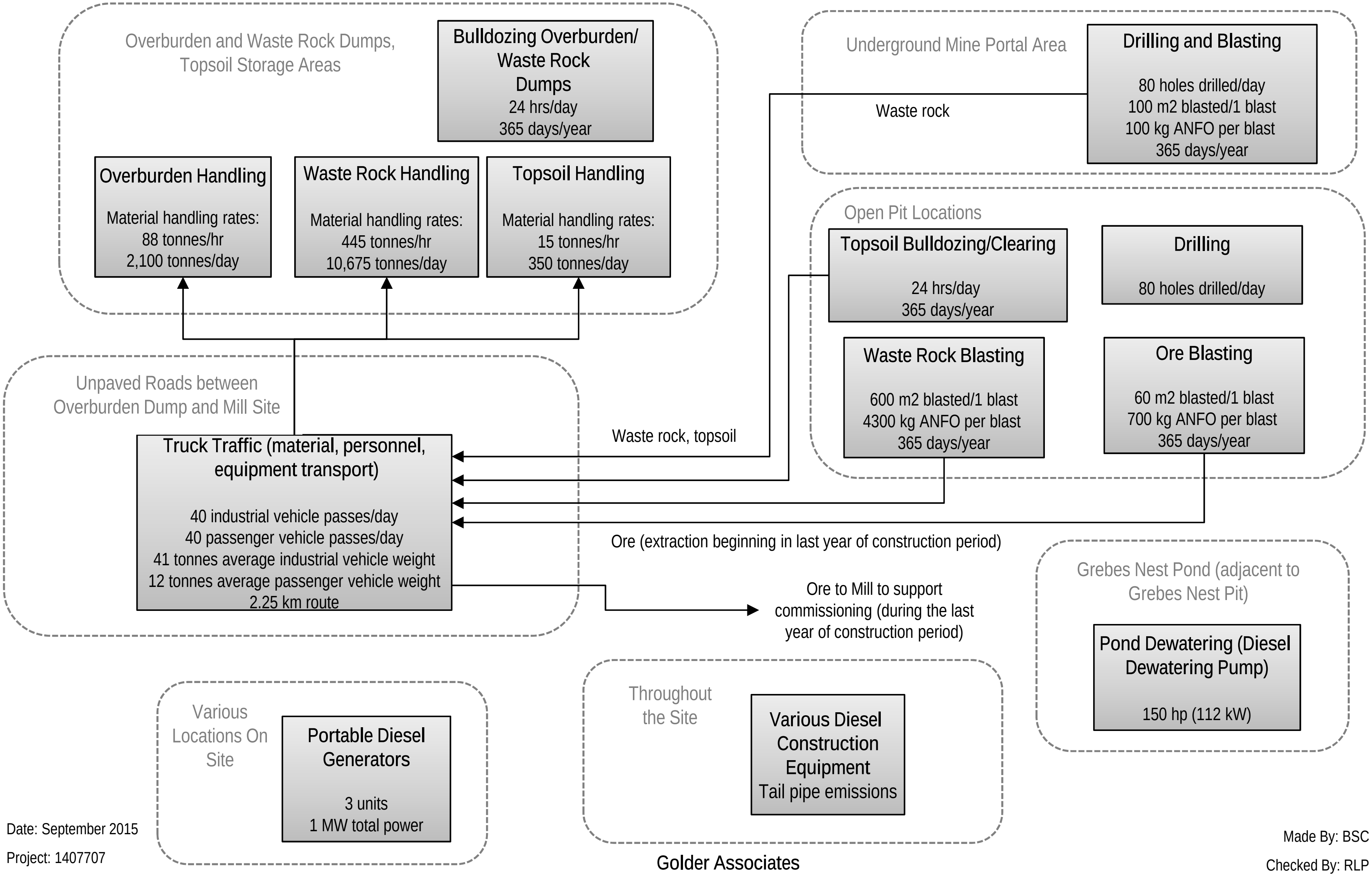
Version	Description of Change
2.0	Added Section 8 – Climate Change
	Added metals emissions to the inventory
	Added emissions from the marine vessels while dorked at the port
	Provided more explanation on Operations Phase worst case scenario in Section 2.2
	Provided more explicit explanation of BACT in Section 6.0
	Provided more detail on commitments, for example the BMPP and ambient monitoring, in Section 9.0
	Updated SO_2 emissions for diesel combustion sources to reference to the 15 mg/kg sulphur content in diesel fuel (Ultra Low Sulphur Diesel [ULSD]) (Sulphur in Diesel Fuel Regulations [SOR/2002-254, dated June 2012] promulgated under CEPA [CEPA 1999])
	Added diesel power generator for the Construction Phase
	Refined tailpipe and road dust emissions for vehicles during the Construction Phase
	Updated emissions associated with hauling material to the marine terminal. This only occurs 40 days of the year as opposed to 350 days which was originally assumed.
	Incorporated precipitation into the annual emission estimates

APPENDIX B

Process Flow Diagrams

PROCESS FLOW DIAGRAM
AGS FLUORSPAR PROJECT
CONSTRUCTION PHASE

Figure A1



Overburden and Waste Rock Dumps, Topsoil Storage Areas

Bulldozing Overburden/ Waste Rock Dumps
24 hrs/day
365 days/year

Overburden Handling
Material handling rates:
88 tonnes/hr
2,100 tonnes/day

Waste Rock Handling
Material handling rates:
445 tonnes/hr
10,675 tonnes/day

Topsoil Handling
Material handling rates:
15 tonnes/hr
350 tonnes/day

Underground Mine Portal Area

Drilling and Blasting
80 holes drilled/day
100 m2 blasted/1 blast
100 kg ANFO per blast
365 days/year

Waste rock

Open Pit Locations

Topsoil Bulldozing/Clearing
24 hrs/day
365 days/year

Drilling
80 holes drilled/day

Waste Rock Blasting
600 m2 blasted/1 blast
4300 kg ANFO per blast
365 days/year

Ore Blasting
60 m2 blasted/1 blast
700 kg ANFO per blast
365 days/year

Unpaved Roads between Overburden Dump and Mill Site

Truck Traffic (material, personnel, equipment transport)
40 industrial vehicle passes/day
40 passenger vehicle passes/day
41 tonnes average industrial vehicle weight
12 tonnes average passenger vehicle weight
2.25 km route

Waste rock, topsoil

Ore (extraction beginning in last year of construction period)

Ore to Mill to support commissioning (during the last year of construction period)

Grebes Nest Pond (adjacent to Grebes Nest Pit)

Pond Dewatering (Diesel Dewatering Pump)
150 hp (112 kW)

Various Locations On Site

Portable Diesel Generators
3 units
1 MW total power

Throughout the Site

Various Diesel Construction Equipment
Tail pipe emissions

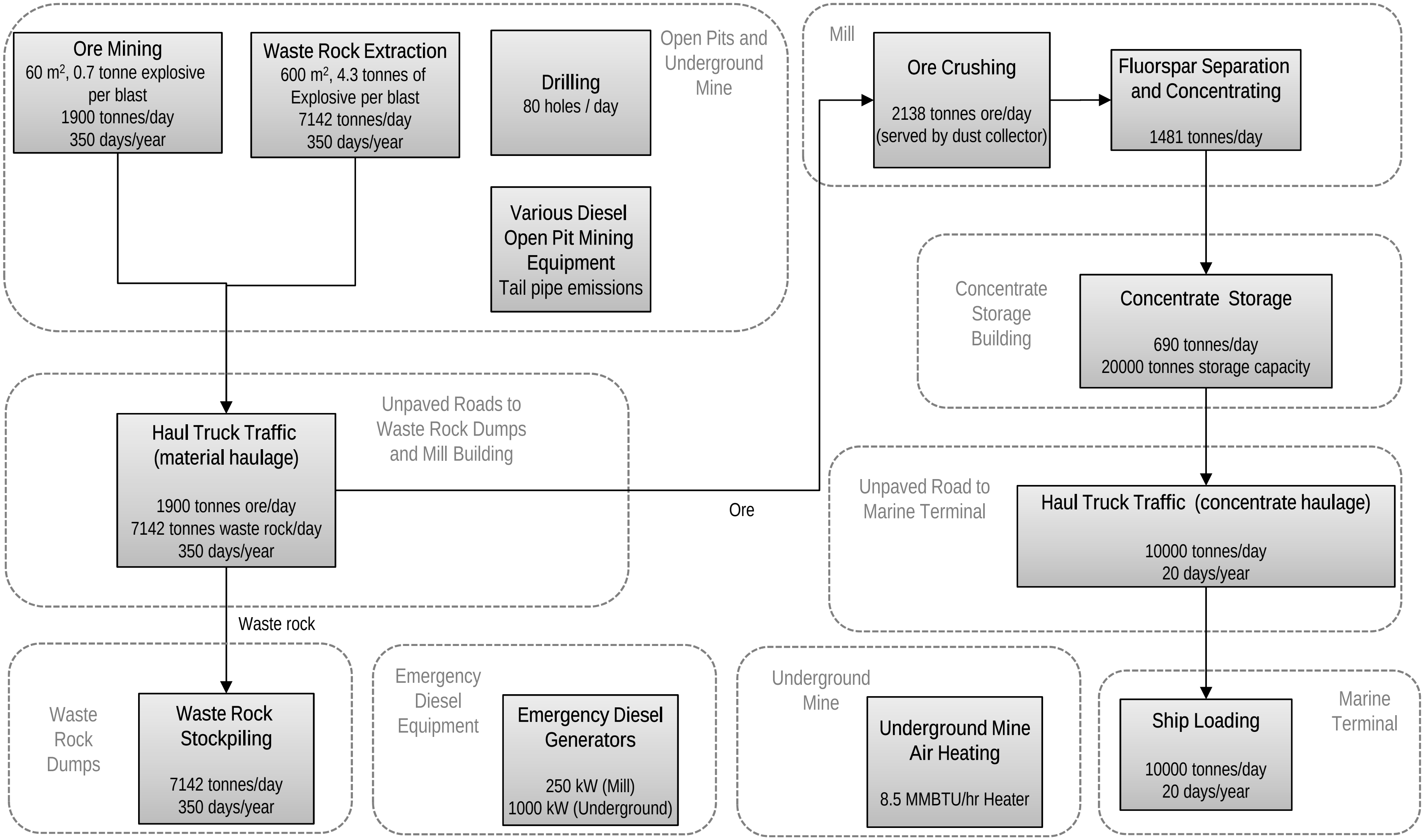
Date: September 2015
Project: 1407707

Golder Associates

Made By: BSC
Checked By: RLP

PROCESS FLOW DIAGRAM
AGS FLUORSPAR PROJECT
PRODUCTION PHASE

FIGURE A2



Date: September 2015

Project: 1407707

Golder Associates

Made By: BSC

Checked By: RLP

APPENDIX C

Emission Estimation Sheets

Construction Phase - Portable Diesel Generators (3 units total)

During the first 6 months of construction (~183 days), a total of 1 MW (1341 hp) of power will be provided by 3 diesel fired portable generators. After 6 months, electricity from the grid will be used to provide power. The diesel generators are assumed to operate 24 hours per day.

Crankcase emission standards from the U.S. EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d (July 2010) (EPA Report NR-009d) were used to calculate exhaust emissions from the diesel generators. It was assumed that the generators comply with at least Tier 3 emission standards, and that the power rating of each unit will fall between >300 to 600 hp.

Emission standards were not provided for PM10 and PM2.5; therefore, it was assumed that all PM emissions consist of PM10 and that PM2.5 emissions are 97% of PM10 emissions.

The following equation was used to calculate the emission rates of carbon monoxide (CO), nitrogen oxides (NOx) and particulate matter (PM) from the generators:

$$ER = EF \times Engine\ Horsepower\ Rating \times LF \times \frac{Hours\ of\ Operation}{24\ hr} \times \frac{1\ hr}{3{,}600\ s}$$

(from U.S. EPA Report No. NR-005d, page 1)

where: ER = emission rate [g/s]
EF = emission factor [g/hp-hr]
LF = load factor

Table 10 of the U.S. EPA's Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling – Report No. NR-005d was used to assign an engine cycle load factor to the generators based on a representative cycle of "None". Emission factors for carbon monoxide (CO), nitrogen oxides (NOx), and particulate matter (PM) were obtained from Table A4: Zero-Hour Steady State Emission Factors for Nonroad CI Engines, under the assumption that the generators will comply with at least Tier 3 emission standards, and that the power rating of each unit will fall between >300 to 600 hp. The emission factor data quality has been assigned an estimated rating of "C", or "Average", as the factors are based on test data (where available), EPA certification data, or on factors used in EPA's Nonroad Engine and Vehicle Emission Study (November 1991).

Sulphur dioxide (SO2) emissions were estimated based on the diesel fuel consumption rate and a sulphur content of 15 mg/kg (Ultra Low Sulphur Diesel [ULSD]), based upon the Sulphur in Diesel Fuel Regulations (SOR/2002-254, dated June 2012) promulgated under CEPA (CEPA 1999). The following equation was used to determine the SO2 emission factor:

$$EF = Fuel\ Density \times Sulphur\ Content \times \frac{MM\ SO_2}{MM\ Sulphur}$$

where: EF = emission factor [g/L]
MM SO_2 = molar mass SO_2 [g/mol] = 64
MM Sulphur = molar mass [g/mol] = 32
diesel fuel density [kg/L] = 0.843
sulphur content [mg/kg] = 15

Total diesel fuel consumption was calculated using the total horsepower rating of all 3 generators (1341 hp) and the steady-state brake specific fuel consumption (BSFC) conversion in Table A4 of the U.S. EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d (July 2010) (EPA Report NR-009d) . Table 10 of the U.S. EPA's Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling – Report No. NR-005d was used to assign an engine cycle load factor to the generators based on a representative cycle of "None". The SO_2 emission rate was then calculated from the emission factor and total fuel consumption.

$$BSFC\left(\frac{lb}{hp-hr}\right) = \frac{Fuel\ Consumption\left(\frac{lb}{hr}\right)}{hp}$$

Therefore,

$$Fuel\ Consumption\left(\frac{L}{hr}\right) = BSFC\left(\frac{lb}{HP-hr}\right) \times hp \times \frac{LF}{fuel\ density\left(\frac{kg}{L}\right)} \times Conversion\ Factors$$

The SO_2 emission rate is then calculated from fuel consumption as follows:

$$ER = EF \times Fuel\ Consumption \times \frac{Hours\ of\ Operation}{24\ hr} \times \frac{1\ hr}{3{,}600\ s}$$

Source Parameters

Equipment	Number of Units	Engine Power Range per Unit [hp]	U.S. EPA Emission Standard	Daily Operating Hours per Unit	Operating Days per Year, per Unit	Representative Cycle[1]	Load Factor Assignment[3]	Load Factor[3]	Table A4 Zero-Hour Steady State Emission Factors for Nonroad CI Engines			
									Brake-Specific Fuel Consumption [lb/hp-hr]	CO [g/hp-hr]	NOx [g/hp-hr]	PM [g/hp-hr]
C_GEN	3	>300 to 600	Tier_3	24	183	None[2]	Avg 7-cycle	0.43	0.367	0.8425	2.5	0.15

[1] NR-005d, Table 10: pg.15, Table 10. CI Load Factor Assignments by Equipment Type

[2] Load Factor of None = steady state

[3] NR-005d, Table 9: pg. 14, Table 9. Compression-Ignition Load Factors

Sample Calculation for NOx

1-hour ER_{NOx} = Total HP of all 3 units x Emission Factor x Load Factor x Conversions

1-hour ER_{NOx} =	1341 hp	2.50E+00 g	0.43	1 hr
		hp-hr		3600 s

1-hour ER_{NOx} =	**4.00E-01 g**
	s

24-hour ER_{NOx} =	1-hour ER_{NOx}	hours of operation
		24 hours in 1 day

24-hour ER_{NOx} =	4.00E-01 g	24 operating hours		
	s	24 hours in 1 day		
24-hour ER_{NOx} =	**4.00E-01 g**	1 kg	3600 s	24 hrs
	s	1000 g	hr	day

24-hour ER_{NOx} =	**3.46E+01 kg**
	day

Annual ER_{NOx} =	24-hour ER_{NOx}	operating days
		number of days in 1 year

Annual ER_{NOx} =	4.00E-01 g	183 operating days
	s	365 days per year

Annual ER_{NOx} =	**2.01E-01 g**	1 kg	3600 s	24 hrs	365 days
	s	1000 g	1 hr	1 day	1 year

Annual ER_{NOx} =	**6.33E+03 kg**
	year

Sample Calculation for SO_2 Emission Factor

EF_{SO2} =	0.843 kg	15 mg	64 g/mol SO_2	1 g
	L	kg	32 g/mol S	1000 mg

EF_{SO2} =	2.53E-02 g
	L

Sample Calculation for Fuel Consumption of C_GEN

Fuel Consumption =	0.367 lb	1341 hp	0.43	1 kg	454 g
	hp-hr		0.843 kg/L	1000 g	lb

Fuel Consumption =	1.14E+02 L
	hr

Sample Calculation for SO2 from C_GEN

$$1\text{-hr } ER_{SO2} = \frac{2.53E\text{-}02 \ \text{g}}{\text{L}} \left| \frac{1.14E\text{+}02 \ \text{L}}{\text{hr}} \right| \frac{1 \ \text{hr}}{3600 \ \text{s}}$$

$$1\text{-hr } ER_{SO2} = \frac{8.01E\text{-}04 \ \text{g}}{\text{s}}$$

Emission Rates for Compounds Emitted by Portable Diesel Powered Generators (3 units total)

Compound	CAS No.	1-hour Emission Rate [g/s]	24-hour Emission Rate [g/s]	24-hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
Nitrogen Oxides	10102-44-0	4.00E-01	4.00E-01	3.46E+01	2.01E-01	6.33E+03
Carbon Monoxide	630-08-0	1.35E-01	1.35E-01	1.17E+01	6.77E-02	2.13E+03
Sulphur Dioxide	7446-09-5	8.01E-04	8.01E-04	6.92E-02	4.01E-04	1.27E+01
PM	N/A	2.40E-02	2.40E-02	2.08E+00	1.20E-02	3.80E+02
PM10	—	2.40E-02	2.40E-02	2.08E+00	1.20E-02	3.80E+02
PM2.5	—	2.33E-02	2.33E-02	2.01E+00	1.17E-02	3.68E+02

*All PM is assumed to be PM10. PM2.5 is assumed to be 97% of PM10, per the U.S. EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d (July 2010) (EPA Report NR-009d).

Construction Phase - Bulldozing and Material Handling Dust

During the construction phase of the Project, fugitive dust emissions could occur from bulldozing and handling (loading, unloading, transfers) of non-metallic mineral materials. Bulldozing will occur in the Overburden Dump, Waste Rock Dump, and topsoil storage areas to prepare the sites for material storage. Material will be loaded into the overburden, waste rock and topsoil stockpiles, as areas are cleared for infrastructure construction and portal and pit development occur.

Annual averaged emissions would be subject to some natural mitigation due to the occurrence of snow or rain days throughout the year. Based on Canadian Climate Normals data obtained for the St. Lawrence station (normals for period 1971-2000), the average days without snow cover or rain is 120 days per year. Therefore, the calculation of annual emissions of fugitive dust assumed emissions will occur on 120 days out of the year.

Bulldozing Source Parameters

	Dozer - Overburden Dump	Dozer - Waste Rock Dump	Dozer - Open Pits, Mill Site, Tailings Management Facility Site
Source ID	OB_BD	WR_BD	TP_BD
Source Description	Overburden Dump Bulldozing	Waste Rock Dump Bulldozing	Topsoil Bulldozing
Operating Hour per Hour	1	1	1
Operating Hours per Day	24	24	24
Number of Days per Year Without Snow Cover/Rain	120	120	120

Material Handling Source Parameters

	Handling - Overburden Dump	Handling - Waste Rock Dump	Handling - Various Topsoil Storage Areas
Source ID	OB_MH	C_WR	TP_MH
Source Description	Overburden Material Handling	Waste Rock Material Handling	Topsoil Material Handling
Operating Hours per Day	24	24	24
Number of Days per Year Without Snow Cover/Rain	120	120	120
Throughput [tonnes/hr]	88	445	15
Throughput [tonnes/day]	2,100	10,675	350

Bulldozing

An equation from U.S. EPA AP-42 Chapter 11.9 "*Western Surface Coal Mining*" (October 1998) was used to calculate the fugitive dust emission factors associated with bulldozing activities in the various areas of the Project site. The equation for PM is as follows:

EF = 2.6 x s^1.2/M^1.3
where: EF = particulate emission factor (kg/hr),
s = silt content of material (%), and
M = moisture content of material (%)

The emission rate is scaled to obtain the 24-hr emission rate based on the number of hours operated per day.

Reference: *U.S. EPA AP-42 11.9 Western Surface Coal Mining (7/98), for overburden*

Compound	EF Equation	Surface Silt Content (s) [%]*	Surface Moisture Content (M) [%]*	EF [kg/hr]	Reference	Rating
PM	$= 2.6 \times s^{1.2}/M^{1.3}$	6.9	7.9	1.80E+00	Table 11.9-2	B
PM_{15}	$= 0.45 \times s^{1.5}/M^{1.4}$	6.9	7.9	4.52E-01	Table 11.9-2	C
PM_{10}	$= EF_{PM15} \times 0.75$	—	—	3.39E-01	Table 11.9-2	D
$PM_{2.5}$	$= EF_{PM} \times 0.105$	—	—	1.89E-01	Table 11.9-2	D

*U.S. AP-42 Table 11.9-3 for overburden

Sample Calculation for PM EF for Overburden Dump Bulldozing

$$\text{EF}= \begin{array}{r|c} 2.6 & 6.9^{\,1.2} \\ \hline & 7.9^{\,1.3} \end{array}$$

$$\text{EF}= \begin{array}{c} 1.80\text{E+00 kg} \\ \hline \text{hr} \end{array}$$

Sample Calculations for PM ERs for Overburden Dump Bulldozing

$$\text{1-hr ER} = \begin{array}{c|c|c|c} 1.80\text{E+00 kg} & 1 \text{ operating hr} & 1000 \text{ g} & 1 \text{ hr} \\ \hline \text{hr} & \text{hr} & \text{kg} & 3600 \text{ s} \end{array}$$

$$\textbf{1-hr ER =} \boxed{\begin{array}{c} \textbf{4.99E-01 g} \\ \hline \textbf{s} \end{array}}$$

$$\text{24-hr ER} = \begin{array}{c|c} 4.99\text{E-01 g} & 24 \text{ operating hours} \\ \hline \text{s} & 24 \text{ hrs in 1 day} \end{array}$$

$$\textbf{24-hr ER =} \boxed{\begin{array}{c} \textbf{4.99E-01 g} \\ \hline \textbf{s} \end{array}} \begin{array}{c|c|c} 1 \text{ kg} & 3600 \text{ s} & 24 \text{ hours} \\ \hline 1000 \text{ g} & 1 \text{ hr} & 1 \text{ day} \end{array}$$

$$\textbf{24-hr ER =} \boxed{\begin{array}{c} \textbf{4.31E+01 kg} \\ \hline \textbf{day} \end{array}}$$

Annual ER = 24-hr ER × (number of days without snow cover or rain/number of days in 1 year)

Annual ER =	4.99E-01 g	120 days without snow cover/rain
	s	365 days in 1 year

Annual ER =	**1.64E-01 g**	1 kg	3600 s	24 hours	365 days
	s	1000 g	1 hr	1 day	1 year

Annual ER =	**5.18E+03 kg**
	year

Dozer - Overburden Dump
Source ID: OB_BD

Compound	EF [kg/hr]	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	1.80E+00	4.99E-01	4.99E-01	4.31E+01	1.64E-01	5.18E+03
PM10	3.39E-01	9.41E-02	9.41E-02	8.13E+00	3.10E-02	9.76E+02
PM2.5	1.89E-01	5.24E-02	5.24E-02	4.53E+00	1.73E-02	5.44E+02

Dozer - Waste Rock Dump
Source ID: WR_BD

Compound	EF [kg/hr]	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	1.80E+00	4.99E-01	4.99E-01	4.31E+01	1.64E-01	5.18E+03
PM10	3.39E-01	9.41E-02	9.41E-02	8.13E+00	3.10E-02	9.76E+02
PM2.5	1.89E-01	5.24E-02	5.24E-02	4.53E+00	1.73E-02	5.44E+02

Dozer - Open Pits, Mill Site, Tailings Management Facility Site
Source ID: TP_BD

Compound	EF [kg/hr]	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	1.80E+00	4.99E-01	4.99E-01	4.31E+01	1.64E-01	5.18E+03
PM10	3.39E-01	9.41E-02	9.41E-02	8.13E+00	3.10E-02	9.76E+02
PM2.5	1.89E-01	5.24E-02	5.24E-02	4.53E+00	1.73E-02	5.44E+02

Material Handling

The material handling emissions associated with loading/unloading to stockpiles in the Overburden Dump, Waste Rock Dump and topsoil storage areas were estimated using the emission factors from Section 13.2.4 "*Aggregate Handling and Storage Piles*" of the AP 42 document (revised November 2006) using the EF equation as follows:

$$EF\ (kg/Mg) = \frac{k\,(0.0016)(U/2.2)^{1.3}}{(M/2)^{1.4}}$$

where k=particle size multiplier (dimensionless)
U= mean wind speed (m/s)
M= material moisture content (%)

Aerodynamic Particle Size Multiplier (k)

Particle Size	<30μm	<15μm	<10μm	<5μm	<2.5μm
Multiplier	0.74	0.48	0.35	0.20	0.05

U=	5.9	m/s	Overall average wind speed at the Environment Canada St. Lawrence climate station in Newfoundland, based on data from January 2006 to present

Reference: *US. EPA AP-42 13.2.4*

Handling - Overburden Dump

Moisture Content (M) [%]*	Parameter	EF [kg/Mg]	Rating
7.9	PM	6.24E-04	A
7.9	PM_{10}	2.95E-04	A
7.9	$PM_{2.5}$	4.47E-05	A

*U.S. AP-42 Table 11.9-3 for overburden

Handling - Waste Rock Dump

Moisture Content (M) [%]*	Parameter	EF [kg/Mg]	Rating
5	PM	1.18E-03	A
5	PM_{10}	5.60E-04	A
5	$PM_{2.5}$	8.48E-05	A

*Assumed based on similar sites

Handling - Various Topsoil Storage Areas

Moisture Content (M) [%]*	Parameter	EF [kg/Mg]	Rating
7.9	PM	6.24E-04	A
7.9	PM_{10}	2.95E-04	A
7.9	$PM_{2.5}$	4.47E-05	A

*U.S. AP-42 Table 11.9-3 for overburden

Sample Calculation for PM EF for Overburden Handling (kg/Mg)

$$EF = 0.74 \;\Big|\; 0.0016 \;\Big|\; \frac{5.90^{1.3}}{2.2^{1.3}} \;\Big|\; \frac{2^{1.4}}{7.9^{1.4}}$$

$$EF = \frac{6.24E\text{-}04\ kg}{Mg}$$

Sample Calculation for PM 1-hr ER for Overburden Handling (g/s)

$$ER = \frac{6.24E\text{-}04\ kg}{Mg} \;\Big|\; \frac{88\ Mg}{hr} \;\Big|\; \frac{1000\ g}{kg} \;\Big|\; \frac{1\ hr}{3600\ s}$$

$$ER = \frac{1.52E\text{-}02\ g}{s}$$

Handling - Overburden Dump
Source ID: OB_MH

Compound	EF [kg/Mg]	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	6.24E-04	1.52E-02	1.52E-02	1.31E+00	4.99E-03	1.57E+02
PM10	2.95E-04	7.17E-03	7.17E-03	6.20E-01	2.36E-03	7.44E+01
PM2.5	4.47E-05	1.09E-03	1.09E-03	9.38E-02	3.57E-04	1.13E+01

Handling - Waste Rock Dump
Source ID: C_WR

Compound	EF [kg/Mg]	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	1.18E-03	1.46E-01	1.46E-01	1.26E+01	4.81E-02	1.52E+03
PM10	5.60E-04	6.92E-02	6.92E-02	5.98E+00	2.28E-02	7.18E+02
PM2.5	8.48E-05	1.05E-02	1.05E-02	9.05E-01	3.45E-03	1.09E+02

Handling - Various Topsoil Storage Areas
Source ID: TP_MH

Compound	EF [kg/Mg]	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	6.24E-04	2.53E-03	2.53E-03	2.18E-01	8.32E-04	2.62E+01
PM10	2.95E-04	1.20E-03	1.20E-03	1.03E-01	3.93E-04	1.24E+01
PM2.5	4.47E-05	1.81E-04	1.81E-04	1.56E-02	5.96E-05	1.88E+00

Construction Phase - Drilling and Blasting

Drilling and blasting activities will occur at the open pits and portal locations to support pit and portal development during the construction phase of the Project. In order to quantify some emissions from construction of the portal, drilling and blasting related to portal development were quantified in addition to pit development activities. The actual construction schedule plans for pit development from late 2015 until 2017, while underground portal development will not commence until 2018. Therefore, the assumption that emissions from pit and portal development occur simultaneously is a conservative assumption. This assumption was made to avoid having to quantify multiple construction years.

Contaminants will be discharged from the portal openings and the pits. Source parameters, such as number of blasts per day, holes drilled per day, etc. are summarized below for the pit and portal. To estimate a 1-hour averaged emission rate for drilling, it was assumed the holes will be drilled throughout the day (i.e. 80 holes/24 hours per day = 3.33 holes/hour). To estimate a 1-hour averaged emission rate for blasting, 1 blast per hour was conservatively assumed.

CFI plans to begin mining small quantities of ore towards the end of pit construction in 2017 to support commissioning of the mill. Therefore, as per data provided by CFI for the construction phase, some emissions from drilling and blasting of ore were estimated in addition to waste rock to avoid having to quantify multiple construction years.

Particulate Matter Emissions from Drilling and Blasting

An equation from Table 11.9-2, U.S. EPA AP-42 Chapter 11.9 “*Western Surface Coal Mining*” (dated 7/98) was used to calculate the fugitive dust emissions associated with blasting activities. The equation is as follows:

$EF=0.00022 \times A^{1.5} \times SF$

where: EF = PM emission factor (kg/blast)
A = horizontal area (m^2)

The particulate emission factor for drilling was taken from U.S. EPA AP-42 Chapter 11.9 "*Western Surface Coal Mining*", Table 11.9-4 (dated 7/98) for overburden. The data quality is rated "C" or "Average".
No EFs for PM10 and PM2.5 from drilling are available therefore PM10 was assumed to be 50% of PM and PM2.5 was assumed to be 50% of PM10.

CFI will implement appropriate BMPs during drilling, therefore a 70% control is applied as per Table 4 in the Australian Government document "*National Pollutant Inventory Emission Estimation Technique Manual for Mining*" Version 3.1 dated January 2012. The maximum PM 1-hour and 24-hour emission rates from either of drilling or blasting are carried through to the Construction Phase Source Summary Table as a maximum emission scenario for each source because drilling and blasting cannot occur simultaneously in one day. Annual averaged PM emission rates for each source are a sum of the emissions from both drilling and blasting, since over the course of a

Source Parameters - P_DEV: Surface Drilling and Blasting (Portal Development)

Number of Holes Drilled in 24-hr	80
Drilling Control	70%
A: Area Blasted per Blast [m²]	100
Bulk Emulsion: Usage per Blast [Mg]	0.1
Total Number of Blasts in 24-hr	2
Operating Days per Year	365

Source Parameters - PIT_DEV: Surface Drilling and Blasting (Open Pit Development)

Number of Holes Drilled in 24-hr	80
Drilling Control	70%
Ore Blasting	
A: Area Blasted per Blast [m²]	60
Bulk Emulsion: Usage per Blast [Mg]	0.7
Total Number of Blasts in 24-hr	1
Operating Days per Year	365
Waste Rock Blasting	
A: Area Blasted per Blast [m²]	600
Bulk Emulsion: Usage per Blast [Mg]	4.3
Total Number of Blasts in 24-hr	1
Operating Days per Year	365

<u>Sample Calculations for Source P_DEV</u>

<u>1-hour Averaged Emissions</u>

Blasting - PM

$$EF_{PM} = 0.00022(A)^{1.5}$$

$$1\text{-hr } ER_{PM} = 0.00022(\ 100.0\ \text{m}^2\ )^{1.5}\ \frac{\text{kg}}{\text{blast}} \times \frac{1\ \text{blast}}{1\ \text{hour}}\ \frac{1\ \text{hour}}{3600\ \text{s}}\ \frac{1000\ \text{g}}{1\ \text{kg}}$$

$$\mathbf{1\text{-hr } ER_{PM}} = \boxed{\frac{6.11\text{E-}02\ \text{g}}{\text{s}}}$$

Drilling - PM

$$ER_{PM} = \frac{0.59\ \text{kg}}{\text{hole}}\ \frac{3.33\ \text{holes}}{1\ \text{hr}}\ \frac{1000\ \text{g}}{\text{kg}}\ \frac{1\ \text{hr}}{3600\ \text{s}}\ (\ 100\% - 70\%\ )$$

$$\mathbf{1\text{-hr } ER_{PM}} = \boxed{\frac{1.64\text{E-}01\ \text{g}}{\text{s}}}$$

24-hour Averaged Emissions

Blasting - PM

$$EF_{PM} = 0.00022(A)^{1.5}$$

$$24\text{-hr } ER_{PM} = 0.00022(\ 100.0\ \text{m}^2\ )^{1.5}\ \frac{\text{kg}}{\text{blast}} \times \frac{2\ \text{blasts}}{24\ \text{hours}}\ \frac{1\ \text{hour}}{3600\ \text{s}}\ \frac{1000\ \text{g}}{1\ \text{kg}}$$

$$\mathbf{24\text{-hr } ER_{PM}} = \boxed{\frac{5.09\text{E-}03\ \text{g}}{\text{s}}}\ \frac{1\ \text{kg}}{1000\ \text{g}}\ \frac{3600\ \text{s}}{1\ \text{hr}}\ \frac{24\ \text{hours}}{1\ \text{day}}$$

$$\mathbf{24\text{-hr } ER_{PM}} = \boxed{\frac{4.40\text{E-}01\ \text{kg}}{\text{day}}}$$

Drilling - PM

$$ER_{PM} = \frac{0.59\ \text{kg}}{\text{hole}}\ \frac{80\ \text{holes}}{24\ \text{hr}}\ \frac{1000\ \text{g}}{\text{kg}}\ \frac{1\ \text{hr}}{3600\ \text{s}}\ (\ 100\% - 70\%\ )$$

$$\mathbf{24\text{-hr } ER_{PM}} = \boxed{\frac{1.64\text{E-}01\ \text{g}}{\text{s}}}\ \frac{1\ \text{kg}}{1000\ \text{g}}\ \frac{3600\ \text{s}}{1\ \text{hr}}\ \frac{24\ \text{hours}}{1\ \text{day}}$$

$$\mathbf{24\text{-hr } ER_{PM}} = \boxed{\frac{1.42\text{E+}01\ \text{kg}}{\text{day}}}$$

Annual Averaged Emissions

Blasting - PM

$$\text{Annual } ER_{PM} = 24\text{-hr } ER_{PM} \times \frac{\text{operating days}}{\text{number days in 1 year}}$$

$$\text{Annual } ER_{PM} = \frac{5.09\text{E-}03\ \text{g}}{\text{s}}\ \frac{365\ \text{operating days}}{365\ \text{days per year}}$$

$$\mathbf{Annual\ ER_{PM}} = \boxed{\frac{5.09\text{E-}03\ \text{g}}{\text{s}}}\ \frac{1\ \text{kg}}{1000\ \text{g}}\ \frac{3600\ \text{s}}{1\ \text{hr}}\ \frac{24\ \text{hours}}{1\ \text{day}}\ \frac{365\ \text{days}}{1\ \text{year}}$$

$$\mathbf{Annual\ ER_{PM}} = \boxed{\frac{1.61\text{E+}02\ \text{kg}}{\text{year}}}$$

Drilling - PM

$$\text{Annual } ER_{PM} = 24\text{-hr } ER_{PM} \times \frac{\text{operating days}}{\text{number days in 1 year}}$$

$$\text{Annual } ER_{PM} = \frac{1.64\text{E-}01\ \text{g}}{\text{s}}\ \frac{365\ \text{operating days}}{365\ \text{days per year}}$$

$$\mathbf{Annual\ ER_{PM}} = \boxed{\frac{1.64\text{E-}01\ \text{g}}{\text{s}}}\ \frac{1\ \text{kg}}{1000\ \text{g}}\ \frac{3600\ \text{s}}{1\ \text{hr}}\ \frac{24\ \text{hours}}{1\ \text{day}}\ \frac{365\ \text{days}}{1\ \text{year}}$$

$$\mathbf{Annual\ ER_{PM}} = \boxed{\frac{5.17\text{E+}03\ \text{kg}}{\text{year}}}$$

PM Emissions from P_DEV

Compound	CAS	EF	EF Units	1-hr ER [g/s]	24-hr ER [g/s]	24-hr ER [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM - Blasting	N/A	$0.00022(A)^{1.5}$	kg/blast	6.11E-02	5.09E-03	4.40E-01	5.09E-03	1.61E+02
PM - Drilling	N/A	0.59	kg/hole	1.64E-01	1.64E-01	1.42E+01	1.64E-01	5.17E+03
						Total Annual PM (Drilling and Blasting)	1.69E-01	5.33E+03

PM Emissions from PIT_DEV

Compound	CAS	EF	EF Units	1-hr ER [g/s]	24-hr ER [g/s]	24-hr ER [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM - Drilling	N/A	0.59	kg/hole	1.64E-01	1.64E-01	1.42E+01	1.64E-01	5.17E+03
Ore Blasting								
PM - Blasting	N/A	$0.00022(A)^{1.5}$	kg/blast	2.84E-02	1.18E-03	1.02E-01	1.18E-03	3.73E+01
Waste Rock Blasting								
PM - Blasting	N/A	$0.00022(A)^{1.5}$	kg/blast	8.98E-01	3.74E-02	3.23E+00	3.74E-02	1.18E+03
PM - Blasting (total)	N/A	—	—	9.27E-01	3.86E-02	3.34E+00	3.86E-02	1.22E+03
						Total Annual PM (Drilling and Blasting)	2.02E-01	6.39E+03

Gaseous Emissions from Blasting

The Carbon Monoxide, Nitrogen Oxides and Sulphur Dioxide emission factors for the blasting using emulsion explosives was obtained from the Australian NPI *"Emission estimation technique manual for Explosives detonation and firing ranges"* Version 3.0 January 2012. The data quality is rated "U" or "Unrated" for emulsion.

Sample Calculations for Source P_DEV (all gaseous emissions were calculated in a similar manner)

Carbon Monoxide (1-hr averaged)

$$\text{1-hr } ER_{CO} = \frac{2.3\text{ kg}}{\text{Mg}} \times \frac{0.100\text{ Mg}}{\text{blast}} \times \frac{1\text{ blast}}{1\text{ hr}} \times \frac{1000\text{ g}}{\text{kg}} \times \frac{1\text{ hr}}{3600\text{ s}}$$

$$\textbf{1-hr } ER_{CO} = \boxed{\frac{6.39\text{E-02 g}}{\text{s}}}$$

Carbon Monoxide (24-hr averaged)

$$\text{24-hr } ER_{CO} = \frac{2.3\text{ kg}}{\text{Mg}} \times \frac{0.100\text{ Mg}}{\text{blast}} \times \frac{2\text{ blasts}}{24\text{ hrs}} \times \frac{1000\text{ g}}{\text{kg}} \times \frac{1\text{ hr}}{3600\text{ s}}$$

$$\textbf{24-hr } ER_{CO} = \boxed{\frac{5.32\text{E-03 g}}{\text{s}}} \times \frac{1\text{ kg}}{1000\text{ g}} \times \frac{3600\text{ s}}{1\text{ hr}} \times \frac{24\text{ hours}}{1\text{ day}}$$

$$\textbf{24-hr } ER_{CO} = \boxed{\frac{4.60\text{E-01 kg}}{\text{day}}}$$

Carbon Monoxide (annual averaged)

$$\text{Annual } ER_{CO} = \text{24-hr } ER_{CO} \times \frac{\text{operating days}}{\text{number days in 1 year}}$$

$$\text{Annual } ER_{CO} = \frac{5.32\text{E-03 g}}{\text{s}} \times \frac{365\text{ operating days}}{365\text{ days per year}}$$

$$\textbf{Annual } ER_{CO} = \boxed{\frac{5.32\text{E-03 g}}{\text{s}}} \times \frac{1\text{ kg}}{1000\text{ g}} \times \frac{3600\text{ s}}{1\text{ hr}} \times \frac{24\text{ hours}}{1\text{ day}} \times \frac{365\text{ days}}{1\text{ year}}$$

$$\textbf{Annual } ER_{CO} = \boxed{\frac{1.68\text{E+02 kg}}{\text{year}}}$$

Summary of Gaseous Emissions from P_DEV

Compound	CAS	Emulsion EF [kg/Mg]	1-hr ER [g/s]	24-hr ER [g/s]	24-hr ER [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
Carbon Monoxide	630-08-0	2.3	6.39E-02	5.32E-03	4.60E-01	5.32E-03	1.68E+02
Nitrogen Oxides	10102-44-0	0.2	5.56E-03	4.63E-04	4.00E-02	4.63E-04	1.46E+01

Summary of Gaseous Emissions from PIT_DEV

Compound	CAS	Emulsion EF [kg/Mg]	1-hr ER [g/s]	24-hr ER [g/s]	24-hr ER [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
Ore Blasting							
Carbon Monoxide	630-08-0	2.3	4.47E-01	1.86E-02	1.61E+00	1.86E-02	5.88E+02
Nitrogen Oxides	10102-44-0	0.2	3.89E-02	1.62E-03	1.40E-01	1.62E-03	5.11E+01
Waste Rock Blasting							
Carbon Monoxide	630-08-0	2.3	2.75E+00	1.14E-01	9.89E+00	1.14E-01	3.61E+03
Nitrogen Oxides	10102-44-0	0.2	2.39E-01	9.95E-03	8.60E-01	9.95E-03	3.14E+02

Construction Phase - Construction Phase Vehicle Tailpipe Emissions

The calculation for emissions from diesel-fired equipment operated during construction assumes activity will occur 24 hours per day, 365 days per year.

Crankcase emission standards from the U.S. EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d (July 2010) (EPA Report NR-009d) were used to calculate exhaust emissions from the diesel-fired equipment. It was assumed that all on-site equipment comply with at least Tier 3 emission standards.

Emission standards were not provided for PM10 and PM2.5; therefore, it was assumed that all PM emissions consist of PM10 and that PM2.5 emissions are 97% of PM10 emissions.

The following equation was used to calculate the emission rates of carbon monoxide (CO), nitrogen oxides (NOx) and particulate matter (PM) from the construction equipment:

$$ER = EF \times Engine\ Horsepower\ Rating \times LF \times \frac{Hours\ of\ Operation}{24\ hr} \times \frac{1\ hr}{3{,}600\ s}$$

(from U.S. EPA Report No. NR-005d, page 1)

where: ER = emission rate [g/s]
EF = emission factor [g/hp-hr]
LF = load factor

Table 10 of the U.S. EPA's Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling – Report No. NR-005d was used to assign engine cycle load factors to the diesel construction equipment based on the type of equipment operated. Emission factors for carbon monoxide (CO), nitrogen oxides (NOx), and particulate matter (PM) were obtained from Table A4: Zero-Hour Steady State Emission Factors for Nonroad CI Engines, based on the horsepower and EPA emission standard tier rating of each diesel engine. The emission factor data quality has been assigned an estimated rating of "C", or "Average", as the factors are based on test data (where available), EPA certification data, or on factors used in EPA's Nonroad Engine and Vehicle Emission Study (November 1991).

Sulphur dioxide (SO_2) emissions were estimated based on the diesel fuel consumption rate per unit and a sulphur content of 15 mg/kg (Ultra Low Sulphur Diesel [ULSD]), based upon the Sulphur in Diesel Fuel Regulations (SOR/2002-254, dated June 2012) promulgated under CEPA (CEPA 1999). The following equation was used to determine the SO_2 emission factor:

$$EF = Fuel\ Density \times Sulphur\ Content \times \frac{MM\ SO_2}{MM\ Sulphur}$$

where: EF = emission factor [g/L]

MM SO_2 = molar mass SO_2 [g/mol] =	64
MM Sulphur = molar mass [g/mol] =	32
diesel fuel density [kg/L] =	0.843
sulphur content [mg/kg] =	15

Diesel fuel consumption was calculated using the horsepower rating of each unit and the steady-state brake specific fuel consumption (BSFC) conversion in Table A4 of EPA Report NR-009d. The SO_2 emission rate per unit was then calculated from the emission factor and fuel consumption.

$$BSFC\left(\frac{lb}{hp-hr}\right) = \frac{Fuel\ Consumption\left(\frac{lb}{hr}\right)}{hp}$$

Therefore,

$$Fuel\ Consumption\left(\frac{L}{hr}\right) = BSFC\left(\frac{lb}{HP-hr}\right) \times hp \times \frac{LF}{fuel\ density\left(\frac{kg}{L}\right)} \times Conversion\ Factors$$

The SO_2 emission rate is then calculated from fuel consumption as follows:

$$ER = EF \times Fuel\ Consumption \times \frac{Hours\ of\ Operation}{24\ hr} \times \frac{1\ hr}{3{,}600\ s}$$

Summary of Construction Phase Vehicles

Equipment	Number of Units	Engine Rating [kW]	Engine Rating [hp]	U.S. EPA Emission Standard	Daily Operating Hours per Unit	Load Factor	Table A4 Zero-Hour Steady State Emission Factors for Nonroad CI			
							Brake-Specific Fuel Consumption [lb/hp-hr]	CO [g/hp-hr]	NOx [g/hp-hr]	PM [g/hp-hr]
Rigid haul truck waste CAT 773G	3	578	775	Tier_3(1)	24	0.58	0.367	0.7642	4.1	0.1316
Articulated Haul truck CAT 740B	1	365	489	Tier_3	24	0.58	0.367	0.8425	2.5	0.15
Drill rig ore AC DTH	1	168	225	Tier_3	24	0.43	0.367	0.7475	2.5	0.15
Drill rig waste AC DTH	1	420	563	Tier_3	24	0.43	0.367	0.8425	2.5	0.15
Bob Cat CAT C15	2	444	595	Tier_3	24	0.48	0.367	0.8425	2.5	0.15
Wheel Loader CAT 980K	6	303	406	Tier_3	24	0.48	0.367	0.8425	2.5	0.15
Wheel Dozer CAT 844H	1	468	628	Tier_3	24	0.58	0.367	1.3272	2.5	0.15
Track Dozer CAT D9	1	325	436	Tier_3	24	0.58	0.367	0.8425	2.5	0.15
Track Dozer CAT D8	2	328	440	Tier_3	24	0.58	0.367	0.8425	2.5	0.15
Motor Grader CAT 14M	1	193	259	Tier_3	24	0.58	0.367	0.7475	2.5	0.15
Wheel Backho/Loader CAT 420E	3	69	93	Tier_3	24	0.21	0.408	2.3655	3.0	0.2
Water/Sander Truck (oil highway truck)	3	269	361	Tier_3	24	0.58	0.367	0.8425	2.5	0.15
Hydraulic excavator CAT 320E L	6	114	153	Tier_3	24	0.53	0.367	0.8667	2.5	0.22
Tandem truck CAT CT680	10	354	475	Tier_3	24	0.58	0.367	0.8425	2.5	0.15
Tow Truck CAT 740B	1	365	489	Tier_3	24	0.58	0.367	0.8425	2.5	0.15
Tow low boy LPM (120-48-20)	1	365	489	Tier_3	24	0.43	0.367	0.8425	2.5	0.15
Fuel/ Lube Truck	1	150	201	Tier_3	24	0.58	0.367	0.7475	2.5	0.15
Service Truck CT660	1	269	361	Tier_3	24	0.58	0.367	0.8425	2.5	0.15
Bulk ANFO Explosives Truck (Kalmar DCD200-12lb)	1	269	361	Tier_3	24	0.58	0.367	0.8425	2.5	0.15
Mini Bus	3	365	489	Tier_3	24	0.43	0.367	0.8425	2.5	0.15
Pick Up Truck Ford E series	20	365	489	Tier_3	24	0.43	0.367	0.8425	2.5	0.15
Crane LTM 110-4.2	2	350	469	Tier_3	24	0.43	0.367	0.8425	2.5	0.15
Scissorlift Getman A64	2	101	135	Tier_3	24	0.43	0.367	0.8667	2.5	0.22
Grader AARD Mining LP	3	92	123	Tier_3	24	0.58	0.367	0.8667	2.5	0.22
Compaction Roller (CAT)	3	25	34	Tier_3(1)	24	0.43	0.408	1.5323	4.7279	0.3389
Pallet Handler/Tractor	1	101	135	Tier_3	24	0.21	0.367	0.8667	2.5	0.22

(1) Tier 2 emission factors were conservatively applied, as Tier 3 emission factors were not available for this engine

Compression Ignition Load Factors -- Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling – Report No. NR-005d, Table 9: pg.14

Equipment Type	Representative Cycle(2)	Load Factor Assignment	Cycle Load Factor	Notes
Rigid haul truck waste CAT 773G	Crawler	Hi LF	0.58	—
Articulated Haul truck CAT 740B	Crawler	Hi LF	0.58	—
Drill rig ore AC DTH	None	Avg 7-cycle	0.43	(3)
Drill rig waste AC DTH	None	Avg 7-cycle	0.43	(3)
Bob Cat CAT C15	Rubber Tired Loade	Hi LF	0.48	—
Wheel Loader CAT 980K	Rubber Tired Loade	Hi LF	0.48	—
Wheel Dozer CAT 844H	Crawler	Hi LF	0.58	—
Track Dozer CAT D9	Crawler	Hi LF	0.58	—
Track Dozer CAT D8	Crawler	Hi LF	0.58	—
Motor Grader CAT 14M	Crawler	Hi LF	0.58	—
Wheel Backho/Loader CAT 420E	Backhoe	LoLF	0.21	—
Water/Sander Truck (oil highway truck)	Crawler	Hi LF	0.58	—
Hydraulic excavator CAT 320E L	Excavator	Hi LF	0.53	—
Tandem truck CAT CT680	Crawler	Hi LF	0.58	—
Tow Truck CAT 740B	Crawler	Hi LF	0.58	—
Tow low boy LPM (120-48-20)	None	Avg 7-cycle	0.43	(3)
Fuel/ Lube Truck	Crawler	Hi LF	0.58	—
Service Truck CT660	Crawler	Hi LF	0.58	—
Bulk ANFO Explosives Truck (Kalmar DCD200-12lb)	Crawler	Hi LF	0.58	—
Mini Bus	None	Avg 7-cycle	0.43	(3)
Pick Up Truck Ford E series	None	Avg 7-cycle	0.43	(3)
Crane LTM 110-4.2	None	Avg 7-cycle	0.43	(3)
Scissorlift Getman A64	None	Avg 7-cycle	0.43	(3)
Grader AARD Mining LP	Crawler	Hi LF	0.58	—
Compaction Roller (CAT)	None	Avg 7-cycle	0.43	(3)
Pallet Handler/Tractor	Backhoe	LoLF	0.21	—

(2) NR-005d, Table 10: pg.15, Table 10. CI Load Factor Assignments by Equipment Type

(3) Load Factor of None = steady state

Sample Calculation for CO from the 3 Rigid haul truck waste CAT 773G

$$\text{1-hr ER}_{CO} = \frac{0.7642 \quad \text{g}}{\text{hp-hr}} \left| \; 775 \quad \text{hp} \; \right| \; 0.58 \; \left| \; \frac{1 \quad \text{hr}}{3600 \quad \text{s}} \; \right| \; 3 \quad \text{vehicles}$$

$$\text{1-hr ER}_{CO} = \frac{2.86\text{E-}01 \quad \text{g}}{\text{s}}$$

Sample Calculation for SO_2 Emission

$$\text{EF}_{SO2} = \frac{0.843 \quad \text{kg}}{\text{L}} \left| \; \frac{15 \quad \text{mg}}{\text{kg}} \; \right| \; \frac{64 \quad \text{g/mol } SO_2}{32 \quad \text{g/mol S}} \; \left| \; \frac{1 \quad \text{g}}{1000 \quad \text{mg}}\right.$$

$$\text{EF}_{SO2} = \frac{2.53\text{E-}02 \quad \text{g}}{\text{L}}$$

Sample Calculation for Fuel Consumption of the 3 Rigid haul truck waste CAT

$$\text{Total Fuel Consumption 3 Rigid haul truck waste CAT 773Gs} = \frac{0.367 \quad \text{lb}}{\text{hp-hr}} \left| \; 775 \quad \text{hp} \; \right| \; \frac{0.58}{0.843 \quad \text{kg/L}} \; \left| \; \frac{1 \quad \text{kg}}{1000 \quad \text{g}} \; \right| \; \frac{454 \quad \text{g}}{\text{lb}} \; \left| \; 3 \quad \text{vehicles}\right.$$

$$\text{Total Fuel Consumption 3 Rigid haul truck waste CAT 773Gs} = \frac{2.67\text{E+}02 \quad \text{L}}{\text{hr}}$$

Sample Calculation for SO2 from the 3 Rigid haul truck waste CAT 773Gs

$$\text{1-hr } ER_{SO2} = \frac{2.53\text{E-}02 \text{ g}}{\text{L}} \left| \frac{2.67\text{E+}02 \text{ L}}{\text{hr}} \right| \frac{1 \text{ hr}}{3600 \text{ s}}$$

$$\text{1-hr } ER_{SO2} = \frac{1.87\text{E-}03 \text{ g}}{\text{s}}$$

Fuel Consumption by Equipment Type

Equipment	Total Fuel Consumption [L/hr]
Rigid haul truck waste CAT 773G	267
Articulated Haul truck CAT 740B	56
Drill rig ore AC DTH	19
Drill rig waste AC DTH	48
Bob Cat CAT C15	113
Wheel Loader CAT 980K	231
Wheel Dozer CAT 844H	72
Track Dozer CAT D9	50
Track Dozer CAT D8	101
Motor Grader CAT 14M	30
Wheel Backho/Loader CAT 420E	13
Water/Sander Truck (oil highway truck)	124
Hydraulic excavator CAT 320E L	96
Tandem truck CAT CT680	544
Tow Truck CAT 740B	56
Tow low boy LPM (120-48-20)	42
Fuel/ Lube Truck	23
Service Truck CT660	41
Bulk ANFO Explosives Truck (Kalmar DCD200-12lb)	41
Mini Bus	125
Pick Up Truck Ford E series	832
Crane LTM 110-4.2	80
Scissorlift Getman A64	23
Grader AARD Mining LP	42
Compaction Roller (CAT)	10
Pallet Handler/Tractor	6

Emission Rates by Equipment

Equipment	1-hr Emission Rate [g/s]			
	CO	NOx	PM	SO_2
Rigid haul truck waste CAT 773G	2.86E-01	1.54E+00	4.93E-02	1.87E-03
Articulated Haul truck CAT 740B	6.64E-02	1.97E-01	1.18E-02	3.94E-04
Drill rig ore AC DTH	2.01E-02	6.73E-02	4.04E-03	1.35E-04
Drill rig waste AC DTH	5.67E-02	1.68E-01	1.01E-02	3.36E-04
Bob Cat CAT C15	1.34E-01	3.97E-01	2.38E-02	7.93E-04
Wheel Loader CAT 980K	2.74E-01	8.13E-01	4.88E-02	1.62E-03
Wheel Dozer CAT 844H	1.34E-01	2.53E-01	1.52E-02	5.05E-04
Track Dozer CAT D9	5.92E-02	1.76E-01	1.05E-02	3.51E-04
Track Dozer CAT D8	1.19E-01	3.54E-01	2.13E-02	7.08E-04
Motor Grader CAT 14M	3.12E-02	1.04E-01	6.25E-03	2.08E-04
Wheel Backho/Loader CAT 420E	3.83E-02	4.86E-02	3.24E-03	9.00E-05
Water/Sander Truck (oil highway truck)	1.47E-01	4.36E-01	2.62E-02	8.72E-04
Hydraulic excavator CAT 320E L	1.17E-01	3.38E-01	2.97E-02	6.75E-04
Tandem truck CAT CT680	6.44E-01	1.91E+00	1.15E-01	3.82E-03
Tow Truck CAT 740B	6.64E-02	1.97E-01	1.18E-02	3.94E-04
Tow low boy LPM (120-48-20)	4.93E-02	1.46E-01	8.77E-03	2.92E-04
Fuel/ Lube Truck	2.42E-02	8.10E-02	4.86E-03	1.62E-04
Service Truck CT660	4.90E-02	1.45E-01	8.72E-03	2.91E-04
Bulk ANFO Explosives Truck (Kalmar DCD200-12lb)	4.90E-02	1.45E-01	8.72E-03	2.91E-04
Mini Bus	1.48E-01	4.38E-01	2.63E-02	8.77E-04
Pick Up Truck Ford E series	9.85E-01	2.92E+00	1.75E-01	5.84E-03
Crane LTM 110-4.2	9.45E-02	2.80E-01	1.68E-02	5.60E-04
Scissorlift Getman A64	2.80E-02	8.09E-02	7.12E-03	1.62E-04
Grader AARD Mining LP	5.17E-02	1.49E-01	1.31E-02	2.98E-04
Compaction Roller (CAT)	1.84E-02	5.68E-02	4.07E-03	6.68E-05
Pallet Handler/Tractor	6.85E-03	1.98E-02	1.74E-03	3.95E-05
Total Source 1-hr Emission Rates	3.70E+00	1.15E+01	6.62E-01	2.17E-02

Sample Calculation for 24-hr and Annual ERs

24-hr ER_{CO} =	1-hr ER_{CO}	24	hrs of operation
		24	hrs per day

24-hr ER_{CO} =	**3.70E+00**	**g**	1	kg	3600	s	24	hrs
		s	1000	g		hr		day

24-hr ER_{CO} =	**3.19E+02**	**kg**
		day

Annual ER_{CO} =	24-hr ER_{CO}	365	days of operation
		365	days per year

Annual ER_{CO} =	**3.70E+00**	**g**	3600	s	24	hrs	365	days	1	kg
		s		hr		day		year	1000	g

Annual ER_{CO} =	**1.17E+05**	**kg**
		year

Summary of Emissions from Construction Phase Diesel Powered Equipment

Source ID	Contaminant	CAS No.	1-hr Emission Rate [g/s]	24-hr Emission Rate [g/s]	24-hr Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
C_TP	CO	630-08-0	3.70E+00	3.70E+00	3.19E+02	3.70E+00	1.17E+05
	NOx	10102-44-0	1.15E+01	1.15E+01	9.90E+02	1.15E+01	3.61E+05
	PM	N/A	6.62E-01	6.62E-01	5.72E+01	6.62E-01	2.09E+04
	PM10*	—	6.62E-01	6.62E-01	5.72E+01	6.62E-01	2.09E+04
	PM2.5*	—	6.42E-01	6.42E-01	5.55E+01	6.42E-01	2.03E+04
	SO_2	7446-09-5	2.17E-02	2.17E-02	1.87E+00	2.17E-02	6.83E+02

*Emission standards were not provided for PM10 and PM2.5; therefore, it was assumed that all PM emissions consist of PM10 and that PM2.5 emissions are 97% of PM10 emissions, per the U.S. EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d (July 2010) (EPA Report NR-009d).

Construction Phase - Unpaved Roads

During the site preparation and construction phase, fugitive dust emissions will occur as equipment and personnel are transported around the site on unpaved roadways. A list of the types and numbers of construction vehicles which will be travelling on the unpaved roadways is provided below.

Fugitive dust emissions are affected by the parameters indicated in the table below. The total length of unpaved construction roads was estimated as 2.25 km, which is the approximate distance between the overburden area and the mill. It is assumed that both industrial and passenger vehicles/buses will make 20 trips per day along this route, for a total of 40 passenger vehicle passes per day and 40 industrial vehicle passes per day, 24 hours per day.

Annual averaged emissions would be subject to some natural mitigation due to the occurrence of snow or rain days throughout the year. Based on Canadian Climate Normals data obtained for the St. Lawrence station (normals for period 1971-2000), the average days without snow cover or rain is 120 days per year. Therefore, the calculation of annual emissions of fugitive dust assumed emissions will occur on 120 days out of the year.

Vehicle	Total Number of Units	Empty Vehicle Weight (per vehicle) [tonnes]	Vehicle Capacity (per vehicle) [tonnes]	Full Vehicle Weight (per vehicle) [tonnes]	Average Vehicle Weight (per vehicle) [tonnes]	Comment
Industrial Vehicles						
Rigid haul truck waste CAT 773G	3	34	52.8	86.8	60	Vehicle weights and capacities provided by CFI
Articulated Haul truck CAT 740B	1	34	39.5	73.5	54	
Water/Sander Truck (oil highway truck)	3	—	—	—	36	ssumed average industrial vehicles weigh 40 ton
Tandem truck CAT CT680	10	—	—	—	36	
Tow Truck CAT 740B	1	—	—	—	36	
Tow low boy LPM (120-48-20)	1	—	—	—	36	
Fuel/ Lube Truck	1	—	—	—	36	
Service Truck CT660	1	—	—	—	30	Estimated from specifications for CAT CT660
Bulk ANFO Explosives Truck (Kalmar DCD200-	1	34	20	54	44	Vehicle weights and capacities provided by CFI
Passenger Vehicles						
Mini Bus	3	3.4	3	5.9	4.7	Vehicle weight and capacity based on Toyota mini bus
Pick Up Truck Ford E series	20	—	—	—	13	Average passenger truck weight approximately 14 tons

Sample Calculation for Average Weight of All Passenger Vehicles

$$\text{Average Mini Bus weight} = \frac{\text{Empty vehicle weight + Full vehicle weight}}{2}$$

$$\text{Average Mini Bus weight} = \frac{3.4 \text{ tonnes} + 5.9 \text{ tonnes}}{2}$$

$$\text{Average Mini Bus weight} = 4.7 \text{ tonnes}$$

Average Pick Up Truck weight was calculated in a similar method.

$$\text{Average weight of all passenger vehicles} = \frac{\text{(3 Mini Buses x 4.7 tonnes per Bus) + (20 Pick Up Trucks x 13 tonnes per Truck)}}{\text{23 total passenger vehicles}}$$

Average weight of all passenger vehicles = 12 tonnes

The average weight of all industrial vehicles was calculated in a similar method.

Calculation of prorated fleet weight assumes:
Average weight of all industrial vehicles = 41 tonnes
= 45 tons

verage weight of all passenger vehicles = 12 tonnes
= 13 tons

Source ID	Source Description	Silt Content [%]**	Daily Passenger Vehicles [Passes/24 hrs]	Daily Industrial Vehicles [Passes/24 hrs]	Prorated Fleet Weight [tons]	Total Length of Road [km]	Daily Operating Hours [hrs/day]	Number of Days per Year Without Snow Cover/Rain
C_UPR	Construction Phase Traffic on Unpaved Roads	8.30	40	40	28.81	2.25	24	120

[**] U.S. EPA AP-42 Table 13.2.2-1 for stone quarrying and processing haul road

The predictive equation in U.S. EPA AP-42 Chapter 13.2.2 *"Unpaved Roads"* (November 2006) was used to calculate the fugitive dust emissions from the unpaved roadways. CFI will implement regular and adequate maintenance of unpaved roads and apply water or other dust suppressants as needed to reduce dust emissions; therefore a control factor was applied to the site roads. Table 4 of the Australian National Pollutant Inventory document "Emission Estimation Technique for Mining", Version 3.1 dated January 2012, states that watering more than 2 L/m² can achieve a 75% emissions reduction. The equation is as follows:

Industrial site equation:

$$\text{unpaved } EF = k\,(s/12)^{a}(W/3)^{b}$$

Where:

EF = Emission factor: grams particulate emitted per vehicle kilometre travelled [lb/VMT]
a, b, k = empirical constants
s = Surface material silt content [%]
W = Prorated fleet weight [tons]

Parameter	k	a	b	Reference	Rating
PM	4.9	0.7	0.45	AP-42 / 13.2.2 - Table 13.2.2-2	B
PM_{10}	1.5	0.9	0.45	AP-42 / 13.2.2 - Table 13.2.2-2	B
$PM_{2.5}$	0.15	0.9	0.45	AP-42 / 13.2.2 - Table 13.2.2-2	B

Sample Calculation

The following parameters were used to calculate emission rates of PM (suspended particulate matter):

k = 4.9 (Table 13.2.2-2)
a = 0.7 (Table 13.2.2-2)
b = 0.45 (Table 13.2.2-2)
s = 8.30 (from U.S. EPA AP-42 Table 13.2.2-1 for stone quarrying and processing haul road)
W = 28.81 tons

Emission Factor for PM

$$EF = \frac{4.9\ \text{lb}}{\text{VMT}} \left| \frac{8.3^{0.7}}{12^{0.7}} \right| \frac{28.81^{0.45}}{3^{0.45}}$$

$$EF = 1.05E{+}01\ \frac{\text{lb}}{\text{VMT}}$$

Controls are implemented along various roadway segments. The controlled emission rate calculation is shown below:

Controlled Emission Rate

Total length of road = 2.25 km

$$ER_{PM} = \frac{1.05E{+}01\ \text{lb}}{\text{VMT}} \left| \frac{80\ \text{veh}}{24\ \text{hr}} \right| \frac{2.25\ \text{km}}{\text{trip}} \left| \frac{1\ \text{hr}}{3600\ \text{s}} \right| \frac{281.9\ \text{g/VKT}}{\text{lb/VMT}} \left| \frac{100\ -\ 75}{100} \right|$$

$$ER_{PM} = 1.54E{+}00\ \frac{\text{g}}{\text{s}}$$

C_UPR **Construction Phase Traffic on Unpaved Roads**

	Fugitive Dust from Vehicle Traffic			Controlled Emission Rate [g/s]	
Compound	EF	EF Unit	Uncontrolled Emission Rate for Entire Segment [g/s]	Control [%]	Controlled Emission Rate for Entire Segment [g/s]
PM	1.05E+01	[lb/VMT]	6.15E+00	75	1.54E+00
PM10	2.98E+00	[lb/VMT]	1.75E+00	75	4.37E-01
PM2.5	2.98E-01	[lb/VMT]	1.75E-01	75	4.37E-02

Emission Rates for PM Emitted by C_UPR - Construction Phase Traffic on Unpaved Roads

Compound	CAS	1-hour Emission Rate [g/s]	24-hour Emission Rate [g/s]	24-hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	N/A	1.54E+00	1.54E+00	1.33E+02	5.06E-01	1.60E+04
PM10	—	4.37E-01	4.37E-01	3.78E+01	1.44E-01	4.54E+03
PM2.5	—	4.37E-02	4.37E-02	3.78E+00	1.44E-02	4.54E+02

Construction Phase - Dewatering Pump

Grebes Nest Pond will be dewatered to allow the excavation of a portion of Grebes Nest Pit during construction. It assumed a 150 hp diesel pump will be used for pit dewatering. This equipment is assumed to be operating 24 hours per day, 365 days per year.

Emission factors from the US EPA AP-42 Table 3.3-1, section dated 10/96, were used to calculate the emission rates of Nitrogen Oxides, Carbon Monoxide and particulate matter from diesel combustion. The data is of "D" quality.

The emission factor for PM10 was taken to be the emission factor for particulate matter (PM), under the conservative assumption that all particulate generated by diesel combustion will be nominally less than 10 μm in aerodynamic diameter. It was also conservatively assumed that 97% of the PM10 will be nominally less than 2.5 μm in aerodynamic diamater (i.e. PM2.5).

Sulphur dioxide (SO2) emissions were estimated based on the diesel fuel consumption rate and a sulphur content of 15 mg/kg (Ultra Low Sulphur Diesel [ULSD]), based upon the Sulphur in Diesel Fuel Regulations (SOR/2002-254, dated June 2012) promulgated under CEPA (CEPA 1999). The following equation was used to determine the SO2 emission factor:

$$EF = Fuel\ Density \times Sulphur\ Content \times \frac{MM\ SO_2}{MM\ Sulphur}$$

where: EF = emission factor [g/L]
MM SO_2 = molar mass SO_2 [g/mol] = 64
MM Sulphur = molar mass [g/mol] = 32
diesel fuel density [kg/L] = 0.843
sulphur content [mg/kg] = 15

Diesel fuel consumption was calculated using the horsepower rating of the dewatering pump and the steady-state brake specific fuel consumption (BSFC) conversion in Table A4 of the U.S. EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d (July 2010) (EPA Report NR-009d) . Table 10 of the U.S. EPA's Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling – Report No. NR-005d was used to assign an engine cycle load factor to the dewatering pump based on a representative cycle of "None". The SO_2 emission rate was then calculated from the emission factor and fuel consumption.

$$BSFC\left(\frac{lb}{hp-hr}\right) = \frac{Fuel\ Consumption\left(\frac{lb}{hr}\right)}{hp}$$

Therefore,

$$Fuel\ Consumption\left(\frac{L}{hr}\right) = BSFC\left(\frac{lb}{HP-hr}\right) \times hp \times \frac{LF}{fuel\ density\left(\frac{kg}{L}\right)} \times Conversion\ Factors$$

The SO_2 emission rate is then calculated from fuel consumption as follows:

$$ER = EF \times Fuel\ Consumption \times \frac{Hours\ of\ Operation}{24\ hr} \times \frac{1\ hr}{3{,}600\ s}$$

Source Parameters

Source ID	Source Description	Power Output [kW]	Power Output [HP]	Representative Cycle[1]	Load Factor Assignment[3]	Load Factor[3]	Brake-Specific Fuel Consumption [lb/hp-hr]	Operating Hours per Day	Operating Days per Year
GNP_DWP	Diesel Powered Dewatering Pump	112	150	None[2]	Avg 7-cycle	0.43	0.367	24	365

[1] NR-005d, Table 10: pg.15, Table 10. CI Load Factor Assignments by Equipment Type

[2] Load Factor of None = steady state

[3] NR-005d, Table 9: pg. 14, Table 9. Compression-Ignition Load Factors

Sample Calculation for NOx

$$\text{1-hour } ER_{NOx} = 150\ \text{HP}\;\; \frac{3.10\text{E-}02\ \text{lb}}{\text{HP-hr}}\;\; \frac{454\ \text{g}}{\text{lb}}\;\; \frac{1\ \text{hr}}{3600\ \text{s}}$$

$$\textbf{1-hour } \mathbf{ER_{NOx}} = \boxed{\frac{5.86\text{E-}01\ \text{g}}{\text{s}}}$$

$$\text{24-hour } ER_{NOx} = \text{1-hour } ER_{NOx}\;\; \frac{\text{hours of operation}}{\text{24 hours in 1 day}}$$

$$\text{24-hour } ER_{NOx} = \frac{5.86\text{E-}01\ \text{g}}{\text{s}}\;\; \frac{24\ \text{operating hours}}{24\ \text{hours in 1 day}}$$

$$\textbf{24-hour } \mathbf{ER_{NOx}} = \boxed{\frac{5.86\text{E-}01\ \text{g}}{\text{s}}}\;\; \frac{1\ \text{kg}}{1000\ \text{g}}\;\; \frac{3600\ \text{s}}{\text{hr}}\;\; \frac{24\ \text{hrs}}{\text{day}}$$

$$\textbf{24-hour } \mathbf{ER_{NOx}} = \boxed{\frac{5.07\text{E+}01\ \text{kg}}{\text{day}}}$$

$$\text{Annual } ER_{NOx} = \text{24-hour } ER_{NOx}\;\; \frac{\text{operating days}}{\text{number of days in 1 year}}$$

$$\text{Annual } ER_{NOx} = \frac{5.86\text{E-}01\ \text{g}}{\text{s}}\;\; \frac{365\ \text{operating days}}{365\ \text{days per year}}$$

$$\textbf{Annual } \mathbf{ER_{NOx}} = \boxed{\frac{5.86\text{E-}01\ \text{g}}{\text{s}}}\;\; \frac{1\ \text{kg}}{1000\ \text{g}}\;\; \frac{3600\ \text{s}}{1\ \text{hr}}\;\; \frac{24\ \text{hrs}}{1\ \text{day}}\;\; \frac{365\ \text{days}}{1\ \text{year}}$$

$$\textbf{Annual } \mathbf{ER_{NOx}} = \boxed{\frac{1.85\text{E+}04\ \text{kg}}{\text{year}}}$$

Sample Calculation for SO_2 Emission Factor

$$EF_{SO2} = \frac{0.843\ \text{kg}}{\text{L}}\;\; \frac{15\ \text{mg}}{\text{kg}}\;\; \frac{64\ \text{g/mol } SO_2}{32\ \text{g/mol S}}\;\; \frac{1\ \text{g}}{1000\ \text{mg}}$$

$$EF_{SO2} = \frac{2.53\text{E-}02\ \text{g}}{\text{L}}$$

Sample Calculation for Fuel Consumption of the Diesel Powered Dewatering Pump

$$\text{Fuel Consumption} = \frac{0.367\ \text{lb}}{\text{hp-hr}}\;\; 150\ \text{hp}\;\; \frac{0.43}{0.843\ \text{kg/L}}\;\; \frac{1\ \text{kg}}{1000\ \text{g}}\;\; \frac{454\ \text{g}}{\text{lb}}$$

$$\text{Fuel Consumption} = \frac{1.27\text{E+}01\ \text{L}}{\text{hr}}$$

Sample Calculation for SO2 from the Diesel Powered Dewatering Pump

$$1\text{-hr } ER_{SO2} = \frac{2.53E\text{-}02 \ \text{g}}{\text{L}} \left| \frac{1.27E\text{+}01 \ \text{L}}{\text{hr}} \right| \frac{1 \ \text{hr}}{3600 \ \text{s}}$$

$$1\text{-hr } ER_{SO2} = \frac{8.96E\text{-}05 \ \text{g}}{\text{s}}$$

Emission Rates for Compounds Emitted by Diesel Powered Dewatering Pump

Compound	CAS	EF	EF Units	1-hour Emission Rate [g/s]	24-hour Emission Rate [g/s]	24-hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
Nitrogen Oxides	10102-44-0	3.10E-02	lb/hp-hr	5.86E-01	5.86E-01	5.07E+01	5.86E-01	1.85E+04
Carbon Monoxide	630-08-0	6.68E-03	lb/hp-hr	1.26E-01	1.26E-01	1.09E+01	1.26E-01	3.98E+03
Sulphur Dioxide	7446-09-5	2.53E-02	g/L	8.96E-05	8.96E-05	7.74E-03	8.96E-05	2.82E+00
PM	N/A	2.20E-03	lb/hp-hr	4.16E-02	4.16E-02	3.60E+00	4.16E-02	1.31E+03
PM10	—	2.20E-03	lb/hp-hr	4.16E-02	4.16E-02	3.60E+00	4.16E-02	1.31E+03
PM2.5	—	2.13E-03	lb/hp-hr	4.04E-02	4.04E-02	3.49E+00	4.04E-02	1.27E+03

*All PM is assumed to be PM10. PM2.5 is assumed to be 97% of PM10, per the U.S. EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d (July 2010) (EPA Report NR-009d).

Operation Phase - Drilling and Blasting

Drilling and blasting activities will occur within the open pits and the underground mine during the operation phase of the Project to support ore mining activities and develop the mines.

The calculation for drilling and blasting emissions assumes the worst-case emissions scenario, which will occur when 100% of ore is mined from the open pits (underground mining will not occur until year 3 of operation). Source parameters were based on the Grebes Nest Pit, as it has the highest expected mining rate of all 4 pits.

The operating time for pit mining equipment and personnel will be two 10-hour shifts per day (resulting in 20 hours of operation in a 24-hour period) for 350 days per year. Both ore and waste rock material will be blasted. Contaminants will be discharged from the open pits. Source parameters, such as number of blasts per day, holes drilled per day, etc. are summarized below. To estimate a 1-hour averaged emission rate for drilling, it was assumed the holes will be drilled throughout the production day (i.e. 80 holes/20 operating hours per day = 4 holes/hour). To estimate a 1-hour averaged emission rate for blasting, 1 blast per hour was conservatively assumed.

Particulate Matter Emissions from Drilling and Blasting

An equation from Table 11.9-2, U.S. EPA AP-42 Chapter 11.9 "*Western Surface Coal Mining*" (dated 7/98) was used to calculate the fugitive dust emissions associated with blasting activities. The equation is as follows:

EF=0.00022×A^1.5×SF
where: EF = PM emission factor (kg/blast)
A = horizontal area (m²)

The particulate emission factor for drilling was taken from U.S. EPA AP-42 Chapter 11.9 "*Western Surface Coal Mining*", Table 11.9-4 (dated 7/98) for overburden. The data quality is rated "C" or "Average".
No EFs for PM10 and PM2.5 from drilling are available therefore PM10 was assumed to be 50% of PM and PM2.5 was assumed to be 50% of PM10.

CFI will implement appropriate BMPs during drilling, therefore a 70% control is applied as per Table 4 in the Australian Government document "National Pollutant Inventory Emission Estimation Technique Manual for Mining" Version 3.1 dated January 2012. The maximum PM 1-hour and 24-hour emission rates from either of drilling or blasting are carried through to the Operation Phase Source Summary Table as a maximum emission scenario because drilling and blasting cannot occur simultaneously in one day. Annual averaged PM emission rates are a sum of the emissions from both drilling and blasting, since over the course of a one year period both activities will occur.

Source Parameters - PIT_DB: Open Pit Drilling and Blasting

Number of Holes Drilled per Day	80
Drilling Control	70%
Operating Hours per Day	20
Operating Days per Year	350
Ore Blasting	
A: Area Blasted per Blast [m²]	60
Bulk Emulsion: Usage per Blast [Mg]	0.7
Operating Hours per Day	20
Total Number of Blasts per Day	1
Operating Days per Year	350
Waste Rock Blasting	
A: Area Blasted per Blast [m²]	600
Bulk Emulsion: Usage per Blast [Mg]	4.3
Operating Hours per Day	20
Total Number of Blasts per Day	1
Operating Days per Year	350

Sample Calculations for Source PIT_DB - Ore Blasting

1-hour Averaged Emissions

Blasting - PM

$$EF_{PM} = 0.00022(A)^{1.5}$$

$$\text{1-hr } ER_{PM} = 0.00022(60.0\ m^2)^{1.5}\ \frac{kg}{blast} \times \frac{1\ blast}{1\ hour}\Big|\frac{1\ hour}{3600\ s}\Big|\frac{1000\ g}{1\ kg}$$

$$\text{1-hr } ER_{PM} = \boxed{\frac{2.84E\text{-}02\ g}{s}}$$

Drilling - PM

$$ER_{PM} = \frac{0.59\ kg}{hole}\Big|\frac{4.00\ holes}{1\ hr}\Big|\frac{1000\ g}{kg}\Big|\frac{1\ hr}{3600\ s}\Big|(100\% - 70\%)$$

$$\text{1-hr } ER_{PM} = \boxed{\frac{1.97E\text{-}01\ g}{s}}$$

24-hour Averaged Emissions

Blasting - PM

$$EF_{PM} = 0.00022(A)^{1.5}$$

$$\text{24-hr } ER_{PM} = 0.00022(\ 60.0\ m^2\ )^{1.5}\ \frac{kg}{blast} \times \frac{1000\ g}{1\ kg}\ \frac{1\ blast}{1\ day}\ \frac{1\ day}{24\ hours}\ \frac{1\ hour}{3600\ s}$$

$$\textbf{24-hr } ER_{PM} = \boxed{\frac{\mathbf{1.18E\text{-}03\ g}}{\mathbf{s}}}\ \frac{1\ kg}{1000\ g}\ \frac{3600\ s}{1\ hr}\ \frac{24\ hrs}{1\ day}$$

$$\textbf{24-hr } ER_{PM} = \boxed{\frac{\mathbf{1.02E\text{-}01\ kg}}{\mathbf{day}}}$$

Annual Averaged Emissions

Blasting - PM

$$\text{Annual } ER_{PM} = \text{24-hr } ER_{PM} \times \frac{\text{operating days}}{\text{number days in 1 year}}$$

$$\text{Annual } ER_{PM} = \frac{1.18E\text{-}03\ g}{s}\ \frac{350\ \text{ operating days}}{365\ \text{ days per year}}$$

$$\textbf{Annual } ER_{PM} = \boxed{\frac{\mathbf{1.13E\text{-}03\ g}}{\mathbf{s}}}\ \frac{1\ kg}{1000\ g}\ \frac{3600\ s}{1\ hr}\ \frac{24\ hrs}{1\ day}\ \frac{365\ days}{1\ year}$$

$$\textbf{Annual } ER_{PM} = \boxed{\frac{\mathbf{3.58E{+}01\ kg}}{\mathbf{year}}}$$

Drilling - PM

$$ER_{PM} = \frac{0.59\ kg}{hole}\ \frac{80\ holes}{1\ day}\ \frac{1000\ g}{kg}\ \frac{1\ day}{24\ hours}\ \frac{20\ op\ hrs}{24\ hours}\ \frac{1\ hr}{3600\ s}\ (\ 100\% - 70\%\ )$$

$$\textbf{24-hr } ER_{PM} = \boxed{\frac{\mathbf{1.37E\text{-}01\ g}}{\mathbf{s}}}\ \frac{1\ kg}{1000\ g}\ \frac{3600\ s}{1\ hr}\ \frac{24\ hrs}{1\ day}$$

$$\textbf{24-hr } ER_{PM} = \boxed{\frac{\mathbf{1.18E{+}01\ kg}}{\mathbf{day}}}$$

Drilling - PM

$$\text{Annual } ER_{PM} = \text{24-hr } ER_{PM} \times \frac{\text{operating days}}{\text{number days in 1 year}}$$

$$\text{Annual } ER_{PM} = \frac{1.37E\text{-}01\ g}{s}\ \frac{350\ \text{ operating days}}{365\ \text{ days per year}}$$

$$\textbf{Annual } ER_{PM} = \boxed{\frac{\mathbf{1.31E\text{-}01\ g}}{\mathbf{s}}}\ \frac{1\ kg}{1000\ g}\ \frac{3600\ s}{1\ hr}\ \frac{24\ hrs}{1\ day}\ \frac{365\ days}{1\ year}$$

$$\textbf{Annual } ER_{PM} = \boxed{\frac{\mathbf{4.13E{+}03\ kg}}{\mathbf{year}}}$$

PM Emissions from PIT_DB

Compound	CAS	EF	EF Units	1-hr ER [g/s]	24-hr ER [g/s]	24-hr ER [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM - Drilling	N/A	0.59	kg/hole	1.97E-01	1.37E-01	1.18E+01	1.31E-01	4.13E+03
Ore Blasting								
PM - Blasting	N/A	$0.00022(A)^{1.}$	kg/blast	2.84E-02	1.18E-03	1.02E-01	1.13E-03	3.58E+01
Waste Rock Blasting								
PM - Blasting	N/A	$0.00022(A)^{1.}$	kg/blast	8.98E-01	3.74E-02	3.23E+00	3.59E-02	1.13E+03
PM - Blasting (total)	N/A	—	—	9.27E-01	3.86E-02	3.34E+00	3.70E-02	1.17E+03

Gaseous Emissions from Blasting

The Carbon Monoxide, Nitrogen Oxides and Sulphur Dioxide emission factors for the blasting using emulsion explosives was obtained from the Australian NPI *"Emission estimation technique manual for Explosives detonation and firing ranges"* Version 3.0 January 2012. The data quality is rated "U" or "Unrated" for emulsion.

Sample Calculations for Source PIT_DB - Ore Blasting (all gaseous emissions were calculated in a similar manner)

Carbon Monoxide (1-hr averaged)

$$\text{1-hr ER}_{CO} = \frac{2.3\text{ kg}}{\text{Mg}} \Big| \frac{0.7\text{ Mg}}{\text{blast}} \Big| \frac{1\text{ blast}}{1\text{ hr}} \Big| \frac{1000\text{ g}}{\text{kg}} \Big| \frac{1\text{ hr}}{3600\text{ s}}$$

$$\textbf{1-hr ER}_{CO} = \boxed{\frac{\textbf{4.47E-01 g}}{\textbf{s}}}$$

Carbon Monoxide (annual averaged)

$$\text{Annual ER}_{CO} = \text{24-hr ER}_{CO} \times \frac{\text{operating days}}{\text{number days in 1 year}}$$

$$\text{Annual ER}_{CO} = \frac{1.86\text{E-02 g}}{\text{s}} \Big| \frac{350\text{ operating days}}{365\text{ days per year}}$$

$$\textbf{Annual ER}_{CO} = \boxed{\frac{\textbf{1.79E-02 g}}{\textbf{s}}} \Big| \frac{1\text{ kg}}{1000\text{ g}} \Big| \frac{3600\text{ s}}{1\text{ hr}} \Big| \frac{24\text{ hrs}}{1\text{ day}} \Big| \frac{365\text{ days}}{1\text{ year}}$$

$$\textbf{Annual ER}_{CO} = \boxed{\frac{\textbf{5.64E+02 kg}}{\textbf{year}}}$$

Carbon Monoxide (24-hr averaged)

$$\text{24-hr ER}_{CO} = \frac{2.3\text{ kg}}{\text{Mg}} \Big| \frac{0.7\text{ Mg}}{\text{blast}} \Big| \frac{1000\text{ g}}{1\text{ kg}} \Big| \frac{1\text{ blast}}{1\text{ day}} \Big| \frac{1\text{ day}}{24\text{ hours}} \Big| \frac{1\text{ hour}}{3600\text{ s}}$$

$$\textbf{24-hr ER}_{CO} = \boxed{\frac{\textbf{1.86E-02 g}}{\textbf{s}}} \Big| \frac{1\text{ kg}}{1000\text{ g}} \Big| \frac{3600\text{ s}}{1\text{ hr}} \Big| \frac{24\text{ hrs}}{1\text{ day}}$$

$$\textbf{24-hr ER}_{CO} = \boxed{\frac{\textbf{1.61E+00 kg}}{\textbf{day}}}$$

Summary of Gaseous Emissions from PIT_DB

Compound	CAS	Emulsion EF [kg/Mg]	1-hr ER [g/s]	24-hr ER [g/s]	24-hr ER [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
Ore Blasting							
Carbon Monoxide	630-08-0	2.3	4.47E-01	1.86E-02	1.61E+00	1.79E-02	5.64E+02
Nitrogen Oxides	10102-44-0	0.2	3.89E-02	1.62E-03	1.40E-01	1.55E-03	4.90E+01
Waste Rock Blasting							
Carbon Monoxide	630-08-0	2.3	2.75E+00	1.14E-01	9.89E+00	1.10E-01	3.46E+03
Nitrogen Oxides	10102-44-0	0.2	2.39E-01	9.95E-03	8.60E-01	9.54E-03	3.01E+02

Total Emissions by Source

Source	Compound	CAS	1-hr ER [g/s]	24-hr ER [g/s]	24-hr ER [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PIT_DB - Open Pit Drilling and Blasting	PM	N/A	9.27E-01	1.37E-01	1.18E+01	1.31E-01	4.13E+03
	PM10*	—	4.63E-01	6.83E-02	5.90E+00	6.55E-02	2.07E+03
	PM2.5*	—	2.32E-01	3.41E-02	2.95E+00	3.27E-02	1.03E+03
	Carbon Monoxide	630-08-0	3.19E+00	1.33E-01	1.15E+01	1.28E-01	4.03E+03
	Nitrogen Oxides	10102-44-0	2.78E-01	1.16E-02	1.00E+00	1.11E-02	3.50E+02

*There are no EFs for PM10 and PM2.5 from drilling, therefore PM10 was assumed to be 50% of PM and PM2.5 was assumed to be 50% of PM10.

Operation Phase - Open Pit Mining Equipment

The calculation for emissions from diesel-fired mining equipment assumes the worst-case emissions scenario, which will occur when 100% of mining is in the open pits (underground mining will not occur until year 3 of operation). Therefore, equipment counts, engine sizes and fuel usages were based on the expected open pit mining fleet.

Crankcase emission standards from the U.S. EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d (July 2010) (EPA Report NR-009d) were used to calculate exhaust emissions from the diesel-fired equipment that will be operated during open pit mining. It was assumed that all on-site vehicles comply with at least Tier 3 emission standards.

Emission standards were not provided for PM10 and PM2.5; therefore, it was assumed that all PM emissions consist of PM10 and that PM2.5 emissions are 97% of PM10 emissions. The operating time for pit mining equipment and personnel will be two 10-hour shifts per day (20 hours per day) for 350 days per year.

The following equation was used to calculate the emission rates of carbon monoxide (CO), nitrogen oxides (NOx) and particulate matter (PM) from the mine equipment:

$$ER = EF \times Engine\ Horsepower\ Rating \times LF \times \frac{Hours\ of\ Operation}{24\ hr} \times \frac{1\ hr}{3{,}600\ s}$$

(from U.S. EPA Report No. NR-005d, page 1)

where: ER = emission rate [g/s]
EF = emission factor [g/hp-hr]
LF = load factor

Table 10 of the U.S. EPA's Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling – Report No. NR-005d was used to assign engine cycle load factors to the diesel mine equipment based on the type of equipment operated. Emission factors for carbon monoxide (CO), nitrogen oxides (NOx), and particulate matter (PM) were obtained from Table A4: Zero-Hour Steady State Emission Factors for Nonroad CI Engines, based on the horsepower and EPA emission standard tier rating of each diesel engine. The emission factor data quality has been assigned an estimated rating of "C", or "Average", as the factors are based on test data (where available), EPA certification data, or on factors used in EPA's Nonroad Engine and Vehicle Emission Study (November 1991).

Sulphur dioxide (SO_2) emissions were estimated based on the diesel fuel consumption rate per vehicle and a sulphur content of 15 mg/kg (Ultra Low Sulphur Diesel [ULSD]), based upon the Sulphur in Diesel Fuel Regulations (SOR/2002-254, dated June 2012) promulgated under CEPA (CEPA 1999). The following equation was used to determine the SO_2 emission factor:

$$EF = Fuel\ Density \times Sulphur\ Content \times \frac{MM\ SO_2}{MM\ Sulphur}$$

where: EF = emission factor [g/L]
MM SO_2 = molar mass SO_2 [g/mol] = 64
MM Sulphur = molar mass [g/mol] = 32
diesel fuel density [kg/L] = 0.843
sulphur content [mg/kg] = 15

The SO_2 emission rate is then calculated from fuel consumption as follows:

$$ER = EF \times Fuel\ Consumption \times \frac{Hours\ of\ Operation}{24\ hr} \times \frac{1\ hr}{3{,}600\ s}$$

Summary of Open Pit Mining Equipment Fleet

Equipment	Number of Units	Engine Rating [hp]	Fuel per Vehicle [L/hr]	U.S. EPA Emission Standard	Load Factor	Daily Operating Hours Per Vehicle	Table A4 Zero-Hour Steady State Emission Factors for Nonroad CI			
							Brake-Specific Fuel Consumption [lb/hp-hr]	CO [g/hp-hr]	NOx [g/hp-hr]	PM [g/hp-hr]
Hydraulic Excavator ore/waste CAT 390FL	1	524	56	Tier_3	0.53	20	0.367	0.8425	2.5	0.15
Hydraulic Excavator ovb/ore CAT 374FL	1	472	62	Tier_3	0.53	20	0.367	0.8425	2.5	0.15
Rigid Haul Truck ore/waste CAT 773G	3	775	57	Tier_3(1)	0.58	20	0.367	0.7642	4.1	0.1316
Articulated Haul Truck ovb/ore CAT 740B	1	489	46	Tier_3	0.58	20	0.367	0.8425	2.5	0.15
Drill rig ore AC DTH	1	225	22	Tier_3	0.43	20	0.367	0.7475	2.5	0.15
Drill rig waste AC DTH	1	563	65	Tier_3	0.43	20	0.367	0.8425	2.5	0.15
Wheel Loader CAT 980K	1	406	25	Tier_3	0.48	20	0.367	0.8425	2.5	0.15
Wheel Dozer CAT 844H	1	628	56	Tier_3	0.58	20	0.367	1.3272	2.5	0.15
Track Dozer CAT D9	1	436	46	Tier_3	0.58	20	0.367	0.8425	2.5	0.15
Motor Grader CAT 14M	1	259	18	Tier_3	0.58	20	0.367	0.7475	2.5	0.15
Water/Sander Truck (oil highway truck)	1	361	57	Tier_3	0.58	20	0.367	0.8425	2.5	0.15
Hydraulic Excavator CAT 320E L	1	153	18	Tier_3	0.53	20	0.367	0.8667	2.5	0.22
Tow Truck CAT	1	489	56	Tier_3	0.58	20	0.367	0.8425	2.5	0.15
Tow Low Boy LPM (120-48-20)	1	489	57	Tier_3	0.43	20	0.367	0.8425	2.5	0.15
Fuel/Lube Truck CT660	1	201	28.2	Tier_3	0.58	20	0.367	0.7475	2.5	0.15
Service Truck Kalmar DCD200-12lb	1	361	50	Tier_3	0.58	20	0.367	0.8425	2.5	0.15
Bulk ANFO Explosives Truck	1	489	28.2	Tier_3	0.58	20	0.367	0.8425	2.5	0.15
Mini Bus Ford E Series	1	489	10	Tier_3	0.43	20	0.367	0.8425	2.5	0.15
Pick Up Truck 4x4 crew cab Chevrolet	1	489	6	Tier_3	0.43	20	0.367	0.8425	2.5	0.15
Light Tower	3	94	2	Tier_3	0.43	20	0.408	0.237	3	0.0092
Dewatering Pump	3	500	75	Tier_3	0.43	20	0.367	1.3272	2.5	0.15

(1) Tier 2 emission factors were conservatively applied, as Tier 3 emission factors were not available for this engine

Compression Ignition Load Factors -- Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling – Report No. NR-005d, Table 9: pg.14

Equipment Type	Representative Cycle[2]	Load Factor Assignment	Cycle Load Factor	Notes
Hydraulic Excavator ore/waste CAT 390FL	Excavator	Hi LF	0.53	—
Hydraulic Excavator ovb/ore CAT 374FL	Excavator	Hi LF	0.53	—
Rigid Haul Truck ore/waste CAT 773G	Crawler	Hi LF	0.58	—
Articulated Haul Truck ovb/ore CAT 740B	Crawler	Hi LF	0.58	—
Drill rig ore AC DTH	None	Avg 7-cycle	0.43	(3)
Drill rig waste AC DTH	None	Avg 7-cycle	0.43	(3)
Wheel Loader CAT 980K	Rubber Tired Loader	Hi LF	0.48	—
Wheel Dozer CAT 844H	Crawler	Hi LF	0.58	—
Track Dozer CAT D9	Crawler	Hi LF	0.58	—
Motor Grader CAT 14M	Crawler	Hi LF	0.58	—
Water/Sander Truck (oil highway truck)	Crawler	Hi LF	0.58	—
Hydraulic Excavator CAT 320E L	Excavator	Hi LF	0.53	—
Tow Truck CAT	Crawler	Hi LF	0.58	—
Tow Low Boy LPM (120-48-20)	None	Avg 7-cycle	0.43	(3)
Fuel/Lube Truck CT660	Crawler	Hi LF	0.58	—
Service Truck Kalmar DCD200-12lb	Crawler	Hi LF	0.58	—
Bulk ANFO Explosives Truck	Crawler	Hi LF	0.58	—
Mini Bus Ford E Series	None	Avg 7-cycle	0.43	(3)
Pick Up Truck 4x4 crew cab Chevrolet	None	Avg 7-cycle	0.43	(3)
Light Tower	None	Avg 7-cycle	0.43	(3)
Dewatering Pump	None	Avg 7-cycle	0.43	(3)

[2] NR-005d, Table 10: pg.15, Table 10. CI Load Factor Assignments by Equipment Type

[3] Load Factor of None = steady state

Sample Calculation for CO from the Hydraulic Excavator ore/waste CAT 390FL

$$\text{1-hr ER}_{CO} = \frac{0.8425\ \text{g}}{\text{hp-hr}} \Big|\ 524\ \text{hp}\ \Big|\ 0.53\ \Big|\ \frac{1\ \text{hr}}{3600\ \text{s}} \Big|\ 1\ \text{vehicles}$$

$$\text{1-hr ER}_{CO} = \frac{6.50\text{E-}02\ \text{g}}{\text{s}}$$

Sample Calculation for SO_2 Emission

$$\text{EF}_{SO2} = \frac{0.843\ \text{kg}}{\text{L}} \Big|\ \frac{15\ \text{mg}}{\text{kg}} \Big|\ \frac{64\ \text{g/mol SO}_2}{32\ \text{g/mol S}} \Big|\ \frac{1\ \text{g}}{1000\ \text{mg}}$$

$$\text{EF}_{SO2} = \frac{2.53\text{E-}02\ \text{g}}{\text{L}}$$

Sample Calculation for SO2 from the Hydraulic Excavator ore/waste CAT 390FL

$$\text{1-hr ER}_{SO2} = \frac{2.53\text{E-}02\ \text{g}}{\text{L}} \Big|\ \frac{5.60\text{E+}01\ \text{L}}{\text{hr}} \Big|\ \frac{1\ \text{hr}}{3600\ \text{s}} \Big|\ 1\ \text{vehicles}$$

$$\text{1-hr ER}_{SO2} = \frac{3.93\text{E-}04\ \text{g}}{\text{s}}$$

Emission Rates by Equipment

Equipment	1-hr Emission Rate [g/s]			
	CO	NOx	PM	SO_2
Hydraulic Excavator ore/waste CAT 390FL	6.50E-02	1.93E-01	1.16E-02	3.93E-04
Hydraulic Excavator ovb/ore CAT 374FL	5.85E-02	1.74E-01	1.04E-02	4.36E-04
Rigid Haul Truck ore/waste CAT 773G	2.86E-01	1.54E+00	4.93E-02	1.20E-03
Articulated Haul Truck ovb/ore CAT 740B	6.64E-02	1.97E-01	1.18E-02	3.23E-04
Drill rig ore AC DTH	2.01E-02	6.73E-02	4.04E-03	1.55E-04
Drill rig waste AC DTH	5.67E-02	1.68E-01	1.01E-02	4.57E-04
Wheel Loader CAT 980K	4.56E-02	1.35E-01	8.13E-03	1.76E-04
Wheel Dozer CAT 844H	1.34E-01	2.53E-01	1.52E-02	3.93E-04
Track Dozer CAT D9	5.92E-02	1.76E-01	1.05E-02	3.23E-04
Motor Grader CAT 14M	3.12E-02	1.04E-01	6.25E-03	1.26E-04
Water/Sander Truck (oil highway truck)	4.90E-02	1.45E-01	8.72E-03	4.00E-04
Hydraulic Excavator CAT 320E L	1.95E-02	5.63E-02	4.95E-03	1.26E-04
Tow Truck CAT	6.64E-02	1.97E-01	1.18E-02	3.93E-04
Tow Low Boy LPM (120-48-20)	4.93E-02	1.46E-01	8.77E-03	4.00E-04
Fuel/Lube Truck CT660	2.42E-02	8.10E-02	4.86E-03	1.98E-04
Service Truck Kalmar DCD200-12lb	4.90E-02	1.45E-01	8.72E-03	3.51E-04
Bulk ANFO Explosives Truck	6.64E-02	1.97E-01	1.18E-02	1.98E-04
Mini Bus Ford E Series	4.93E-02	1.46E-01	8.77E-03	7.03E-05
Pick Up Truck 4x4 crew cab Chevrolet	4.93E-02	1.46E-01	8.77E-03	4.22E-05
Light Tower	7.97E-03	1.01E-01	3.09E-04	4.22E-05
Dewatering Pump	2.38E-01	4.48E-01	2.69E-02	1.58E-03
Total Source 1-hr Emission Rates	1.49E+00	4.81E+00	2.42E-01	7.79E-03

Sample Calculation for 24-hr and Annual ERs

$$\text{24-hr ER}_{CO} = \text{1-hr ER}_{CO} \quad \frac{20 \text{ hrs of operation}}{24 \text{ hrs per day}}$$

$$\textbf{24-hr ER}_{CO} = \frac{1.24E+00 \text{ g}}{\text{s}} \quad \frac{1 \text{ kg}}{1000 \text{ g}} \quad \frac{3600 \text{ s}}{\text{hr}} \quad \frac{24 \text{ hrs}}{\text{day}}$$

$$\textbf{24-hr ER}_{CO} = \frac{1.07E+02 \text{ kg}}{\text{day}}$$

$$\text{Annual ER}_{CO} = \text{24-hr ER}_{CO} \quad \frac{350 \text{ days of operation}}{365 \text{ days per year}}$$

$$\textbf{Annual ER}_{CO} = \frac{1.19E+00 \text{ g}}{\text{s}} \quad \frac{3600 \text{ s}}{\text{hr}} \quad \frac{24 \text{ hrs}}{\text{day}} \quad \frac{365 \text{ days}}{\text{year}} \quad \frac{1 \text{ kg}}{1000 \text{ g}}$$

$$\textbf{Annual ER}_{CO} = \frac{3.76E+04 \text{ kg}}{\text{year}}$$

Summary of Emissions from Open Pit Mining Equipment

Source ID	Contaminant	CAS No.	1-hr Emission Rate [g/s]	24-hr Emission Rate [g/s]	24-hr Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PIT_EQUIP	CO	630-08-0	1.49E+00	1.24E+00	1.07E+02	1.19E+00	3.76E+04
	NOx	10102-44-0	4.81E+00	4.01E+00	3.47E+02	3.85E+00	1.21E+05
	PM	N/A	2.42E-01	2.01E-01	1.74E+01	1.93E-01	6.09E+03
	PM10*	—	2.42E-01	2.01E-01	1.74E+01	1.93E-01	6.09E+03
	PM2.5*	—	2.34E-01	1.95E-01	1.69E+01	1.87E-01	5.91E+03
	SO_2	7446-09-5	7.79E-03	6.49E-03	5.61E-01	6.22E-03	1.96E+02

*Emission standards were not provided for PM10 and PM2.5; therefore, it was assumed that all PM emissions consist of PM10 and that PM2.5 emissions are 97% of PM10 emissions, per the U.S. EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d (July 2010) (EPA Report NR-009d).

Operation Phase - Propane-fired Underground Mine Heating

In order to quantify some emissions from underground mining, only sources that are specific to underground mining were quantified since the worst case emisisons occur during open pit mining. This is conservative because it assumes emissions from some of the underground mining activities occur at the same time as the open pit activities. This assumption was made to avoid having to quantify multiple production years.

A propane fired heater will be used for underground air heating during underground mine production. Emission rates were calculated using emission factors from U.S. EPA AP-42 Section 1.5 "Liquefied Petroleum Gas Combustion" (dated 7/08), based on the maximum heat input rating for the heater and assuming a sulphur content in propane of 0.18 gr/100ft3, per Footnote (e) to Table 1.5-1 of Section 1.5. The data quality rating is "E" or "Marginal". A total heat input of 8.5 MMBTU/hr was assumed based on comfort heating requirements at similar sites. It is assumed the heater will be operating 20 hours per day.

Source Parameters

Source ID	Source Description	Btu Rating [MMBtu/hr]	Operating Hours per Day	Operating Days per Year
U_PH	Propane-fired Underground Mine Heating	8.5	20	350

Emission Factors

Compound	Emission Factor [lb/10^3 gal of propane]
PM	0.7
PM10	0.7
PM2.5	0.7
SO2	0.018
NOX	13
CO	7.5

*All PM is conservatively assumed to be PM2.5

Sample Calculation for Nitrogen Oxides

Btu Rating of Heater =	8.5	MMBtu/hr
U.S. EPA AP-42 Emission Factor =	13	lb/10^3 gal
Heat Content of Propane =	91.5	MMBtu/10^3 gal (from Table 1.5-1 of AP-42 EF document)

$$1\text{-hour } ER_{NOx} = \frac{8.5\ \text{MMBtu}}{\text{hr}} \left| \frac{13\ \text{lb}}{1000\ \text{gal}} \right| \frac{453.59\ \text{g}}{\text{lb}} \left| \frac{1\ \text{hr}}{3600\ \text{s}} \right| \frac{1000\ \text{gal}}{91.5\ \text{MMBtu}}$$

$$\mathbf{1\text{-hour } ER_{NOx}} = \boxed{\frac{1.52\text{E-}01\ \text{g}}{\text{s}}}$$

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Checked by: RLP

$$\text{24-hour ER}_{NOx} = \frac{\text{1-hour ER}_{NOx}}{} \bigg| \frac{\text{20 operating hours}}{\text{24 hours in 1 day}}$$

$$\text{Annual ER}_{NOx} = \frac{\text{24-hour ER}_{NOx}}{} \bigg| \frac{\text{operating days}}{\text{number of days in 1 year}}$$

$$\text{24-hour ER}_{NOx} = \frac{\text{1.52E-01 g}}{\text{s}} \bigg| \frac{\text{20 operating hours}}{\text{24 hours in 1 day}}$$

$$\text{Annual ER}_{NOx} = \frac{\text{1.27E-01 g}}{\text{s}} \bigg| \frac{\text{350 operating days}}{\text{365 days per year}}$$

$$\textbf{24-hour ER}_{NOx} = \boxed{\frac{\textbf{1.27E-01 g}}{\textbf{s}}} \bigg| \frac{\text{1 kg}}{\text{1000 g}} \bigg| \frac{\text{3600 s}}{\text{hr}} \bigg| \frac{\text{24 hrs}}{\text{day}}$$

$$\textbf{Annual ER}_{NOx} = \boxed{\frac{\textbf{1.22E-01 g}}{\textbf{s}}} \bigg| \frac{\text{1 kg}}{\text{1000 g}} \bigg| \frac{\text{3600 s}}{\text{1 hr}} \bigg| \frac{\text{24 hrs}}{\text{1 day}} \bigg| \frac{\text{365 days}}{\text{1 year}}$$

$$\textbf{24-hour ER}_{NOx} = \boxed{\frac{\textbf{1.10E+01 kg}}{\textbf{day}}}$$

$$\textbf{Annual ER}_{NOx} = \boxed{\frac{\textbf{3.83E+03 kg}}{\textbf{year}}}$$

Emission Rates for Contaminants Emitted by Source U_PH

Compound	CAS	1-hour Emission Rate [g/s]	24-hour Emission Rate [g/s]	24-hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	N/A	8.19E-03	6.83E-03	5.90E-01	6.55E-03	2.06E+02
PM10	—	8.19E-03	6.83E-03	5.90E-01	6.55E-03	2.06E+02
PM2.5	—	8.19E-03	6.83E-03	5.90E-01	6.55E-03	2.06E+02
SO2	7446-09-5	2.11E-04	1.76E-04	1.52E-02	1.68E-04	5.31E+00
NOX	10102-44-0	1.52E-01	1.27E-01	1.10E+01	1.22E-01	3.83E+03
CO	630-08-0	8.78E-02	7.32E-02	6.32E+00	7.01E-02	2.21E+03

*All PM is conservatively assumed to be PM2.5

Operation Phase - Material Handling Dust

During the operation phase of the Project, fugitive dust emissions could occur from material handling of non-metallic mineral materials at various locations on site. Ore and waste rock from open pit and underground mining operations will be stockpiled at above-ground stockpile areas and the waste rock dump. There will also be various transfer points at the mill where ore will be transferred by loader or conveyor. Fluorspar concentrate will be conveyed to a heated storage building where on-spec and off-spec product will be loaded to separate stockpiles.

Material handling emissions were estimated using the emission factors from Section 13.2.4 "*Aggregate Handling and Storage Piles*" of the AP 42 document (revised November 2006) using the EF equation as follows:

$$EF\ (kg/Mg) = \frac{k\,(0.0016)(U/2.2)^{1.3}}{(M/2)^{1.4}}$$

where k=particle size multiplier (dimensionless)

U= mean wind speed (m/s)

M= material moisture content (%)

For the outdoor material handling sources, the annual averaged emissions would be subject to some natural mitigation due to the occurrence of snow or rain days throughout the year. Based on Canadian Climate Normals data obtained for the St. Lawrence station (normals for period 1971-2000), the average days without snow cover or rain is 120 days per year. Therefore, the calculation of annual emissions of fugitive dust from outdoor sources assumed emissions will occur on 120 days out of the year.

Material Handling Source Parameters

	Handling - Above-Ground Ore Stockpiles	**Handling - Waste Rock Dump**	**Handling - Mill**	**Handling - Mill**	**Handling - Concentrate Storage Building**	**Handling - Concentrate Storage Building**
Source ID	ORE_MH	OP_WR	ROM	FINE	ONSPEC	OFFSPEC
Source Description	Above-Ground Ore Material Handling	Waste Rock Material Handling	Run-Of-Mine Ore Transfer to Stationary Grizzly	Fine Ore Transfer from Storage Bin to Feed Conveyor for Dense Media Separator	On-spec Concentrate Stockpile Loading	Off-spec Concentrate Stockpile Loading
Operating Hours per Day	24	24	24	24	24	24
Operating Days per Year	350	350	350	350	350	350
Number of Days per Year Without Snow Cover/Rain	120	120	N/A - indoors, in mill building	N/A - indoors, in mill building	N/A - indoors, in mill building	N/A - indoors, in mill building
Throughput [tonnes/hr]	79	298	89.1	89.1	21.57	7.19
Throughput [tonnes/day]	1,900	7,142	2,138	2,138	518	173

Aerodynamic Particle Size Multiplier (k)

Particle Size	<30μm	<15μm	<10μm	<5μm	<2.5μm
Multiplier	0.74	0.48	0.35	0.20	0.05

U=	5.9	m/s	Average of the maximum hourly wind speeds from January to December from Canadian Climate Normals data for St. Lawrence, Nfld. Station, 1971-2000 Climate Normals and Averages

Reference: *US. EPA AP-42 13.2.4*

Above-Ground Ore Material Handling

Moisture Content (M) [%]	**Parameter**	**EF [kg/Mg]**	**Rating**
4	PM	1.62E-03	A
4	PM_{10}	7.65E-04	A
4	$PM_{2.5}$	1.16E-04	A

Waste Rock Material Handling

Moisture Content (M) [%]*	**Parameter**	**EF [kg/Mg]**	**Rating**
5	PM	1.18E-03	A
5	PM_{10}	5.60E-04	A
5	$PM_{2.5}$	8.48E-05	A

*Assumed based on similar sites

Run-Of-Mine Ore Transfer to Stationary Grizzly

Moisture Content (M) [%]	**Parameter**	**EF [kg/Mg]**	**Rating**
4	PM	1.62E-03	A
4	PM_{10}	7.65E-04	A
4	$PM_{2.5}$	1.16E-04	A

Fine Ore Transfer from Storage Bin to Feed Conveyor for Dense Media Separator

Moisture Content (M) [%]	**Parameter**	**EF [kg/Mg]**	**Rating**
4	PM	1.62E-03	A
4	PM_{10}	7.65E-04	A
4	$PM_{2.5}$	1.16E-04	A

On-spec Concentrate Stockpile Loading

Moisture Content (M) [%]	**Parameter**	**EF [kg/Mg]**	**Rating**
8	PM	6.13E-04	A
8	PM_{10}	2.90E-04	A
8	$PM_{2.5}$	4.39E-05	A

Off-spec Concentrate Stockpile Loading

Moisture Content (M) [%]	**Parameter**	**EF [kg/Mg]**	**Rating**
8	PM	6.13E-04	A
8	PM_{10}	2.90E-04	A
8	$PM_{2.5}$	4.39E-05	A

Sample Calculation for PM EF for Above-Ground Ore Material Handling (kg/Mg)

EF=	0.74	0.0016	$5.90^{1.3}$	$2^{1.4}$
			$2.2^{1.3}$	$4^{1.4}$

EF=	1.62E-03 kg
	Mg

Sample Calculation for PM 1-hr ER for Above-Ground Ore Material Handling (g/s)

ER =	1.62E-03 kg	79 Mg	1000 g	1 hr
	Mg	hr	kg	3600 s

ER =	3.56E-02 g
	s

Handling - Above-Ground Ore Stockpiles
Source ID: ORE_MH

Compound	EF [kg/Mg]	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	1.62E-03	3.56E-02	3.56E-02	3.07E+00	1.17E-02	3.69E+02
PM10	7.65E-04	1.68E-02	1.68E-02	1.45E+00	5.54E-03	1.75E+02
PM2.5	1.16E-04	2.55E-03	2.55E-03	2.20E-01	8.38E-04	2.64E+01

Handling - Waste Rock Dump
Source ID: OP_WR

Compound	EF [kg/Mg]	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	1.18E-03	9.78E-02	9.78E-02	8.45E+00	3.22E-02	1.02E+03
PM10	5.60E-04	4.63E-02	4.63E-02	4.00E+00	1.52E-02	4.80E+02
PM2.5	8.48E-05	7.01E-03	7.01E-03	6.05E-01	2.31E-03	7.27E+01

Handling - Mill
Source ID: ROM

Compound	EF [kg/Mg]	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	1.62E-03	4.00E-02	4.00E-02	3.46E+00	3.84E-02	1.21E+03
PM10	7.65E-04	1.89E-02	1.89E-02	1.64E+00	1.82E-02	5.73E+02
PM2.5	1.16E-04	2.87E-03	2.87E-03	2.48E-01	2.75E-03	8.67E+01

Handling - Mill
Source ID: FINE

Compound	EF [kg/Mg]	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	1.62E-03	4.00E-02	4.00E-02	3.46E+00	3.84E-02	1.21E+03
PM10	7.65E-04	1.89E-02	1.89E-02	1.64E+00	1.82E-02	5.73E+02
PM2.5	1.16E-04	2.87E-03	2.87E-03	2.48E-01	2.75E-03	8.67E+01

Handling - Concentrate Storage Building
Source ID: ONSPEC

Compound	EF [kg/Mg]	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	6.13E-04	3.67E-03	3.67E-03	3.17E-01	3.52E-03	1.11E+02
PM10	2.90E-04	1.74E-03	1.74E-03	1.50E-01	1.67E-03	5.25E+01
PM2.5	4.39E-05	2.63E-04	2.63E-04	2.27E-02	2.52E-04	7.95E+00

Handling - Concentrate Storage Building
Source ID: OFFSPEC

Compound	EF [kg/Mg]	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	6.13E-04	1.22E-03	1.22E-03	1.06E-01	1.17E-03	3.70E+01
PM10	2.90E-04	5.79E-04	5.79E-04	5.00E-02	5.55E-04	1.75E+01
PM2.5	4.39E-05	8.77E-05	8.77E-05	7.58E-03	8.41E-05	2.65E+00

Operation Phase - Individual Diesel Generator MILL_EPG

Individual diesel generators will be used for emergency power generation in the underground mine and at the mill.

Emission factors for generators <600 hp were obtained from U.S. EPA AP-42 Chapter 3.3 "*Gasoline and Diesel Industrial Engines*" Table 3.3-1, section dated 10/96. The emission factor for PM10 was taken to be the emission factor for particulate matter. The data is of "Marginal" quality.

Sulphur dioxide (SO2) emissions were estimated based on the diesel fuel consumption rate and a sulphur content of 15 mg/kg (Ultra Low Sulphur Diesel [ULSD]), based upon the Sulphur in Diesel Fuel Regulations (SOR/2002-254, dated June 2012) promulgated under CEPA (CEPA 1999). The following equation was used to determine the SO2 emission factor:

$$EF = Fuel\ Density \times Sulphur\ Content \times \frac{MM\ SO_2}{MM\ Sulphur}$$

where: EF = emission factor [g/L]
MM SO_2 = molar mass SO_2 [g/mol 64
MM Sulphur = molar mass [g/mol] 32
diesel fuel density [kg/L] = 0.843
sulphur content [mg/kg] = 15

Diesel fuel consumption was calculated using the horsepower rating of the generator and the steady-state brake specific fuel consumption (BSFC) conversion in Table A4 of the U.S. EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d (July 2010) (EPA Report NR-009d) . Table 10 of the U.S. EPA's Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling – Report No. NR-005d was used to assign an engine cycle load factor to the generator based on a representative cycle of "None". The SO2 emission rate was then calculated from the emission factor and fuel consumption.

$$BSFC\left(\frac{lb}{hp-hr}\right) = \frac{Fuel\ Consumption\left(\frac{lb}{hr}\right)}{hp}$$

Therefore,

$$Fuel\ Consumption\left(\frac{L}{hr}\right) = BSFC\left(\frac{lb}{HP-hr}\right) \times hp \times \frac{LF}{fuel\ density\left(\frac{kg}{L}\right)} \times Conversion\ Factors$$

The SO_2 emission rate is then calculated from fuel consumption as follows:

$$ER = EF \times Fuel\ Consumption \times \frac{Hours\ of\ Operation}{24\ hr} \times \frac{1\ hr}{3{,}600\ s}$$

Diesel Generators <600 hp

Source ID	Power Rating [kW]	Power Rating [hp]	Representative Cycle[1]	Load Factor Assignment[3]	Load Factor[3]	Brake-Specific Fuel Consumption [lb/hp-hr]	Operating Hours per Day	Operating Days per Year
MILL_EPG	250	335	None[2]	Avg 7-cycle	0.43	0.367	24	365

[1] NR-005d, Table 10: pg.15, Table 10. CI Load Factor Assignments by Equipment Type

[2] Load Factor of None = steady state

[3] NR-005d, Table 9: pg. 14, Table 9. Compression-Ignition Load Factors

Emission Factors Generators <600hp

Contaminant	CAS #	EF [lb/hp-hr]
CO	630-08-0	6.68E-03
NOx	10102-44-0	3.10E-02
PM	N/A	2.20E-03
PM10	—	2.20E-03
PM2.5	—	2.13E-03

All PM is assumed to be PM10. PM2.5 is assumed to be 97% of PM10, per the U.S. EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d (July 2010) (EPA Report NR-009d).

Sample Calculation for MILL_EPG

$$ER_{NOx} = 335\ \text{hp} \times \frac{3.10\text{E-}02\ \text{lb}}{\text{hp-hr}} \times \frac{453.6\ \text{g}}{\text{lb}} \times \frac{1\ \text{hr}}{3600\ \text{s}}$$

$$ER_{NOx} = \frac{1.31\text{E+}00\ \text{g}}{\text{s}}$$

CO and particulate were calculated in a similar manner. The results are tabulated in the emission summary table below.

Sample Calculation for SO_2 Emission Factor

$$EF_{SO2} = \frac{0.843\ \text{kg}}{\text{L}} \left| \frac{15\ \text{mg}}{\text{kg}} \right| \frac{64\ \text{g/mol}\ SO_2}{32\ \text{g/mol S}} \left| \frac{1\ \text{g}}{1000\ \text{mg}} \right.$$

$$EF_{SO2} = \frac{2.53\text{E-}02\ \text{g}}{\text{L}}$$

Sample Calculation for Fuel Consumption of MILL_EPG

$$\text{Fuel Consumption} = \frac{0.367\ \text{lb}}{\text{hp-hr}} \left| \frac{335\ \text{hp}}{} \right| \frac{0.43}{0.843\ \text{kg/L}} \left| \frac{1\ \text{kg}}{1000\ \text{g}} \right| \frac{454\ \text{g}}{\text{lb}}$$

$$\text{Fuel Consumption} = \frac{2.85\text{E+}01\ \text{L}}{\text{hr}}$$

Sample Calculation for SO2 from MILL_EPG

$$\text{1-hr } ER_{SO2} = \frac{2.53\text{E-}02\ \text{g}}{\text{L}} \left| \frac{2.85\text{E+}01\ \text{L}}{\text{hr}} \right| \frac{1\ \text{hr}}{3600\ \text{s}}$$

$$\text{1-hr } ER_{SO2} = \frac{2.00\text{E-}04\ \text{g}}{\text{s}}$$

Individual Diesel Generator U_EPG

This diesel generator is rated >600hp. Emission factors were obtained from U.S. EPA AP-42 Chapter 3.4 "Large Stationary Diesel And All Stationary Dual-fuel Engines", Table 3.4-1, section dated 10/96. A sulphur content of 15ppm is assumed which is the maximum allowable sulphur content in diesel as per "Sulphur in Diesel Fuel Regulations SOR/2002-254", dated June 2012, promulgated under CEPA (CEPA 1999). The data is of "A-Average" quality for NOx, PM and SO2, and "Average" quality for CO. The emission factor for oxides of sulphur was taken to be the emission factor for sulphur dioxide.

Diesel Generators >600 hp

Source ID	Power Rating [kW]	Power Rating [hp]
U_EPG	1000	1341

Emission Factors for Generators >600hp

Contaminant	CAS #	EF [lb/hp-hr]
CO	630-08-0	5.50E-03
NOx	10102-44-0	2.40E-02
PM	N/A	7.00E-04
PM10	—	7.00E-04
PM2.5	—	6.79E-04
SO_2	7446-09-5	1.21E-05

All PM is assumed to be PM10. PM2.5 is assumed to be 97% of PM10, per the U.S. EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d (July 2010) (EPA Report NR-009d).

Sample Calculation for U_EPG

$$ER_{NOx} = 1{,}341\ \text{hp} \times \frac{2.40E\text{-}02\ \text{lb}}{\text{hp-hr}} \times \frac{453.6\ \text{g}}{\text{lb}} \times \frac{1\ \text{hr}}{3600\ \text{s}}$$

$$ER_{NOx} = \frac{4.06E\text{+}00\ \text{g}}{\text{s}}$$

All other contaminants were calculated in a similar manner. The results are tabulated in the emission summary table below.

Calculation for SO_2 EF

$EF_{\text{Sulphur Dioxide}} =$ 0.00809 x S

$EF_{\text{Sulphur Dioxide}} =$ 0.00809 x 0.0015

$EF_{\text{Sulphur Dioxide}} =$ 1.21E-05 lb/hp-hr

It is assumed the generators will be tested simultaneously for 1-hr once per week. Planned operating days will be 350 days per year (50 weeks).

Scaling Table	
Hours per Day	1
Days per Year	50

Summary of Emissions from Emergency Diesel Generators

Source ID	Contaminant	CAS No.	1-hr Emission Rate [g/s]	24-hr Emission Rate [g/s]	24-hr Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
U_EPG	CO	630-08-0	9.29E-01	3.87E-02	3.35E+00	5.30E-03	1.67E+02
	NOx	10102-44-0	4.06E+00	1.69E-01	1.46E+01	2.31E-02	7.30E+02
	PM	N/A	1.18E-01	4.93E-03	4.26E-01	6.75E-04	2.13E+01
	PM10*	—	1.18E-01	4.93E-03	4.26E-01	6.75E-04	2.13E+01
	PM2.5*	—	1.15E-01	4.78E-03	4.13E-01	6.55E-04	2.07E+01
	SO_2	7446-09-5	2.05E-03	8.54E-05	7.38E-03	1.17E-05	3.69E-01
MILL_EPG	CO	630-08-0	2.82E-01	1.18E-02	1.02E+00	1.61E-03	5.08E+01
	NOx	10102-44-0	1.31E+00	5.46E-02	4.71E+00	7.47E-03	2.36E+02
	PM	N/A	9.29E-02	3.87E-03	3.35E-01	5.30E-04	1.67E+01
	PM10*	—	9.29E-02	3.87E-03	3.35E-01	5.30E-04	1.67E+01
	PM2.5*	—	9.01E-02	3.76E-03	3.25E-01	5.15E-04	1.62E+01
	SO_2	7446-09-5	2.00E-04	8.34E-06	7.21E-04	1.14E-06	3.60E-02

*All PM is assumed to be PM10. PM2.5 is assumed to be 97% of PM10, per the U.S. EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d (July 2010) (EPA Report NR-009d).

Operation Phase - Crushing Circuit Dust Collector

A baghouse dust collection system will serve the crushing circuit and collect dust from: the primary, secondary and tertiary crushers; screening; transfer points; and fine ore bin loading. The emission factor for PM was obtained from the Air and Waste Management Association's "Air Pollution Engineering Manual, 2nd ed.", Chapter 3: Control of Particulate Matter, section on fabric filters (baghouses). It is a conservative factor of "Above Average" quality. It was assumed that PM10 is 50% of PM and PM2.5 is 50% of PM10. The entire crushing circuit will operate up to 24 hours per day, 350 days per year.

Sample Calculation

Exhaust Flow Rate = 24000 m^3/hr

PM Emission Factor = 23 mg/m^3

$$ER_{PM} = 24000\ \frac{m^3}{hr} \times 23\ \frac{mg}{m^3} \times \frac{1\ hr}{60\ min} \times \frac{1\ g}{1000\ mg} \times \frac{1\ min}{60\ s}$$

$$ER_{PM} = 1.53E\text{-}01\ \frac{g}{s}$$

Daily operating hours	24
Annual operating days	350

1-hour Emission Rates

Contaminant	CAS #	EF	EF Units	ER [g/s]
PM	N/A	23	mg/m^3	1.53E-01
PM10	—	50%	% of PM	7.67E-02
PM2.5	—	50%	% of PM10	3.83E-02

Sample Calculation for 24-hour and Annual ERs

$$\text{24-hr ER} = \frac{1.53E\text{-}01\ g}{s} \cdot \frac{24\ \text{operating hours}}{24\ \text{hrs in 1 day}}$$

$$\textbf{24-hr ER} = \boxed{\frac{1.53E\text{-}01\ g}{s}} \cdot \frac{1\ kg}{1000\ g} \cdot \frac{3600\ s}{1\ hr} \cdot \frac{24\ hrs}{1\ day}$$

$$\textbf{24-hr ER} = \boxed{\frac{1.32E\text{+}01\ kg}{day}}$$

Annual ER = 24-hr ER × (operating days/number of days in 1 year)

$$\text{Annual ER} = \frac{1.53\text{E-}01 \text{ g}}{\text{s}} \;\Big|\; \frac{350 \text{ operating days}}{365 \text{ days in 1 year}}$$

$$\textbf{Annual ER} = \boxed{\frac{\mathbf{1.47E\text{-}01\ g}}{\mathbf{s}}} \;\Big|\; \frac{1 \text{ kg}}{1000 \text{ g}} \;\Big|\; \frac{3600 \text{ s}}{1 \text{ hr}} \;\Big|\; \frac{24 \text{ hrs}}{1 \text{ day}} \;\Big|\; \frac{365 \text{ days}}{1 \text{ year}}$$

$$\textbf{Annual ER} = \boxed{\frac{\mathbf{4.64E{+}03\ kg}}{\mathbf{year}}}$$

Summary of Emissions from DC - Crushing Circuit Dust Collector

Compound	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	1.53E-01	1.53E-01	1.32E+01	1.47E-01	4.64E+03
PM10	7.67E-02	7.67E-02	6.62E+00	7.35E-02	2.32E+03
PM2.5	3.83E-02	3.83E-02	3.31E+00	3.68E-02	1.16E+03

Operation Phase - Sink Product Sulphide Flotation

After ore is crushed in the crushing circuit the material will be screened and washed, with undersize particles feeding to a dense media separator. Hydrocyclones will de-slime and further separate materials by particle size, with oversize particles undergoing further grinding in a ball mill. Ball mill hydrocyclones will separate the re-ground products, with undersize material proceeding to the sulphides/slimes flotation circuit to remove sulphides from the ore prior to fluorspar concentrating. Material will flow through a series of flotation cells, with a 10% potassium amyl xanthate solution as the flotation collector. Tailings pulp from this sulphides/slimes flotation circuit will be pumped to a thickening tank to increase the slurry density prior to the conditioning circuit, where fluorspar will

Potassium amyl xanthate decomposes to Carbon Disulphide and Pentanol in air at ambient temperatures. The following method was taken from the Australian National Pollutant Inventory "Emission Estimation Technique Manual for Nickel Concentrating, Smelting and Refining" dated June 1999.

Source ID	SULPH					
Name	Sink Product Sulphide Flotation					
Building	Mill					
Operating Hours per Day	24					
Operating Days per Year	350					

Contaminant	CAS Number	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
Carbon Disulphide	75-15-0	4.99E-02	4.99E-02	4.31E+00	4.79E-02	1.51E+03
Pentanol	71-41-0	5.79E-02	5.79E-02	5.00E+00	5.55E-02	1.75E+03

PAX solution usage rate =	50	g/tonne of flotation feed
Total flotation slurry feed rate =	150.78	m3/hr
Slurry density =	1270	kg/m3

$$\text{Mass feed rate of slurry to flotation} = \frac{150.78\ \text{m}^3}{\text{hr}} \Big| \frac{1270\ \text{kg}}{\text{m}^3} \Big| \frac{1\ \text{tonne}}{1000\ \text{kg}}$$

$$\text{Mass feed rate of slurry to flotation} = \frac{191.49\ \text{tonnes}}{\text{hr}}$$

$$\text{PAX solution usage rate} = \frac{191.49\ \text{tonnes}}{\text{hr}} \Big| \frac{50\ \text{g PAX solution}}{\text{tonne}}$$

$$\text{PAX solution usage rate} = \frac{9{,}575\ \text{g}}{\text{hr}}$$

PAX solution usage rate =	9574.5 g/hr	
PAX usage rate =	957.5 g/hr	Solution is 10% PAX
Molecular Weight of Potassium Amyl Xanthate (MW_{PAX}):	202.4 g/mol	
Molecular Weight of Carbon Disulphide (MW_{CS2}):	76 g/mol	
Molecular Weight of Pentanol:	88.2 g/mol	
Amount of CS_2 produced per mole of PAX:	0.5 mol (alkali conditions)	
Amount of Pentanol produced per mole of PAX:	0.5 mol (alkali conditions)	

1-hr averaged emission rates

$$ER_{\text{Carbon Disulphide}} = 0.5 \quad \times \quad \text{PAX Usage Rate} \quad \times \frac{MW_{CS2}}{MW_{PAX}}$$

$$ER_{\text{Carbon Disulphide}} = 0.5 \quad \times \quad \frac{957.5\ \text{g}}{\text{hr}} \quad \times \quad \frac{76\ \text{g/mol}}{202\ \text{g/mol}} \times \frac{1\ \text{hr}}{60\ \text{min}} \times \frac{1\ \text{min}}{60\ \text{s}}$$

$$\mathbf{ER_{\text{Carbon Disulphide}} = 4.99\text{E-}02\ g/s}$$

$$ER_{\text{Pentanol}} = 0.5 \quad \times \quad \frac{957.5\ \text{g}}{\text{hr}} \quad \times \quad \frac{88.2\ \text{g/mol}}{202\ \text{g/mol}} \times \frac{1\ \text{hr}}{60\ \text{min}} \times \frac{1\ \text{min}}{60\ \text{s}}$$

$$\mathbf{ER_{\text{Pentanol}} = 5.79\text{E-}02\ g/s}$$

For alkali conditions (the PAX solution is maintained at a pH between 8 and 9)

24-hr averaged emission rates

$$\text{24-hr } ER_{\text{Carbon Disulphide}} = \frac{4.99\text{E-}02\ \text{g}}{\text{s}} \Big| \frac{24\ \text{operating hours}}{24\ \text{hours in 1 day}}$$

$$\textbf{24-hr } \mathbf{ER_{\text{Carbon Disulphide}}} = \boxed{\frac{4.99\text{E-}02\ \text{g}}{\text{s}}} \ \frac{1\ \text{kg}}{1000\ \text{g}} \Big| \frac{3600\ \text{s}}{1\ \text{hr}} \Big| \frac{24\ \text{hrs}}{1\ \text{day}}$$

$$\textbf{24-hr } \mathbf{ER_{CO}} = \boxed{\frac{4.31\text{E+}00\ \text{kg}}{\text{day}}}$$

Annual averaged emission rates

$$\text{Annual } ER_{\text{Carbon Disulphide}} = \text{24-hr } ER_{\text{Carbon Disulphide}} \times \frac{\text{operating days}}{\text{number days in 1 year}}$$

$$\text{Annual } ER_{\text{Carbon Disulphide}} = \frac{4.99\text{E-}02\ \text{g}}{\text{s}} \Big| \frac{350\ \text{operating days}}{365\ \text{days per year}}$$

$$\textbf{Annual } \mathbf{ER_{\text{Carbon Disulphide}}} = \boxed{\frac{4.79\text{E-}02\ \text{g}}{\text{s}}} \ \frac{1\ \text{kg}}{1000\ \text{g}} \Big| \frac{3600\ \text{s}}{1\ \text{hr}} \Big| \frac{24\ \text{hrs}}{1\ \text{day}} \Big| \frac{365\ \text{days}}{1\ \text{year}}$$

$$\textbf{Annual } \mathbf{ER_{\text{Carbon Disulphide}}} = \boxed{\frac{1.51\text{E+}03\ \text{kg}}{\text{year}}}$$

Operation Phase - Tailings Pond

Flotation tailings generated at the mill will be discharged into a Tailings Management Facility (TMF) centered on Shoal Cove Pond, where tailings were disposed of historically. Material will be conveyed as a slurry by pipeline. The pond liquor may contain residual potassium amyl xanthate from the flotation processes, which decomposes to Carbon Disulphide and Pentanol in air at ambient temperatures. Per the Australian National Pollutant Inventory "Emission Estimation Technique Manual for Mining" dated January 2012, approximately 1% of the xanthates will be discharged to the tailings.

Therefore, emissions of Carbon Disulphide and Pentanol from xanthate decomposition in the tailings pond were estimated as 1% of the rates of emission from the flotation process, under the assumption from Australian NPI that the discharge flowrate of xanthates to tailings will be 1% of the xanthate usage rate in flotation.

Source ID	TAILS					
Name	Tailings Pond					
General Location	Tailings Management Facility					
Contaminant	**CAS Number**	**1- hour Emission Rate [g/s]**	**24- hour Emission Rate [g/s]**	**24- hour Emission Rate [kg/day]**	**Annual Emission Rate [g/s]**	**Annual Emission Rate [kg/year]**
Carbon Disulphide	75-15-0	4.99E-04	4.99E-04	4.31E-02	4.79E-04	1.51E+01
Pentanol	71-41-0	5.79E-04	5.79E-04	5.00E-02	5.55E-04	1.75E+01

1-hr averaged emission rates

$1\text{-hr ER}_{\text{Carbon Disulphide}} = $ 1-hr ER from flotation process x 1%

$$1\text{-hr ER}_{\text{Carbon Disulphide}} = \frac{4.99\text{E-}02 \text{ g}}{\text{s}} \times 0.01$$

$$1\text{-hr ER}_{\text{Carbon Disulphide}} = \frac{4.99\text{E-}04 \text{ g}}{\text{s}}$$

Made By: BSC
Checked By: RLP

Operation Phase - Fluorspar Concentrate or Aggregate from DMS Float Process Haul Truck Loading

Fluorspar will be concentrated using a froth flotation process. The concentrate will undergo thickening and filtration to remove water, producing a solid cake which will be conveyed to a heated building where on-spec and off-spec concentrate will be stored in stockpiles prior to transport off-site. The building will be capable of storing approximately 15,000 tonnes of on-spec concentrate and 5,000 tonnes of off-spec concentrate. Concentrate will be loaded from the stockpiles onto haul trucks for transport to the marine terminal, where the product will be shipped to market. Trucks will be loaded with concentrate for only 20 days per year. Aggregate generated from the DMS float process will also be loaded into haul trucks for transport to the marine terminal. Trucks will be loaded with aggregate for another 20 days per year.

Emissions from material loading onto haul trucks were estimated using the emission factors from Section 13.2.4 "*Aggregate Handling and Storage Piles*" of the AP 42 document (revised November 2006) using the EF equation as follows:

Source Parameters

Source ID	TL
Source Description	Haul Truck Loading for Transport to Marine Terminal
Operating Hours per Day	20
Total Operating Days per Year	40
Throughput [tonnes/hr]	500
Throughput [tonnes/day]	10,000

Emission Factor

$$EF\ (kg/Mg) = \frac{k\,(0.0016)(U/2.2)^{1.3}}{(M/2)^{1.4}}$$

where k=particle size multiplier (dimensionless)

U= mean wind speed (m/s)

M= material moisture content (%)

Aerodynamic Particle Size Multiplier (k)

Particle Size	<30µm	<15µm	<10µm	<5µm	<2.5µm
Multiplier	0.74	0.48	0.35	0.20	0.05

U= 5.9 m/s — Average of the maximum hourly wind speeds from January to December from Canadian Climate Normals data for St. Lawrence, Nfld. Station, 1971-2000 Climate Normals and Averages

Haul Truck Loading for Transport to Marine Terminal

Moisture Content (M) [%]	Parameter	EF [kg/Mg]	Rating
8	PM	6.13E-04	A
8	PM_{10}	2.90E-04	A
8	$PM_{2.5}$	4.39E-05	A

Made by: BSC
Checked by: NCH

Sample Calculation for PM EF for Haul Truck Loading for Transport to Marine Terminal (kg/Mg)

EF=	0.74	0.0016	$5.90^{1.3}$	$2^{1.4}$
			$2.2^{1.3}$	$8^{1.4}$

EF=	6.13E-04 kg
	Mg

Sample Calculation for PM 1-hr ER for Haul Truck Loading for Transport to Marine Terminal (g/s)

ER =	6.13E-04 kg	500 Mg	1000 g	1 hr
	Mg	hr	kg	3600 s

ER =	8.51E-02 g
	s

Summary of Emissions from TL - Haul Truck Loading for Transport to Marine Terminal

Compound	EF [kg/Mg]	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	6.13E-04	8.51E-02	8.51E-02	6.13E+00	9.33E-03	2.94E+02
PM10	2.90E-04	4.03E-02	4.03E-02	2.90E+00	4.41E-03	1.39E+02
PM2.5	4.39E-05	6.10E-03	6.10E-03	4.39E-01	6.68E-04	2.11E+01

Operation Phase - Fugitive Dust Emissions from Roadways

During the operation phase of the Project, fugitive dust emissions will occur from haulage on on-site unpaved roadways as ore is hauled out of the pits to the mill, as waste rock and overburden is hauled from the mines to the dumps, and as fluorspar concentrate and aggregate from DMS flotation is hauled from the mill site to the marine terminal. The emissions are affected by the parameters indicated in the table below. The lengths of the haul routes were estimated based on the site layout. The number of truck trips per day along each route was estimated based on ore production rate or product transport rate, and the carrying capacities of the trucks.

Annual averaged emissions would be subject to some natural mitigation due to the occurrence of snow or rain days throughout the year. Based on Canadian Climate Normals data obtained for the St. Lawrence station (normals for period 1971-2000), the average days without snow cover or rain is 120 days per year. Therefore, the calculation of annual emissions of fugitive dust from UPR1, UPR2 and UPR3 assumed emissions will occur on 120 days out of the year.

Natural mitigation was not accounted for in emissions from UPR4 since activity on this roadway occurs infrequently throughout the year (concentrate will be transported for only 20 days per year. Aggregate will be transported for another 20 days per year). It was therefore conservatively assumed that there would be no snow cover or precipitation during any of the 40 days total that concentrate and aggregate are hauled on UPR4.

Source ID	Source Description	Silt Content [%]**	Daily Tonnage [tonnes/day]	Empty Industrial Vehicle Weight [tonnes]	Capacity of One Truck [tonnes/truck]	Full Industrial Vehicle Weight [tonnes]	Daily Full Haul Trucks [Passes/24 hrs]	Daily Empty Haul Trucks [Passes/24 hrs]	Prorated Mean Vehicle Weight [tons]	Length [km]
UPR1	Road - GNP In-Pit	8.30	1900	15	37.8	52.8	50	50	37.37	1.25
UPR2	GNP Haul Road to North Dump	8.30	7142	15	57.5	72.5	124	124	48.23	1.18
UPR3	Surface Haul Road - GNP Pit Exit to Mill	8.30	1900	15	49.3	64.3	39	39	43.71	2.42
UPR4	Haul Road from Mill Site to Marine Termina	8.30	10000	15	50.0	65.0	200	200	44.09	5.45

[**] U.S. EPA AP-42 Table 13.2.2-1 for stone quarrying and processing haul road

Emissions from Road Dust

The predictive equation in U.S. EPA AP-42 Chapter 13.2.2 *"Unpaved Roads"* (November 2006) was used to calculate the fugitive dust emissions from the unpaved roadways. CFI will implement regular and adequate maintenance of unpaved roads and apply water or other dust suppressants as needed to reduce dust emissions; therefore a control factor was applied to the site roads. Table 4 of the Australian National Pollutant Inventory document "Emission Estimation Technique for Mining", Version 3.1 dated January 2012, states that watering more than 2 L/m² can achieve a 75% emissions reduction. The equation is as follows:

Industrial site equation:

$$\text{unpaved } EF = k\,(s/12)^{a}(W/3)^{b}$$

Where:

EF = Emission factor: grams particulate emitted per vehicle kilometre travelled [lb/VMT]
a, b, k = empirical constants
s = Surface material silt content [%]
W = Average vehicle weight [tons]

Parameter	k	a	b	Reference	Rating
PM	4.9	0.7	0.45	AP-42 / 13.2.2 - Table 13.2.2-2	B
PM_{10}	1.5	0.9	0.45	AP-42 / 13.2.2 - Table 13.2.2-2	B
$PM_{2.5}$	0.15	0.9	0.45	AP-42 / 13.2.2 - Table 13.2.2-2	B

Sample Calculation for UPR1

The following parameters were used to calculate emission rates of PM (suspended particulate matter):

k = 4.9 (Table 13.2.2-2)
a = 0.7 (Table 13.2.2-2)
b = 0.45 (Table 13.2.2-2)
s = 8.3 (from U.S. EPA AP-42 Table 13.2.2-1 for stone quarrying and processing haul road)
W = 37.37 tons

Emission Factor for PM

$$EF = \frac{4.9 \text{ lb}}{\text{VMT}} \;\Bigg|\; \frac{8.3^{0.7}}{12^{0.7}} \;\Bigg|\; \frac{37.37^{0.45}}{3^{0.45}}$$

$$EF = 1.18E{+}01 \ \frac{\text{lb}}{\text{VMT}}$$

UPR1 **Road - GNP In-Pit**

	Fugitive Dust from Vehicle Traffic			Controlled Emission Rate [g/s]	
Compound	EF	EF Unit	Uncontrolled Emission Rate for Entire Segment [g/s]	Control [%]	Controlled Emission Rate for Entire Segment [g/s]
PM	1.18E+01	[lb/VMT]	4.83E+00	75	1.21E+00
PM10	3.35E+00	[lb/VMT]	1.37E+00	75	3.43E-01
PM2.5	3.35E-01	[lb/VMT]	1.37E-01	75	3.43E-02

UPR2 **GNP Haul Road to North Dump**

	Fugitive Dust from Vehicle Traffic			Controlled Emission Rate	
Compound	EF	EF Unit	Uncontrolled Emission Rate for Entire Segment [g/s]	Control [%]	Controlled Emission Rate for Entire Segment [g/s]
PM	1.32E+01	[lb/VMT]	1.26E+01	75	3.15E+00
PM10	3.76E+00	[lb/VMT]	3.59E+00	75	8.97E-01
PM2.5	3.76E-01	[lb/VMT]	3.59E-01	75	8.97E-02

UPR3 **Surface Haul Road - GNP Pit Exit to Mill**

	Fugitive Dust from Vehicle Traffic			Controlled Emission Rate	
Compound	EF	EF Unit	Uncontrolled Emission Rate for Entire Segment [g/s]	Control [%]	Controlled Emission Rate for Entire Segment [g/s]
PM	1.26E+01	[lb/VMT]	7.69E+00	75	1.92E+00
PM10	3.59E+00	[lb/VMT]	2.19E+00	75	5.47E-01
PM2.5	3.59E-01	[lb/VMT]	2.19E-01	75	5.47E-02

UPR4 **Haul Road from Mill Site to Marine Terminal**

	Fugitive Dust from Vehicle Traffic			Controlled Emission Rate	
Compound	EF	EF Unit	Uncontrolled Emission Rate for Entire Segment [g/s]	Control [%]	Controlled Emission Rate for Entire Segment [g/s]
PM	1.27E+01	[lb/VMT]	9.02E+01	75	2.26E+01
PM10	3.61E+00	[lb/VMT]	2.57E+01	75	6.42E+00
PM2.5	3.61E-01	[lb/VMT]	2.57E+00	75	6.42E-01

Controls are implemented are various roadway segments. The controlled emission rate calculation is shown below:

Controlled Emission Rate

Total length of road = 1.250 km

ER$_{PM}$ =	1.18E+01 lb	101 veh	1.25 km	1 hr	281.9 g/VKT	100 - 75
	VMT	24 hr	trip	3600 s	lb/VMT	100
ER$_{PM}$ =	1.21E+00 g					
	s					

The truck haulage schedule for in-pit activity is assumed to be the same as the mining equipment operating schedule (20 hours/day). Emissions are assumed to occur on days without snow cover or rain (on average 120 days per year).

Fluorspar concentrate or aggregate will only be hauled to the marine terminal for a total of 40 days out of the year. On those days, transport will occur for 20 hours/day. It was conservatively assumed there would be no snow cover or precipitation on any of the 40 days, and hence no natural mitigation of emissions.

Sample Calculation for UPR1

24-hr ER =	1.21E+00 g	20 operating hours		
	s	24 hrs in 1 day		
24-hr ER =	**1.01E+00 g**	1 kg	3600 s	24 hours
	s	1000 g	1 hr	1 day
24-hr ER =	**8.69E+01 kg**			
	day			

Annual ER = 24-hr ER × (days without snow cover or rain/number of days in 1 year)

Annual ER =	1.01E+00 g	120 days without snow cover/rain			
	s	365 days in 1 year			
Annual ER =	**3.31E-01 g**	1 kg	3600 s	24 hours	365 days
	s	1000 g	1 hr	1 day	1 year
Annual ER =	**1.04E+04 kg**				
	year				

Emission Rates for Contaminants Emitted by UPR1 - Road - GNP In-Pit

Compound	CAS	Operating Hours per Day	Number of Days per Year Without Snow Cover/Rain	1-hour Emission Rate [g/s]	24-hour Emission Rate [g/s]	24-hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	N/A	20	120	1.21E+00	1.01E+00	8.69E+01	3.31E-01	1.04E+04
PM10	—	20	120	3.43E-01	2.86E-01	2.47E+01	9.41E-02	2.97E+03
PM2.5	—	20	120	3.43E-02	2.86E-02	2.47E+00	9.41E-03	2.97E+02

Emission Rates for Contaminants Emitted by UPR2 - GNP Haul Road to North Dump

Compound	CAS	Operating Hours per Day	Number of Days per Year Without Snow Cover/Rain	1-hour Emission Rate [g/s]	24-hour Emission Rate [g/s]	24-hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	N/A	20	120	3.15E+00	2.63E+00	2.27E+02	8.65E-01	2.73E+04
PM10	—	20	120	8.97E-01	7.47E-01	6.46E+01	2.46E-01	7.75E+03
PM2.5	—	20	120	8.97E-02	7.47E-02	6.46E+00	2.46E-02	7.75E+02

Emission Rates for Contaminants Emitted by UPR3 - Surface Haul Road - GNP Pit Exit to Mill

Compound	CAS	Operating Hours per Day	Number of Days per Year Without Snow Cover/Rain	1-hour Emission Rate [g/s]	24-hour Emission Rate [g/s]	24-hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	N/A	20	120	1.92E+00	1.60E+00	1.38E+02	5.27E-01	1.66E+04
PM10	—	20	120	5.47E-01	4.56E-01	3.94E+01	1.50E-01	4.73E+03
PM2.5	—	20	120	5.47E-02	4.56E-02	3.94E+00	1.50E-02	4.73E+02

Emission Rates for Contaminants Emitted by UPR4 - Haul Road from Mill Site to Marine Terminal

Compound	CAS	Operating Hours per Day	Operating Days per Year	1-hour Emission Rate [g/s]	24-hour Emission Rate [g/s]	24-hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	N/A	20	40	2.26E+01	1.88E+01	1.62E+03	2.06E+00	6.50E+04
PM10	—	20	40	6.42E+00	5.35E+00	4.62E+02	5.86E-01	1.85E+04
PM2.5	—	20	40	6.42E-01	5.35E-01	4.62E+01	5.86E-02	1.85E+03

Operation Phase - Loading at Marine Terminal

At the marine terminal, fluorspar concentrate or aggregate from the DMS float process will be delivered from the storage facilities at the Mill Site to the feeder system via direct dumping from trucks. Loading of marine transport ships will be through a covered conveyor, at the maximum loading rate indicated below. A feeder will feed the mobile ship loader continuously without the need for an intermediate storage area. Concentrate will be loaded for 20 days per year and aaggregate will be loaded for another 20 days per year.

Natural mitigation was not accounted for in emissions from loading at the marine terminal since activity occurs infrequently throughout the year.

Emissions from concentrate dumping from the haul trucks into the ship feeder system were estimated using the emission factors from Section 13.2.4 "*Aggregate Handling and Storage Piles*" of the AP 42 document (revised November 2006) using the EF equation as follows:

Source Parameters

Source ID	MAR_TD
Source Description	Transfer from Trucks into Ship Feeder
Operating Hours per Day	20
Operating Days per Year	40
Throughput [tonnes/hr]	500
Throughput [tonnes/day]	10,000

Emission Factor

EF (kg/Mg)= $\frac{k\,(0.0016)(U/2.2)^{1.3}}{(M/2)^{1.4}}$

where k=particle size multiplier (dimensionless)

U= mean wind speed (m/s)

M= material moisture content (%)

Aerodynamic Particle Size Multiplier (k)

Particle Size	<30μm	<15μm	<10μm	<5μm	<2.5μm
Multiplier	0.74	0.48	0.35	0.20	0.05

U=	5.9	m/s	Average of the maximum hourly wind speeds from January to December from Canadian Climate Normals data for St. Lawrence, Nfld. Station, 1971-2000 Climate Normals and Averages

Truck Dumping into Feeder System

Moisture Content (M) [%]	Parameter	EF [kg/Mg]	Rating
8	PM	6.13E-04	A
8	PM_{10}	2.90E-04	A
8	$PM_{2.5}$	4.39E-05	A

Sample Calculation for PM EF for Truck Dumping into Feeder System (kg/Mg)

$$EF= \frac{0.74}{} \left| \frac{0.0016}{} \right| \frac{5.90^{1.3}}{2.2^{1.3}} \left| \frac{2^{1.4}}{8^{1.4}} \right.$$

$$EF= \frac{6.13E\text{-}04 \text{ kg}}{\text{Mg}}$$

Sample Calculation for PM 1-hr ER for Truck Dumping into Feeder System (g/s)

$$ER = \frac{6.13E\text{-}04 \text{ kg}}{\text{Mg}} \left| \frac{500 \text{ Mg}}{\text{hr}} \right| \frac{1000 \text{ g}}{\text{kg}} \left| \frac{1 \text{ hr}}{3600 \text{ s}} \right.$$

$$ER = \frac{8.51E\text{-}02 \text{ g}}{\text{s}}$$

Summary of Emissions from MAR_TD - Transfer from Trucks into Ship Feeder

Compound	EF [kg/Mg]	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate [kg/year]
PM	6.13E-04	8.51E-02	8.51E-02	6.13E+00	9.33E-03	2.94E+02
PM10	2.90E-04	4.03E-02	4.03E-02	2.90E+00	4.41E-03	1.39E+02
PM2.5	4.39E-05	6.10E-03	6.10E-03	4.39E-01	6.68E-04	2.11E+01

Ships will be loaded via a covered conveyor from the feeder system at the maximum rate shown below. Emission factors for conveyor transfer were obtained from the U.S. EPA AP-42 Section 11.19.2 "*Crushed Stone Processing and Pulverized Mineral Processing*" Table 11.9.2-1, section dated 08/04. The data quality rating for the emission factor is E or 'Marginal'. The controlled emission factor was applied since the conveyor will be covered.

Source Parameters

Source ID	MAR_CONV
Source Description	Loading onto Ship via Covered Conveyor
Operating Hours per Day	20
Operating Days per Year	40
Throughput [tonnes/hr]	500
Throughput [tonnes/day]	10,000

Sample Calculation for Source MAR_CONV:

$$\text{Emission Rate}_{PM} = \frac{500 \quad \text{tonnes}}{\text{hr}} \left| \frac{7.00\text{E-}05 \quad \text{kg}}{\text{Mg}} \right| \frac{1{,}000 \quad \text{g}}{\text{kg}} \left| \frac{1 \quad \text{hr}}{3600 \quad \text{s}} \right.$$

$$\textbf{Emission Rate}_{PM} = \frac{\mathbf{9.72E\text{-}03} \quad \mathbf{g}}{\mathbf{s}}$$

Summary of Emissions from MAR_CONV - Loading onto Ship via Covered Conveyor

Compound	EF [kg/Mg]	1- hour Emission Rate [g/s]	24- hour Emission Rate [g/s]	24- hour Emission Rate [kg/day]	Annual Emission Rate [g/s]	Annual Emission Rate
PM	7.00E-05	9.72E-03	9.72E-03	7.00E-01	1.07E-03	3.36E+01
PM10*	50% of PM	4.86E-03	4.05E-03	3.50E-01	5.33E-04	1.68E+01
PM2.5*	50% of PM10	2.43E-03	2.03E-03	1.75E-01	2.66E-04	8.40E+00

*It was assumed that PM10 is 50% of PM and PM2.5 is 50% of PM10.

Operation Phase - Marine Vessel Emissions

Emissions from marine vessels (ships) were estimated for an operating scenario where a ship is docked at the port with auxiliary engines running for the duration of the time that the ship spends docked. Estimates of auxiliary engine number and size, docking time and number of trips were provided by CFI. Emission factors for Marine Gas Oil (MGO) combustion in ship auxiliary engines were obtained from the British Columbia Chamber of Shipping document entitled "2005-2006 BC Ocean-Going Vessel Emissions Inventory" (dated January 25, 2007), Table 18. For conservatism emission factors for the "medium" engine type have been assumed in this assessment.

Source Summary

Source ID	Source Description	Power Rating [kW]	Time Ship Spends Docked Per Trip [hours]	Ship Trips Per Year
SHIP_1	Auxiliary Engine 1	800	24	40
SHIP_2	Auxiliary Engine 2	800		
SHIP_3	Auxiliary Engine 3	800		

Emission Factors Ship Auxiliary Engines
(Marine Gas Oil; Medium)

Compound	CAS #	EF [g/kW-hr]
CO	630-08-0	1.10
NOx	10102-44-0	13.90
PM	N/A	0.27
PM10	—	0.27
PM2.5	—	0.24
SO2	7446-09-5	4.20

All PM is assumed to be PM10. SO2 emission factor conservatively assumes that all SO_X is SO_2 and also that sulphur content in MGO is 1%.

Sample Calculation for SHIP_1

$$\text{1-hour } ER_{NOx} = 800\ \text{kW} \times \frac{13.90\ \text{g}}{\text{kW-hr}} \times \frac{1\ \text{hr}}{3600\ \text{s}}$$

$$\textbf{1-hour } ER_{NOx} = \boxed{3.09E+00\ \frac{\text{g}}{\text{s}}}$$

$$\text{24-hour } ER_{NOx} = \text{1-hour } ER_{NOx} \times \frac{\text{operating hours}}{\text{24 hours in 1 day}}$$

$$\text{24-hour } ER_{NOx} = 3.09E+00\ \frac{\text{g}}{\text{s}} \times \frac{24\ \text{operating hours}}{24\ \text{hours in 1 day}}$$

$$\textbf{24-hour } ER_{NOx} = \boxed{3.09E+00\ \frac{\text{g}}{\text{s}}} \times \frac{1\ \text{kg}}{1000\ \text{g}} \times \frac{3600\ \text{s}}{\text{hr}} \times \frac{24\ \text{hrs}}{\text{day}}$$

$$\textbf{24-hour } ER_{NOx} = \boxed{2.67E+02\ \frac{\text{kg}}{\text{day}}}$$

$$\text{Annual } ER_{NOx} = \text{1-hour } ER_{NOx} \times \text{operating hours in one year}$$

$$\text{Annual } ER_{NOx} = 3.09E+00\ \frac{\text{g}}{\text{s}} \times \frac{24\ \text{hours}}{\text{trip}} \times \frac{40\ \text{trip}}{\text{year}} \times \frac{1\ \text{year}}{8760\ \text{hours}}$$

$$\textbf{Annual } ER_{NOx} = \boxed{3.39E-01\ \frac{\text{g}}{\text{s}}} \times \frac{1\ \text{kg}}{1000\ \text{g}} \times \frac{3600\ \text{s}}{1\ \text{hr}} \times \frac{24\ \text{hrs}}{1\ \text{day}} \times \frac{365\ \text{days}}{1\ \text{year}}$$

$$\textbf{Annual } ER_{NOx} = \boxed{1.07E+04\ \frac{\text{kg}}{\text{year}}}$$

Source ID	Compound	CAS No.	1 - hr	24 - hr		Annual	
			ER [g/s]	ER [g/s]	ER [kg/day]	ER [g/s]	ER [kg/year]
SHIP_1	CO	630-08-0	2.44E-01	2.44E-01	2.11E+01	2.68E-02	8.45E+02
	NOx	10102-44-0	3.09E+00	3.09E+00	2.67E+02	3.39E-01	1.07E+04
	PM	N/A	6.00E-02	6.00E-02	5.18E+00	6.58E-03	2.07E+02
	DPM	—	6.00E-02	6.00E-02	5.18E+00	6.58E-03	2.07E+02
	PM10	—	6.00E-02	6.00E-02	5.18E+00	6.58E-03	2.07E+02
	PM2.5	—	5.33E-02	5.33E-02	4.61E+00	5.84E-03	1.84E+02
	SO2	7446-09-5	9.33E-01	9.33E-01	8.06E+01	1.02E-01	3.23E+03
SHIP_2	CO	630-08-0	2.44E-01	2.44E-01	2.11E+01	2.68E-02	8.45E+02
	NOx	10102-44-0	3.09E+00	3.09E+00	2.67E+02	3.39E-01	1.07E+04
	PM	N/A	6.00E-02	6.00E-02	5.18E+00	6.58E-03	2.07E+02
	DPM	—	6.00E-02	6.00E-02	5.18E+00	6.58E-03	2.07E+02
	PM10	—	6.00E-02	6.00E-02	5.18E+00	6.58E-03	2.07E+02
	PM2.5	—	5.33E-02	5.33E-02	4.61E+00	5.84E-03	1.84E+02
	SO2	7446-09-5	9.33E-01	9.33E-01	8.06E+01	1.02E-01	3.23E+03
SHIP_3	CO	630-08-0	2.44E-01	2.44E-01	2.11E+01	2.68E-02	8.45E+02
	NOx	10102-44-0	3.09E+00	3.09E+00	2.67E+02	3.39E-01	1.07E+04
	PM	N/A	6.00E-02	6.00E-02	5.18E+00	6.58E-03	2.07E+02
	DPM	—	6.00E-02	6.00E-02	5.18E+00	6.58E-03	2.07E+02
	PM10	—	6.00E-02	6.00E-02	5.18E+00	6.58E-03	2.07E+02
	PM2.5	—	5.33E-02	5.33E-02	4.61E+00	5.84E-03	1.84E+02
	SO2	7446-09-5	9.33E-01	9.33E-01	8.06E+01	1.02E-01	3.23E+03

APPENDIX D

Metals Emissions Estimation

Summary of Estimated Metals Emission Rates

Source ID	Source Description	Compound	Metals Data		1 - hr		24 - hr			Annual		
			Assumed PM Speciation Profile[1]	Assumed Concentration in of PM [%]	ER [g/s]	% of Overall g/s Emissions for Scenario	ER [g/s]	ER [kg/day]	% of Overall kg/day Emissions for Scenario	ER [g/s]	ER [kg/year]	% of Overall kg/year Emissions for Scenario
Scenario 1 - Project Construction Phase												
C_WR	Waste Rock Material Handling	PM	N/A	N/A	0.15	3%	0.15	12.63	4%	0.05	1,517.42	3%
		Antimony	Max % in Ore & WR	0.00046	6.73E-07	4%	6.73E-07	5.81E-05	6%	2.21E-07	0.007	4%
		Arsenic	Max % in Ore & WR	0.013	1.90E-05	4%	1.90E-05	0.002	6%	6.26E-06	0.2	4%
		Barium	Max % in Ore & WR	0.095	1.39E-04	4%	1.39E-04	0.01	6%	4.57E-05	1.44	4%
		Beryllium	Max % in Ore & WR	0.0018	2.63E-06	4%	2.63E-06	2.27E-04	6%	8.66E-07	0.03	4%
		Cadmium	Max % in Ore & WR	0.0025	3.66E-06	4%	3.66E-06	3.16E-04	6%	1.20E-06	0.04	4%
		Chromium	Max % in Ore & WR	0.011	1.61E-05	4%	1.61E-05	0.001	6%	5.29E-06	0.17	4%
		Cobalt	Max % in Ore & WR	0.002	2.92E-06	4%	2.92E-06	2.53E-04	6%	9.62E-07	0.03	4%
		Lithium	Max % in Ore & WR	0.028	4.09E-05	4%	4.09E-05	0.004	6%	1.35E-05	0.42	4%
		Copper	Max % in Ore & WR	0.016	2.34E-05	4%	2.34E-05	0.002	6%	7.70E-06	0.24	4%
		Lead	Max % in Ore & WR	0.15	2.19E-04	7%	2.19E-04	0.02	12%	7.22E-05	2.28	7%
		Manganese	Max % in Ore & WR	0.14	2.05E-04	4%	2.05E-04	0.02	6%	6.74E-05	2.12	4%
		Mercury	Max % in Ore & WR	0.00005	7.31E-08	4%	7.31E-08	6.32E-06	6%	2.41E-08	7.59E-04	4%
		Nickel	Max % in Ore & WR	0.0044	6.43E-06	4%	6.43E-06	5.56E-04	6%	2.12E-06	0.07	4%
		Selenium	Max % in Ore & WR	0.0001	1.46E-07	4%	1.46E-07	1.26E-05	6%	4.81E-08	0.002	4%
		Silver	Max % in Ore & WR	0.000069	1.01E-07	4%	1.01E-07	8.72E-06	6%	3.32E-08	0.001	4%
		Vanadium	Max % in Ore & WR	0.0097	1.42E-05	4%	1.42E-05	0.001	6%	4.67E-06	0.15	4%
		Zinc	Max % in Ore & WR	0.5	7.31E-04	7%	7.31E-04	0.06	10%	2.41E-04	7.59	6%
WR_BD	Waste Rock Dump Bulldozing	PM	N/A	N/A	0.50	12%	0.50	43.14	14%	0.16	5,181.21	11%
		Antimony	Max % in Ore & WR	0.00046	2.30E-06	15%	2.30E-06	1.98E-04	20%	7.56E-07	0.02	15%
		Arsenic	Max % in Ore & WR	0.013	6.49E-05	15%	6.49E-05	0.006	20%	2.14E-05	0.67	15%
		Barium	Max % in Ore & WR	0.095	4.74E-04	15%	4.74E-04	0.04	20%	1.56E-04	4.92	15%
		Beryllium	Max % in Ore & WR	0.0018	8.99E-06	15%	8.99E-06	7.77E-04	20%	2.96E-06	0.09	15%
		Cadmium	Max % in Ore & WR	0.0025	1.25E-05	15%	1.25E-05	0.001	20%	4.11E-06	0.13	15%
		Chromium	Max % in Ore & WR	0.011	5.49E-05	15%	5.49E-05	0.005	20%	1.81E-05	0.57	15%
		Cobalt	Max % in Ore & WR	0.002	9.99E-06	15%	9.99E-06	8.63E-04	20%	3.29E-06	0.1	15%
		Lithium	Max % in Ore & WR	0.028	1.40E-04	15%	1.40E-04	0.01	20%	4.60E-05	1.45	15%
		Copper	Max % in Ore & WR	0.016	7.99E-05	15%	7.99E-05	0.007	20%	2.63E-05	0.83	15%
		Lead	Max % in Ore & WR	0.15	7.49E-04	25%	7.49E-04	0.06	41%	2.46E-04	7.77	25%
		Manganese	Max % in Ore & WR	0.14	6.99E-04	15%	6.99E-04	0.06	20%	2.30E-04	7.25	15%
		Mercury	Max % in Ore & WR	0.00005	2.50E-07	15%	2.50E-07	2.16E-05	20%	8.21E-08	0.003	15%
		Nickel	Max % in Ore & WR	0.0044	2.20E-05	15%	2.20E-05	0.002	20%	7.23E-06	0.23	15%
		Selenium	Max % in Ore & WR	0.0001	4.99E-07	15%	4.99E-07	4.31E-05	20%	1.64E-07	0.01	15%
		Silver	Max % in Ore & WR	0.000069	3.45E-07	15%	3.45E-07	2.98E-05	20%	1.13E-07	0.004	15%
		Vanadium	Max % in Ore & WR	0.0097	4.84E-05	15%	4.84E-05	0.004	20%	1.59E-05	0.5	15%
		Zinc	Max % in Ore & WR	0.5	0.002	22%	0.002	0.22	34%	8.21E-04	25.91	22%
P_DEV	Surface Drilling and Blasting (Portal Development)	PM	N/A	N/A	0.16	4%	0.16	14.16	5%	0.17	5,329.00	12%
		Antimony	Max % in Ore & WR	0.00046	7.54E-07	5%	7.54E-07	6.51E-05	7%	7.77E-07	0.02	16%
		Arsenic	Max % in Ore & WR	0.013	2.13E-05	5%	2.13E-05	0.002	7%	2.20E-05	0.69	16%
		Barium	Max % in Ore & WR	0.095	1.56E-04	5%	1.56E-04	0.01	7%	1.61E-04	5.06	16%
		Beryllium	Max % in Ore & WR	0.0018	2.95E-06	5%	2.95E-06	2.55E-04	7%	3.04E-06	0.10	16%
		Cadmium	Max % in Ore & WR	0.0025	4.10E-06	5%	4.10E-06	3.54E-04	7%	4.22E-06	0.13	16%
		Chromium	Max % in Ore & WR	0.011	1.80E-05	5%	1.80E-05	0.002	7%	1.86E-05	0.59	16%
		Cobalt	Max % in Ore & WR	0.002	3.28E-06	5%	3.28E-06	2.83E-04	7%	3.38E-06	0.11	16%
		Lithium	Max % in Ore & WR	0.028	4.59E-05	5%	4.59E-05	0.004	7%	4.73E-05	1.49	16%
		Copper	Max % in Ore & WR	0.016	2.62E-05	5%	2.62E-05	0.002	7%	2.70E-05	0.85	16%
		Lead	Max % in Ore & WR	0.15	2.46E-04	8%	2.46E-04	0.02	14%	2.53E-04	7.99	26%
		Manganese	Max % in Ore & WR	0.14	2.29E-04	5%	2.29E-04	0.02	7%	2.37E-04	7.46	16%
		Mercury	Max % in Ore & WR	0.00005	8.19E-08	5%	8.19E-08	7.08E-06	7%	8.45E-08	0.003	16%
		Nickel	Max % in Ore & WR	0.0044	7.21E-06	5%	7.21E-06	6.23E-04	7%	7.44E-06	0.23	16%
		Selenium	Max % in Ore & WR	0.0001	1.64E-07	5%	1.64E-07	1.42E-05	7%	1.69E-07	0.01	16%
		Silver	Max % in Ore & WR	0.000069	1.13E-07	5%	1.13E-07	9.77E-06	7%	1.17E-07	0.004	16%
		Vanadium	Max % in Ore & WR	0.0097	1.59E-05	5%	1.59E-05	0.001	7%	1.64E-05	0.52	16%
		Zinc	Max % in Ore & WR	0.5	8.19E-04	7%	8.19E-04	0.07	11%	8.45E-04	26.65	23%

Summary of Estimated Metals Emission Rates

			Metals Data		1 - hr		24 - hr			Annual		
Source ID	Source Description	Compound	Assumed PM Speciation Profile[1]	Assumed Concentration in of PM [%]	ER [g/s]	% of Overall g/s Emissions for Scenario	ER [g/s]	ER [kg/day]	% of Overall kg/day Emissions for Scenario	ER [g/s]	ER [kg/year]	% of Overall kg/year Emissions for Scenario
PIT_DEV	Surface Drilling and Blasting (Open Pit Development)	PM	N/A	N/A	0.93	21%	0.16	14.16	5%	0.20	6,385.88	14%
		Antimony	Max % in Ore & WR	0.00046	4.26E-06	28%	7.54E-07	6.51E-05	7%	9.31E-07	0.03	19%
		Arsenic	Max % in Ore & WR	0.013	1.20E-04	28%	2.13E-05	0.002	7%	2.63E-05	0.83	19%
		Barium	Max % in Ore & WR	0.095	8.80E-04	28%	1.56E-04	0.01	7%	1.92E-04	6.07	19%
		Beryllium	Max % in Ore & WR	0.0018	1.67E-05	28%	2.95E-06	2.55E-04	7%	3.64E-06	0.11	19%
		Cadmium	Max % in Ore & WR	0.0025	2.32E-05	28%	4.10E-06	3.54E-04	7%	5.06E-06	0.16	19%
		Chromium	Max % in Ore & WR	0.011	1.02E-04	28%	1.80E-05	0.002	7%	2.23E-05	0.70	19%
		Cobalt	Max % in Ore & WR	0.002	1.85E-05	28%	3.28E-06	2.83E-04	7%	4.05E-06	0.13	19%
		Lithium	Max % in Ore & WR	0.028	2.59E-04	28%	4.59E-05	0.004	7%	5.67E-05	1.79	19%
		Copper	Max % in Ore & WR	0.016	1.48E-04	28%	2.62E-05	0.002	7%	3.24E-05	1.02	19%
		Lead	Max % in Ore & WR	0.15	0.001	47%	2.46E-04	0.02	14%	3.04E-04	9.58	31%
		Manganese	Max % in Ore & WR	0.14	0.001	28%	2.29E-04	0.02	7%	2.83E-04	8.94	19%
		Mercury	Max % in Ore & WR	0.00005	4.63E-07	28%	8.19E-08	7.08E-06	7%	1.01E-07	0.003	19%
		Nickel	Max % in Ore & WR	0.0044	4.08E-05	28%	7.21E-06	6.23E-04	7%	8.91E-06	0.28	19%
		Selenium	Max % in Ore & WR	0.0001	9.27E-07	28%	1.64E-07	1.42E-05	7%	2.02E-07	0.01	19%
		Silver	Max % in Ore & WR	0.000069	6.39E-07	28%	1.13E-07	9.77E-06	7%	1.40E-07	0.004	19%
		Vanadium	Max % in Ore & WR	0.0097	8.99E-05	28%	1.59E-05	0.001	7%	1.96E-05	0.62	19%
		Zinc	Max % in Ore & WR	0.5	0.005	42%	8.19E-04	0.07	11%	0.001	31.93	27%
C_UPR	Construction Phase Unpaved Haul Roads Fugitive Dust	PM	N/A	N/A	1.54	36%	1.54	132.91	43%	0.51	15,962.36	35%
		Antimony	Max % in WR	0.00046	7.08E-06	47%	7.08E-06	6.11E-04	61%	2.33E-06	0.07	46%
		Arsenic	Max % in WR	0.013	2.00E-04	47%	2.00E-04	0.02	61%	6.58E-05	2.08	46%
		Barium	Max % in WR	0.095	0.001	47%	0.001	0.13	61%	4.81E-04	15.16	46%
		Beryllium	Max % in WR	0.0018	2.77E-05	47%	2.77E-05	0.002	61%	9.11E-06	0.29	46%
		Cadmium	Max % in WR	0.0025	3.85E-05	47%	3.85E-05	0.003	61%	1.27E-05	0.40	46%
		Chromium	Max % in WR	0.011	1.69E-04	47%	1.69E-04	0.01	61%	5.57E-05	1.76	46%
		Cobalt	Max % in WR	0.002	3.08E-05	47%	3.08E-05	0.003	61%	1.01E-05	0.32	46%
		Lithium	Max % in WR	0.028	4.31E-04	47%	4.31E-04	0.04	61%	1.42E-04	4.47	46%
		Copper	Max % in WR	0.016	2.46E-04	47%	2.46E-04	0.02	61%	8.10E-05	2.55	46%
		Lead	Max % in WR	0.023	3.54E-04	12%	3.54E-04	0.03	20%	1.16E-04	3.67	12%
		Manganese	Max % in WR	0.14	0.002	47%	0.002	0.19	61%	7.09E-04	22.35	46%
		Mercury	Max % in WR	0.00005	7.69E-07	47%	7.69E-07	6.65E-05	61%	2.53E-07	0.01	46%
		Nickel	Max % in WR	0.0044	6.77E-05	47%	6.77E-05	0.01	61%	2.23E-05	0.70	46%
		Selenium	Max % in WR	0.0001	1.54E-06	47%	1.54E-06	1.33E-04	61%	5.06E-07	0.02	46%
		Silver	Max % in WR	0.000069	1.06E-06	47%	1.06E-06	9.17E-05	61%	3.49E-07	0.01	46%
		Vanadium	Max % in WR	0.0097	1.49E-04	47%	1.49E-04	0.01	61%	4.91E-05	1.55	46%
		Zinc	Max % in WR	0.16	0.002	22%	0.002	0.21	34%	8.10E-04	25.54	22%
Scenario 2 - Project Operations Phase												
PIT_DB	Open Pit Drilling and Blasting	PM	N/A	N/A	0.93	3%	0.14	11.80	2%	0.13	4130.00	5%
		Antimony	Max % in Ore & WR	0.00046	4.26E-06	12%	6.28E-07	5.43E-05	2%	6.02E-07	0.02	6%
		Arsenic	Max % in Ore & WR	0.013	1.20E-04	12%	1.78E-05	0.002	2%	1.70E-05	0.54	6%
		Barium	Max % in Ore & WR	0.095	8.80E-04	12%	1.30E-04	0.01	2%	1.24E-04	3.92	6%
		Beryllium	Max % in Ore & WR	0.0018	1.67E-05	12%	2.46E-06	2.12E-04	2%	2.36E-06	0.07	6%
		Cadmium	Max % in Ore & WR	0.0025	2.32E-05	12%	3.41E-06	2.95E-04	2%	3.27E-06	0.10	6%
		Chromium	Max % in Ore & WR	0.011	1.02E-04	12%	1.50E-05	0.001	2%	1.44E-05	0.45	6%
		Cobalt	Max % in Ore & WR	0.002	1.85E-05	12%	2.73E-06	2.36E-04	2%	2.62E-06	0.08	6%
		Lithium	Max % in Ore & WR	0.028	2.59E-04	12%	3.82E-05	0.003	2%	3.67E-05	1.16	6%
		Copper	Max % in Ore & WR	0.016	1.48E-04	12%	2.19E-05	0.002	2%	2.10E-05	0.66	6%
		Lead	Max % in Ore & WR	0.15	0.001	41%	2.05E-04	0.02	10%	1.96E-04	6.20	20%
		Manganese	Max % in Ore & WR	0.14	0.001	12%	1.91E-04	0.02	2%	1.83E-04	5.78	6%
		Mercury	Max % in Ore & WR	0.00005	4.63E-07	12%	6.83E-08	5.90E-06	2%	6.55E-08	0.002	6%
		Nickel	Max % in Ore & WR	0.0044	4.08E-05	12%	6.01E-06	5.19E-04	2%	5.76E-06	0.18	6%
		Selenium	Max % in Ore & WR	0.0001	9.27E-07	12%	1.37E-07	1.18E-05	2%	1.31E-07	0.004	6%
		Silver	Max % in Ore & WR	0.000069	6.39E-07	12%	9.42E-08	8.14E-06	2%	9.04E-08	0.003	6%
		Vanadium	Max % in Ore & WR	0.0097	8.99E-05	12%	1.32E-05	0.001	2%	1.27E-05	0.40	6%
		Zinc	Max % in Ore & WR	0.5	0.005	28%	6.83E-04	0.06	6%	6.55E-04	20.65	14%

Summary of Estimated Metals Emission Rates

			Metals Data		1 - hr		24 - hr			Annual		
Source ID	Source Description	Compound	Assumed PM Speciation Profile[1]	Assumed Concentration in of PM [%]	ER [g/s]	% of Overall g/s Emissions for Scenario	ER [g/s]	ER [kg/day]	% of Overall kg/day Emissions for Scenario	ER [g/s]	ER [kg/year]	% of Overall kg/year Emissions for Scenario
ORE_MH	Above-Ground Ore Material Handling	PM	N/A	N/A	0.04	<1%	0.04	3.07	<1%	0.01	369.12	<1%
		Antimony	Max % in Ore & WR	0.00046	1.64E-07	<1%	1.64E-07	1.41E-05	<1%	5.38E-08	0.002	<1%
		Arsenic	Max % in Ore & WR	0.013	4.62E-06	<1%	4.62E-06	4.00E-04	<1%	1.52E-06	0.05	<1%
		Barium	Max % in Ore & WR	0.095	3.38E-05	<1%	3.38E-05	0.003	<1%	1.11E-05	0.35	<1%
		Beryllium	Max % in Ore & WR	0.0018	6.40E-07	<1%	6.40E-07	5.53E-05	<1%	2.11E-07	0.01	<1%
		Cadmium	Max % in Ore & WR	0.0025	8.89E-07	<1%	8.89E-07	7.68E-05	<1%	2.93E-07	0.01	<1%
		Chromium	Max % in Ore & WR	0.011	3.91E-06	<1%	3.91E-06	3.38E-04	<1%	1.29E-06	0.04	<1%
		Cobalt	Max % in Ore & WR	0.002	7.11E-07	<1%	7.11E-07	6.15E-05	<1%	2.34E-07	0.01	<1%
		Lithium	Max % in Ore & WR	0.028	9.96E-06	<1%	9.96E-06	8.61E-04	<1%	3.28E-06	0.10	<1%
		Copper	Max % in Ore & WR	0.016	5.69E-06	<1%	5.69E-06	4.92E-04	<1%	1.87E-06	0.06	<1%
		Lead	Max % in Ore & WR	0.15	5.34E-05	2%	5.34E-05	0.005	3%	1.76E-05	0.55	2%
		Manganese	Max % in Ore & WR	0.14	4.98E-05	<1%	4.98E-05	0.004	<1%	1.64E-05	0.52	<1%
		Mercury	Max % in Ore & WR	0.00005	1.78E-08	<1%	1.78E-08	1.54E-06	<1%	5.85E-09	1.85E-04	<1%
		Nickel	Max % in Ore & WR	0.0044	1.57E-06	<1%	1.57E-06	1.35E-04	<1%	5.15E-07	0.02	<1%
		Selenium	Max % in Ore & WR	0.0001	3.56E-08	<1%	3.56E-08	3.07E-06	<1%	1.17E-08	3.69E-04	<1%
		Silver	Max % in Ore & WR	0.000069	2.45E-08	<1%	2.45E-08	2.12E-06	<1%	8.08E-09	2.55E-04	<1%
		Vanadium	Max % in Ore & WR	0.0097	3.45E-06	<1%	3.45E-06	2.98E-04	<1%	1.14E-06	0.04	<1%
		Zinc	Max % in Ore & WR	0.5	1.78E-04	1%	1.78E-04	0.02	2%	5.85E-05	1.85	1%
OP_WR	Waste Rock Material Handling	PM	N/A	N/A	0.10	<1%	0.10	8.45	2%	0.03	1,015.21	1%
		Antimony	Max % in Ore & WR	0.00046	4.50E-07	1%	4.50E-07	3.89E-05	2%	1.48E-07	0.005	2%
		Arsenic	Max % in Ore & WR	0.013	1.27E-05	1%	1.27E-05	0.001	2%	4.18E-06	0.13	2%
		Barium	Max % in Ore & WR	0.095	9.29E-05	1%	9.29E-05	0.008	2%	3.06E-05	0.96	2%
		Beryllium	Max % in Ore & WR	0.0018	1.76E-06	1%	1.76E-06	1.52E-04	2%	5.79E-07	0.02	2%
		Cadmium	Max % in Ore & WR	0.0025	2.45E-06	1%	2.45E-06	2.11E-04	2%	8.05E-07	0.03	2%
		Chromium	Max % in Ore & WR	0.011	1.08E-05	1%	1.08E-05	9.30E-04	2%	3.54E-06	0.11	2%
		Cobalt	Max % in Ore & WR	0.002	1.96E-06	1%	1.96E-06	1.69E-04	2%	6.44E-07	0.02	2%
		Lithium	Max % in Ore & WR	0.028	2.74E-05	1%	2.74E-05	0.002	2%	9.01E-06	0.28	2%
		Copper	Max % in Ore & WR	0.016	1.57E-05	1%	1.57E-05	0.001	2%	5.15E-06	0.16	2%
		Lead	Max % in Ore & WR	0.15	1.47E-04	4%	1.47E-04	0.01	7%	4.83E-05	1.52	5%
		Manganese	Max % in Ore & WR	0.14	1.37E-04	1%	1.37E-04	0.01	2%	4.51E-05	1.42	2%
		Mercury	Max % in Ore & WR	0.00005	4.89E-08	1%	4.89E-08	4.23E-06	2%	1.61E-08	5.08E-04	2%
		Nickel	Max % in Ore & WR	0.0044	4.30E-06	1%	4.30E-06	3.72E-04	2%	1.42E-06	0.04	2%
		Selenium	Max % in Ore & WR	0.0001	9.78E-08	1%	9.78E-08	8.45E-06	2%	3.22E-08	0.001	2%
		Silver	Max % in Ore & WR	0.000069	6.75E-08	1%	6.75E-08	5.83E-06	2%	2.22E-08	7.00E-04	2%
		Vanadium	Max % in Ore & WR	0.0097	9.49E-06	1%	9.49E-06	8.20E-04	2%	3.12E-06	0.10	2%
		Zinc	Max % in Ore & WR	0.5	4.89E-04	3%	4.89E-04	0.04	4%	1.61E-04	5.08	3%
ROM	Run-Of-Mine Ore Transfer to Stationary Grizzly	PM	N/A	N/A	0.04	<1%	0.04	3.46	<1%	0.04	1,210.44	2%
		Antimony	Max % in Ore & WR	0.00046	1.84E-07	<1%	1.84E-07	1.59E-05	<1%	1.77E-07	0.01	2%
		Arsenic	Max % in Ore & WR	0.013	5.20E-06	<1%	5.20E-06	4.50E-04	<1%	4.99E-06	0.16	2%
		Barium	Max % in Ore & WR	0.095	3.80E-05	<1%	3.80E-05	0.003	<1%	3.65E-05	1.15	2%
		Beryllium	Max % in Ore & WR	0.0018	7.21E-07	<1%	7.21E-07	6.23E-05	<1%	6.91E-07	0.02	2%
		Cadmium	Max % in Ore & WR	0.0025	1.00E-06	<1%	1.00E-06	8.65E-05	<1%	9.60E-07	0.03	2%
		Chromium	Max % in Ore & WR	0.011	4.40E-06	<1%	4.40E-06	3.80E-04	<1%	4.22E-06	0.13	2%
		Cobalt	Max % in Ore & WR	0.002	8.01E-07	<1%	8.01E-07	6.92E-05	<1%	7.68E-07	0.02	2%
		Lithium	Max % in Ore & WR	0.028	1.12E-05	<1%	1.12E-05	9.68E-04	<1%	1.07E-05	0.34	2%
		Copper	Max % in Ore & WR	0.016	6.40E-06	<1%	6.40E-06	5.53E-04	<1%	6.14E-06	0.19	2%
		Lead	Max % in Ore & WR	0.15	6.00E-05	2%	6.00E-05	0.01	3%	5.76E-05	1.82	6%
		Manganese	Max % in Ore & WR	0.14	5.60E-05	<1%	5.60E-05	0.005	<1%	5.37E-05	1.69	2%
		Mercury	Max % in Ore & WR	0.00005	2.00E-08	<1%	2.00E-08	1.73E-06	<1%	1.92E-08	6.05E-04	2%
		Nickel	Max % in Ore & WR	0.0044	1.76E-06	<1%	1.76E-06	1.52E-04	<1%	1.69E-06	0.05	2%
		Selenium	Max % in Ore & WR	0.0001	4.00E-08	<1%	4.00E-08	3.46E-06	<1%	3.84E-08	0.001	2%
		Silver	Max % in Ore & WR	0.000069	2.76E-08	<1%	2.76E-08	2.39E-06	<1%	2.65E-08	8.35E-04	2%
		Vanadium	Max % in Ore & WR	0.0097	3.88E-06	<1%	3.88E-06	3.35E-04	<1%	3.72E-06	0.12	2%
		Zinc	Max % in Ore & WR	0.5	2.00E-04	1%	2.00E-04	0.02	2%	1.92E-04	6.05	4%

Summary of Estimated Metals Emission Rates

Source ID	Source Description	Compound	Metals Data		1 - hr		24 - hr			Annual		
			Assumed PM Speciation Profile[1]	Assumed Concentration in of PM [%]	ER [g/s]	% of Overall g/s Emissions for Scenario	ER [g/s]	ER [kg/day]	% of Overall kg/day Emissions for Scenario	ER [g/s]	ER [kg/year]	% of Overall kg/year Emissions for Scenario
DC	Crushing Circuit Dust Collector	PM	N/A	N/A	0.15	<1%	0.15	13.25	2%	0.15	4,636.80	6%
		Antimony	Max % in Ore & WR	0.00046	7.05E-07	2%	7.05E-07	6.09E-05	3%	6.76E-07	0.02	7%
		Arsenic	Max % in Ore & WR	0.013	1.99E-05	2%	1.99E-05	0.002	3%	1.91E-05	0.60	7%
		Barium	Max % in Ore & WR	0.095	1.46E-04	2%	1.46E-04	0.01	3%	1.40E-04	4.40	7%
		Beryllium	Max % in Ore & WR	0.0018	2.76E-06	2%	2.76E-06	2.38E-04	3%	2.65E-06	0.08	7%
		Cadmium	Max % in Ore & WR	0.0025	3.83E-06	2%	3.83E-06	3.31E-04	3%	3.68E-06	0.12	7%
		Chromium	Max % in Ore & WR	0.011	1.69E-05	2%	1.69E-05	0.001	3%	1.62E-05	0.51	7%
		Cobalt	Max % in Ore & WR	0.002	3.07E-06	2%	3.07E-06	2.65E-04	3%	2.94E-06	0.09	7%
		Lithium	Max % in Ore & WR	0.028	4.29E-05	2%	4.29E-05	0.004	3%	4.12E-05	1.30	7%
		Copper	Max % in Ore & WR	0.016	2.45E-05	2%	2.45E-05	0.002	3%	2.35E-05	0.74	7%
		Lead	Max % in Ore & WR	0.15	2.30E-04	7%	2.30E-04	0.02	12%	2.21E-04	6.96	22%
		Manganese	Max % in Ore & WR	0.14	2.15E-04	2%	2.15E-04	0.02	3%	2.06E-04	6.49	7%
		Mercury	Max % in Ore & WR	0.00005	7.67E-08	2%	7.67E-08	6.62E-06	3%	7.35E-08	0.002	7%
		Nickel	Max % in Ore & WR	0.0044	6.75E-06	2%	6.75E-06	5.83E-04	3%	6.47E-06	0.20	7%
		Selenium	Max % in Ore & WR	0.0001	1.53E-07	2%	1.53E-07	1.32E-05	3%	1.47E-07	0.005	7%
		Silver	Max % in Ore & WR	0.000069	1.06E-07	2%	1.06E-07	9.14E-06	3%	1.01E-07	0.003	7%
		Vanadium	Max % in Ore & WR	0.0097	1.49E-05	2%	1.49E-05	0.001	3%	1.43E-05	0.45	7%
		Zinc	Max % in Ore & WR	0.5	7.67E-04	5%	7.67E-04	0.07	7%	7.35E-04	23.18	15%
FINE	Fine Ore Transfer from Storage Bin to Feed Conveyor for Dense M	PM	N/A	N/A	0.04	<1%	0.04	3.46	<1%	0.04	1,210.67	2%
		Antimony	Max % in Ore & WR	0.00046	1.84E-07	<1%	1.84E-07	1.59E-05	<1%	1.77E-07	0.01	2%
		Arsenic	Max % in Ore & WR	0.013	5.20E-06	<1%	5.20E-06	4.50E-04	<1%	4.99E-06	0.16	2%
		Barium	Max % in Ore & WR	0.095	3.80E-05	<1%	3.80E-05	0.003	<1%	3.65E-05	1.15	2%
		Beryllium	Max % in Ore & WR	0.0018	7.21E-07	<1%	7.21E-07	6.23E-05	<1%	6.91E-07	0.02	2%
		Cadmium	Max % in Ore & WR	0.0025	1.00E-06	<1%	1.00E-06	8.65E-05	<1%	9.60E-07	0.03	2%
		Chromium	Max % in Ore & WR	0.011	4.40E-06	<1%	4.40E-06	3.80E-04	<1%	4.22E-06	0.13	2%
		Cobalt	Max % in Ore & WR	0.002	8.01E-07	<1%	8.01E-07	6.92E-05	<1%	7.68E-07	0.02	2%
		Lithium	Max % in Ore & WR	0.028	1.12E-05	<1%	1.12E-05	9.69E-04	<1%	1.07E-05	0.34	2%
		Copper	Max % in Ore & WR	0.016	6.41E-06	<1%	6.41E-06	5.53E-04	<1%	6.14E-06	0.19	2%
		Lead	Max % in Ore & WR	0.15	6.01E-05	2%	6.01E-05	0.01	3%	5.76E-05	1.82	6%
		Manganese	Max % in Ore & WR	0.14	5.60E-05	<1%	5.60E-05	0.005	<1%	5.37E-05	1.69	2%
		Mercury	Max % in Ore & WR	0.00005	2.00E-08	<1%	2.00E-08	1.73E-06	<1%	1.92E-08	6.05E-04	2%
		Nickel	Max % in Ore & WR	0.0044	1.76E-06	<1%	1.76E-06	1.52E-04	<1%	1.69E-06	0.05	2%
		Selenium	Max % in Ore & WR	0.0001	4.00E-08	<1%	4.00E-08	3.46E-06	<1%	3.84E-08	0.001	2%
		Silver	Max % in Ore & WR	0.000069	2.76E-08	<1%	2.76E-08	2.39E-06	<1%	2.65E-08	8.35E-04	2%
		Vanadium	Max % in Ore & WR	0.0097	3.88E-06	<1%	3.88E-06	3.36E-04	<1%	3.72E-06	0.12	2%
		Zinc	Max % in Ore & WR	0.5	2.00E-04	1%	2.00E-04	0.02	2%	1.92E-04	6.05	4%

Summary of Estimated Metals Emission Rates

Source ID	Source Description	Compound	Metals Data		1 - hr		24 - hr			Annual		
			Assumed PM Speciation Profile[1]	Assumed Concentration in of PM [%]	ER [g/s]	% of Overall g/s Emissions for Scenario	ER [g/s]	ER [kg/day]	% of Overall kg/day Emissions for Scenario	ER [g/s]	ER [kg/year]	% of Overall kg/year Emissions for Scenario
UPR1	Road - GNP In-Pit	PM	N/A	N/A	1.21	4%	1.01	86.88	16%	0.33	10434.73	14%
		Antimony	Max % in WR	0.00046	5.55E-06	16%	4.63E-06	4.00E-04	18%	1.52E-06	0.05	16%
		Arsenic	Max % in WR	0.013	1.57E-04	16%	1.31E-04	0.01	18%	4.30E-05	1.36	16%
		Barium	Max % in WR	0.095	0.001	16%	9.55E-04	0.08	18%	3.14E-04	9.91	16%
		Beryllium	Max % in WR	0.0018	2.17E-05	16%	1.81E-05	0.002	18%	5.96E-06	0.19	16%
		Cadmium	Max % in WR	0.0025	3.02E-05	16%	2.51E-05	0.002	18%	8.27E-06	0.26	16%
		Chromium	Max % in WR	0.011	1.33E-04	16%	1.11E-04	0.01	18%	3.64E-05	1.15	16%
		Cobalt	Max % in WR	0.002	2.41E-05	16%	2.01E-05	0.002	18%	6.62E-06	0.21	16%
		Lithium	Max % in WR	0.028	3.38E-04	16%	2.82E-04	0.02	18%	9.26E-05	2.92	16%
		Copper	Max % in WR	0.016	1.93E-04	16%	1.61E-04	0.01	18%	5.29E-05	1.67	16%
		Lead	Max % in WR	0.023	2.78E-04	8%	2.31E-04	0.02	12%	7.61E-05	2.40	8%
		Manganese	Max % in WR	0.14	0.002	16%	0.001	0.122	18%	4.63E-04	14.61	16%
		Mercury	Max % in WR	0.00005	6.03E-07	16%	5.03E-07	4.34E-05	18%	1.65E-07	0.01	16%
		Nickel	Max % in WR	0.0044	5.31E-05	16%	4.42E-05	0.004	18%	1.46E-05	0.46	16%
		Selenium	Max % in WR	0.0001	1.21E-06	16%	1.01E-06	8.69E-05	18%	3.31E-07	0.01	16%
		Silver	Max % in WR	0.000069	8.33E-07	16%	6.94E-07	5.99E-05	18%	2.28E-07	0.01	16%
		Vanadium	Max % in WR	0.0097	1.17E-04	16%	9.75E-05	0.008	18%	3.21E-05	1.01	16%
		Zinc	Max % in WR	0.16	0.002	12%	0.002	0.14	15%	5.29E-04	16.70	11%
UPR2	GNP Haul Road to North Dump	PM	N/A	N/A	3.15	11%	2.63	227.04	41%	0.86	27267.58	36%
		Antimony	Max % in WR	0.00046	1.45E-05	42%	1.21E-05	0.001	46%	3.98E-06	0.13	41%
		Arsenic	Max % in WR	0.013	4.10E-04	42%	3.42E-04	0.03	46%	1.12E-04	3.54	41%
		Barium	Max % in WR	0.095	0.003	42%	0.002	0.22	46%	8.21E-04	25.90	41%
		Beryllium	Max % in WR	0.0018	5.68E-05	42%	4.73E-05	0.004	46%	1.56E-05	0.49	41%
		Cadmium	Max % in WR	0.0025	7.88E-05	42%	6.57E-05	0.006	46%	2.16E-05	0.68	41%
		Chromium	Max % in WR	0.011	3.47E-04	42%	2.89E-04	0.025	46%	9.51E-05	3.00	41%
		Cobalt	Max % in WR	0.002	6.31E-05	42%	5.26E-05	0.005	46%	1.73E-05	0.55	41%
		Lithium	Max % in WR	0.028	8.83E-04	42%	7.36E-04	0.064	46%	2.42E-04	7.63	41%
		Copper	Max % in WR	0.016	5.05E-04	42%	4.20E-04	0.036	46%	1.38E-04	4.36	41%
		Lead	Max % in WR	0.023	7.25E-04	21%	6.04E-04	0.052	31%	1.99E-04	6.27	20%
		Manganese	Max % in WR	0.14	0.004	42%	0.004	0.32	46%	0.001	38.17	41%
		Mercury	Max % in WR	0.00005	1.58E-06	42%	1.31E-06	1.14E-04	46%	4.32E-07	0.01	41%
		Nickel	Max % in WR	0.0044	1.39E-04	42%	1.16E-04	0.01	46%	3.80E-05	1.20	41%
		Selenium	Max % in WR	0.0001	3.15E-06	42%	2.63E-06	2.27E-04	46%	8.65E-07	0.03	41%
		Silver	Max % in WR	0.000069	2.18E-06	42%	1.81E-06	1.57E-04	46%	5.97E-07	0.02	41%
		Vanadium	Max % in WR	0.0097	3.06E-04	42%	2.55E-04	0.02	46%	8.39E-05	2.64	41%
		Zinc	Max % in WR	0.16	0.005	31%	0.004	0.36	39%	0.001	43.63	29%

Summary of Estimated Metals Emission Rates

Source ID	Source Description	Compound	Metals Data		1 - hr		24 - hr			Annual		
			Assumed PM Speciation Profile[1]	Assumed Concentration in of PM [%]	ER [g/s]	% of Overall g/s Emissions for Scenario	ER [g/s]	ER [kg/day]	% of Overall kg/day Emissions for Scenario	ER [g/s]	ER [kg/year]	% of Overall kg/year Emissions for Scenario
UPR3	Surface Haul Road - GNP Pit Exit to Mill	PM	N/A	N/A	1.92	7%	1.60	138.44	25%	0.53	16627.02	22%
		Antimony	Max % in WR	0.00046	8.84E-06	25%	7.37E-06	6.37E-04	28%	2.43E-06	0.08	25%
		Arsenic	Max % in WR	0.013	2.50E-04	25%	2.08E-04	0.018	28%	6.85E-05	2.16	25%
		Barium	Max % in WR	0.095	0.002	25%	0.002	0.13	28%	5.01E-04	15.80	25%
		Beryllium	Max % in WR	0.0018	3.46E-05	25%	2.88E-05	0.002	28%	9.49E-06	0.30	25%
		Cadmium	Max % in WR	0.0025	4.81E-05	25%	4.01E-05	0.003	28%	1.32E-05	0.42	25%
		Chromium	Max % in WR	0.011	2.12E-04	25%	1.76E-04	0.015	28%	5.80E-05	1.83	25%
		Cobalt	Max % in WR	0.002	3.85E-05	25%	3.20E-05	0.003	28%	1.05E-05	0.33	25%
		Lithium	Max % in WR	0.028	5.38E-04	25%	4.49E-04	0.039	28%	1.48E-04	4.66	25%
		Copper	Max % in WR	0.016	3.08E-04	25%	2.56E-04	0.022	28%	8.44E-05	2.66	25%
		Lead	Max % in WR	0.023	4.42E-04	13%	3.69E-04	0.032	19%	1.21E-04	3.82	12%
		Manganese	Max % in WR	0.14	0.003	25%	0.002	0.19	28%	7.38E-04	23.28	25%
		Mercury	Max % in WR	0.00005	9.61E-07	25%	8.01E-07	6.92E-05	28%	2.64E-07	0.01	25%
		Nickel	Max % in WR	0.0044	8.46E-05	25%	7.05E-05	0.006	28%	2.32E-05	0.73	25%
		Selenium	Max % in WR	0.0001	1.92E-06	25%	1.60E-06	1.38E-04	28%	5.27E-07	0.02	25%
		Silver	Max % in WR	0.000069	1.33E-06	25%	1.11E-06	9.55E-05	28%	3.64E-07	0.01	25%
		Vanadium	Max % in WR	0.0097	1.87E-04	25%	1.55E-04	0.013	28%	5.11E-05	1.61	25%
		Zinc	Max % in WR	0.16	0.003	19%	0.003	0.22	24%	8.44E-04	26.60	18%

[1]: PM speciation profiles were developed to estimate metals emissions based on Particulate Matter (PM) emission estimates from sources that emit PM that could poentially contain metals. For sources associated with handling ore or waste rock, PM emission estimates were speciated into metal emission rate estimates by conservatively assuming that the metal concentration in the emitted PM is equal to the maximum concentration taken from ore and waste rock assay data provided by CFI. For PM from roads used for hauling material that may have metals, it has been conservatively assumed that metal concentration is equal to the maximum concentration taken from waste rock assay data provided by CFI.

APPENDIX E

Summary of Input Parameters

Area	Source	Parameter	Known Value	Assumed Value	Notes (source of data/ rationale for assumption)
SCENARIO 1 - CONSTRUCTION PHASE					
Overburden Dump	Material Handling	amount of material moved (tonnes/day)	2100 tonnes/day		provided by CFI
		moisture content (%)		moisture = 7.9%	assumed based on AP-42 table 11.9-3 for overburden
Overburden Dump	Bulldozing	silt content (%)		silt = 6.9%	assumed based on AP-42 table 11.9-3 for overburden
		moisture content (%)		moisture = 7.9%	assumed based on AP-42 table 11.9-3 for overburden
		hours per day		24 hours/day	assumed based on similar sites
Waste Rock Dump	Material Handling	amount of material moved (tonnes/day)	10675 tonnes/day		provided by CFI
		moisture content (%)		moisture = 5%	assumed based on similar sites
Waste Rock Dump	Bulldozing	silt content (%)		silt = 6.9%	assumed based on AP-42 table 11.9-3 for overburden
		moisture content (%)		moisture = 7.9%	assumed based on AP-42 table 11.9-3 for overburden
		hours per day		24 hours/day	assumed based on similar sites
Open Pits, Mill Site, Tailings Management Facility Site	Topsoil Clearing				PFS s.16.4.4, p. 16-174 - topsoil will be pushed to and placed on small individual piles near the pit crests
		silt content (%)		silt = 6.9%	assumed based on AP-42 table 11.9-3 for overburden
		moisture content (%)		moisture = 7.9%	assumed based on AP-42 table 11.9-3 for overburden
		hours per day		24 hours/day	assumed based on similar sites
		amount of material moved (tonnes/day)		350 tonnes/day	assume same as rate of waste rock generation
In order to quantify some emissions from construction of the underground mine portal, drilling and blasting related to portal development were quantified in addition to the pit development activities. This is conservative because underground portal and ramp development are not anticipated to commence during pit development. I is assumed that emissions from some of the underground mining activities occur at the same time as the open pit activities. This is to avoid having to quantify multiple production years.					
Underground Mine Portal Area	Surface Drilling and Blasting (Portal Development)	number of holes drilled per day	80 holes drilled/day		provided by CFI
		control efficiency for drilling (%)		70 % control	EA Registration s.7.2.1 states appropriate BMPs will be implemented. 70% control efficiency applied as per Table 4 of the NPI Emissions Estimation Technique Manual for Mining, Version 3.0, dated June 2011
		maximum surface area blasted per day (m2)		100 m2 per day	assumed based on similar sites
		amount of explosives used per blast (kg)		100 kg ANFO per blast	assumed based on volume blasted per day, density of waste rock (1 g/cm3), and ratio to kg ANFO used in open pit waste rock blasting (PFS Table 16-20 kg ANFO per hole)
		number of blasts per day		2 blasts/day	PFS s.15.8, p. 15-151 - inferred from advance per blast when raising (2 m) and total m/day advancement (4 m/day)
Open Pit Development	Surface Drilling and Blasting	number of holes drilled per day	80 holes drilled/day		provided by CFI
		control efficiency for drilling (%)		70 % control	assumed similar to portal development
		area blasted per day (m2)	600 m2 waste rock		provided by CFI
			60 m2 ore		provided by CFI
		amount of explosives used per blast (kg)	700 kg emulsion per blast (ore) 4300 kg emulsion per blast (waste)		provided by CFI
		number of blasts per day	1 blast/day		provided by CFI
Grebes Nest Pond	Diesel Powered Dewatering Pump	hp of pump engine	150 hp		provided by CFI

Area	Source	Parameter	Known Value	Assumed Value	Notes (source of data/ rationale for assumption)
Haul Roads	Unpaved Road Dust	average weight of industrial vehicles	41 tonnes		prorated average weight of all industrial vehicles, calculated from data provided by CFI
		average weight of passenger vehicles	12 tonnes		prorated average weight of all passenger vehicles, calculated from data provided by CFI
		control factor (%)		75% control	75% control (Australian NPI Emissions Estimation Technique Manual for Mining) due to application of water or other dust suppressants (EA Registration Report s.7.2.1)
		silt content (%)		silt content = 8.3%	silt content from AP-42 Table 13.2.2-1 for stone quarrying and processing haul road
		number of trips per day		40 trips/day each for industrial vehicles and passenger vehicles	assumed each vehicle type makes 40 trips/day, based on original data provided by CFI of 2 trucks x 20 trips = 40 trips / d
		length of road travelled (km)		2.25 km	distance from overburden area to mill. Estimated from Project Site Plan
Throughout the Site	Vehicle Tailpipe Emissions	It is assumed that all construction equipment is diesel powered			
		Rigid Haul Truck waste CAT 773G	578 kW 3 units		provided by CFI
		Articulated Haul Truck ovb/ore CAT 740B	365 kW 1 unit		provided by CFI
		Drill rig ore AC DTH	168 kW 1 unit		provided by CFI
		Drill rig waste AC DTH	420 kW 1 unit		provided by CFI
		Bob Cat CAT C15	2 units	595 hp	assumed based on manufacturer specification for the C15 engine (from manufacturer website). Assumed the maximum rating of the 2 equipment results for C15 engine
		Wheel Loader CAT 980K	303 kW 6 units		provided by CFI
		Wheel Dozer CAT 844H	468 kW 1 unit		provided by CFI
		Track Dozer CAT D9	325 kW 1 unit		provided by CFI
		Track Dozer CAT D8	328 kW 2 units		provided by CFI
		Motor Grader CAT 14M	193 kW 1 unit		provided by CFI
		Wheel Backho/Loader CAT 420E	69 kW 3 units		provided by CFI
		Water/Sander Truck (oil highway truck)	269 kW 3 units		provided by CFI
		Hydraulic Excavator CAT 320E L	114 kW 6 units		provided by CFI
		Tandem truck CAT CT680	354 kW 10 units		provided by CFI
		Tow Truck CAT 740B	365 kW 1 unit		provided by CFI
		Tow Low Boy LPM (120-48-20)	1 unit	365 kW	assumed same as Tow Truck
		Fuel/Lube Truck	1 unit	150 kW	assumed same as Fuel/Lube Truck CT660 used in operations phase provided by CFI

Area	Source	Parameter	Known Value	Assumed Value	Notes (source of data/ rationale for assumption)
		Service Truck CT660	269 kW 1 unit		provided by CFI
		Bulk ANFO Explosives Truck (Kalmar DCD200-12lb)	1 unit	289 kW	assumed same as the Kalmar DCD200-12lb truck used in operations
		Mini Bus	3 units	365 kW	assumed same as the mini bus used in operations
		Pick Up Truck Ford E series	20 units	365 kW	assumed same as the Ford E series vehicle used in operations
		Crane LTM 110-4.2	350 kW 2 units		
		Scissorlift Getman A64	101 kW 2 units		
		Grader AARD Mining LP	92 kW 3 units		
		Compaction Roller (CAT)	25 kW 3 units		
		Pallet Handler/Tractor	101 kW 1 unit		
Various Locations On-site	Portable Diesel Powered Generators (3 units)	total MW rating of all 3 units (MW)	1 MW		provided by CFI
		operating hours per day		24 hours/day	
		operating days per year	183 days/year		per CFI, the diesel generators will be used during the first 6 months of construction (~ half of the year). After 6 months, electricity will come from the grid
Off-site - located in nearby community of Burin	Emergency Diesel Power for Construction Phase	no diesel emissions on-site; generator is located off-site			EA Registration s.2.3.6
Temporary Staging Area	Temporary Oil and Fuel Storage	assuming negligible emissions			EA Registration s.2.3.7
Temporary Staging Area	Temporary Portable Office/Dining Trailers Comfort Heating	no emissions. Electrical heating for temporary buildings			provided by CFI

Area	Source	Parameter	Known Value	Assumed Value	Notes (source of data/ rationale for assumption)
SCENARIO 2 - OPERATION PHASE					
		operating hours	20 hours/day, 350 days per year, 2 shifts/day, 9.7 productive hrs/shift 8400 hours/year		PFS - Table 16-13 on page 16-176; and PFS Mill Design Criteria, s. 1.7
		average daily ore mining rate	1,900 tonnes/day		PFS Study s.22.1 average tonnes per day mined from the AGS mine. Confirmed by CFI
Open Pit Mines	It is assumed that the worst-case emissions from open pits will occur in 2019 when 100% of ore mining is occurring from Grebes Nest Pit. All data below is with respect to mining the GNP Pit				
	Open Pit Drilling	total number of holes drilled per day	80 holes/day		provided by CFI
		control efficiency for drilling (%)		70%	EA Registration s.7.2.2 states appropriate BMPs will be implemented. 70% control efficiency applied as per Table 4 of the NPI Emissions Estimation Technique Manual for Mining, Version 3.0, dated June 2011
	Open Pit Blasting	Blast hole depth (ore) (m)	10.8 m		PFS - s.16.6.1
		Density of ore (g/cm3)	2.92 g/cm3		provided by CFI
		Tonnes ore blasted per blast	15000 tonnes		provided by CFI
		maximum surface area blasted per blast (m2)	60 m2		provided by CFI
		kg emulsion per blast (ore)	700 kg		provided by CFI. 700 kgs / d emulsion at 1 blast / d
		number of blasts per day (ore)	1 blast/day		provided by CFI
		Blast hole depth (waste rock) (m)	22.5 m		PFS - s.16.6.1
		Density of waste rock (g/cm3)	1 g/cm3		PFS Table 16-20
		Tonnes waste rock blasted per blast	53000 tonnes		provided by CFI
		maximum surface area blasted per blast (m2)	600 m2		provided by CFI
		kg emulsion per blast (waste rock)	4300 kg		provided by CFI
		number of blasts per day (waste rock)	1 blast/day		provided by CFI

Area	Source	Parameter	Known Value	Assumed Value	Notes (source of data/ rationale for assumption)
	Open Pit Mining Equipment	It is assumed that all mine equipment is diesel powered			
		Hydraulic Excavator ore/waste CAT 390FL	391 kW		PFS Table 16-12
			1 unit		
			56 L/hr average fuel consumption		PFS Table 21-11
		Hydraulic Excavator ovb/ore CAT 374FL	352 kW		PFS Table 16-12
			1 unit		
			62 L/hr average fuel consumption		PFS Table 21-11
		Rigid Haul Truck ore/waste CAT 773G	578 kW		PFS Table 16-12
			3 units		
			57 L/hr average fuel consumption		PFS Table 21-11
		Articulated Haul Truck ovb/ore CAT 740B	365 kW		PFS Table 16-12
			1 unit		
			46 L/hr average fuel consumption		PFS Table 21-11
		Drill rig ore AC DTH	168 kW		PFS Table 16-12
			1 unit		
			22 L/hr average fuel consumption		PFS Table 21-11
		Drill rig waste AC DTH	420 kW		PFS Table 16-12
			1 unit		
			65 L/hr average fuel consumption		PFS Table 21-11
		Wheel Loader CAT 980K	303 kW		PFS Table 16-12
			1 unit		
			25 L/hr average fuel consumption		PFS Table 21-11
		Wheel Dozer CAT 844H	468 kW		PFS Table 16-12
			1 unit		
			56 L/hr average fuel consumption		PFS Table 21-11
		Track Dozer CAT D9	325 kW		PFS Table 16-12
			1 unit		
			46 L/hr average fuel consumption		PFS Table 21-11
		Motor Grader CAT 14M	193 kW		PFS Table 16-12
			1 unit		
			18 L/hr average fuel consumption		PFS Table 21-11
		Water/Sander Truck (oil highway truck)	269 kW		PFS Table 16-12
			1 unit		
			57 L/hr average fuel consumption		PFS Table 21-11
		Hydraulic Excavator CAT 320E L	114 kW		PFS Table 16-12
			1 unit		
			18 L/hr average fuel consumption		

Area	Source	Parameter	Known Value	Assumed Value	Notes (source of data/ rationale for assumption)
		Tow Truck CAT	365 kW 1 unit 56 L/hr average fuel consumption		PFS Table 16-12
		Tow Low Boy LPM (120-48-20)	1 unit 57 L/hr average fuel consumption	365 kW	assumed same as Tow Truck
		Fuel/Lube Truck CT660	150 kW 1 unit 28.2 L/hr average fuel consumption		provided by CFI
		Service Truck Kalmar DCD200-12lb	269 kW 1 unit 50 L/hr average fuel consumption		
		Bulk ANFO Explosives Truck	1 unit 28.2 L/hr average fuel consumption	365 kW	assumed same as Tow Truck
		Mini Bus Ford E Series	1 unit 10 L/hr average fuel consumption	365 kW	assumed same as Tow Truck
		Pick Up Truck 4x4 crew cab Chevrolet	1 unit 6 L/hr average fuel consumption	365 kW	assumed same as Tow Truck
		Light Tower	3 units 2 L/hr average fuel consumption	70 kW	assumed based on similar sites
		Dewatering Pump	3 units 75 L/hr average fuel consumption	500 hp	assumed based on similar sites provided by CFI
In order to quantify some emissions from underground mining, only sources that are specific to underground mining were quantified since the worst case emissions occur during open pit mining. This is conservative because it assumes emissions from some of the underground mining activities occur at the same time as the open pit activities. This is to avoid having to quantify multiple production years.					
Underground Mine	Propane-fired Underground Mine Heating	total heat input (BTU/hr) rating of mine heating		8.5 million BTU/hr	assumed based on similar sites
	Underground Mine Standby Diesel Generator	power rating	1 MW		PFS s.18.7, p. 18-233
Above-Ground Ore Stockpiles	Material Handling	amount of material stockpiled (tonnes/day)		1900 tonnes/day	EA Registration s.2.4.1.3 - stockpiles for ore blending between pit and UG. Utilized during Year 1 of operation to achieve min head grade. Separate AG assumed based on PFS Study s.22.1 average tonnes per day mined from the AGS mine
		moisture content (%)	4% moisture		Worley Parsons Mill design criteria s.3.1 run-of-mine material moisture content

Area	Source	Parameter	Known Value	Assumed Value	Notes (source of data/ rationale for assumption)
Waste Rock Stockpiles	Material Handling	amount of material stockpiled (tonnes/day)		7142 tonnes/day	EA Registration s.2.2.2 and Figure 2-11 - approx maximum waste rock generated from the GNP 2.5 M tonnes in 2023, assumed as the worst case annual generation rate. Converted to tonnes/day based on 350 operating
		moisture content (%)		5% moisture	assumed based on similar sites
Mill Operations		plant operating hours per day (hours/day)	24 hours/day		Worley Parsons Mill design criteria Table 3-5 Production Rate and Plant
	It is assumed that power for all mill equipment will be electric, as per the EA Registration Report that main power for the Mill will come from the provincial grid.				
	Run-Of-Mine Ore Transfer to Stationary Grizzly	material handling rate (tonnes/day)		2138 tonnes/day	Process described in EA Registration s.2.4.1.3 and s.2.4.2; and Worley Parsons Mill design criteria s.3.4. Material rate assumed based on Worley Parsons Mill design criteria Table 3-6 Crushing Plant Design Criteria, total
		moisture content (%)	4% moisture		
	Primary Jaw Crusher	assuming electric powered			EA Registration Report says main power will come from the grid
	Secondary Cone Crusher	assuming electric powered			EA Registration Report says main power will come from the grid
	Tertiary Cone Crusher	assuming electric powered			EA Registration Report says main power will come from the grid
	Crushing Circuit Dust Collector (Primary, Secondary and Tertiary Crushers, Screening, Transfer Points, and Fine Ore Bin Loading)				Worley Parsons Mill design criteria section 3.4.1 - the crushing circuit is to be located in a standalone building with dust control implemented. A baghouse dust collection system will collect dust throughout crushing circuit at various points (EA Registration s.2.4.1.3, p. 30; s.2.4.2, p. 33, and PFDs from PFS)
		dust collector exhaust flowrate (m3/hr)		24,000 m3/hr	assumed flowrate based on similar operations
		total suspended particulate (TSP) concentration in dust collector exhaust (mg/m3)		23 mg/m3	assumed conservative outlet loading of dust collector, per AWMA Air Pollution Engineering Manual
	Transfer from Fine Ore Bin to Dense Media Separator Feed Conveyor	material transfer rate (tonnes/hour)	89.1 tonnes/hour		Worley Parsons Mill design criteria section 3.6.1 DMS design feed rate
		moisture content (%)		4% moisture	Table 3-5 Production Rate and Plant Availability
		operating hours per day (hours/day)	24 hours/day		assuming this is not ducted through dust collector, from PFD of process
	DMS Feed Prep Screen, De-Sliming Process, Transfer to Dense Media Separator	assuming no emissions. Fine ore fraction is washed from the feed at prep screen, so assuming feed is wet. Desliming cyclone product is wet (50% water).			Worley Parsons Mill design criteria section 3.6; App B mass balance PFD
	De-Sliming Hydrocyclones	assuming no emissions. Material is fed as a slurry			Worley Parsons Mill design criteria Table 3-11 De-Slime Hydrocyclone Design Criteria
	Dense Media Separator	assuming no emissions. Ore is fed to DMS with a stream of slurried ferrosilicon. Assuming material is wet enough that there are no emissions.			PFS s.17.2.6, p. 17-189; Worley Parsons Mill design criteria section 3.6 and PFD -0002
	DMS Sink and Float Wash Screens	assuming no emissions. Products washed with process water, assuming material is wet			Worley Parsons Mill design criteria section 3.6
	Screened Float Product Stockpiling	assuming no emissions. Products washed with process water, assuming material is wet			PFD -0002 from PFS
	Sink Product Ball Mill Grinding and Ball Mill Hydrocyclones	assuming no emissions. Ball mill is a closed circuit and material is fed as a pulp. Hydrocyclone feed is a slurry. Hydrocyclone overflow is 65% liquid (35% solids w/w)			Worley Parsons Mill design criteria section 3.7, Table 3-12, and PFD -0003 from PFS. Note Soda Ash (sodium carbonate) is used here (Table 17-1. Dry reagent). PFS s.17.3.2, p. 17-190; Worley Parsons Mill design criteria Table 3-13 and

Area	Source	Parameter	Known Value	Assumed Value	Notes (source of data/ rationale for assumption)
	Sink Product Sulphide Flotation	potassium amyl xanthate solution usage rate	50 g per tonne of flotation feed		EA Registration s.2.4.2, p. 36; Worley Parsons Mill design criteria Table 3-28
		xanthate solution concentration (%)		10% PAX	concentration assumed based on July 7 conference call with CFI - chemicals are added as liquids to the process, between 5-10% concentrate
		xanthate solution density (g/cm3)		1 g/cm3	assumed similar to water
		pH of solution		assume alkaline	assuming alkaline, based on information from CFI that the tailings will be alkaline at ~pH8.2
		MIBC	20 g per tonne flotation feed		Worley Parsons Mill design criteria Table 3-34. It is assumed that there are no emissions associated with MIBC usage
		total flotation slurry feed (m3/hr)	150.78 m3/hr		Worley Parsons Mill design criteria App B - Mass Balance
		slurry specific gravity	1.27		Worley Parsons Mill design criteria App B - Mass Balance
		mass rate of flotation feed (tonnes/hr)	191.5 tonnes/hr		calculated from slurry feed m3/hr and slurry specific gravity
		operating hours per day (hours/day)		24 hours/day	assumed based on Mill Design Criteria Table 3-5 Production Rate and Plant Availability
	Pulp Thickening	assuming no emissions, confirmed by CFI. Thickening tank is open, but agitation is slow.			Worley Parsons Mill design criteria PFD -0003 and -0004, Table 3-16
	Pulp Conditioning, Rougher and Scavenger Flotation, Flotation Cleaner Circuit	assuming no emissions, confirmed by CFI.			conditioners/cleaners are non-volatile (internet data search) and in solution (soda ash, quebracho, emulsified tall oil, caustic dextrin, sodium silicate). U.S. EPA emissions document for similar non-metallic mineral processing of feldspar does not indicate emissions from flotation process
	Final Concentrate Thickening and Filtration	assuming no emissions, confirmed by CFI			confirmed by CFI
	Concentrate Stockpile Conveyor Transfers	assuming no emissions due to the high moisture content of the concentrate			Worley Parsons Mill design criteria App B- Mass Balance (25.88 tph solids rate, at 90% solids in the stream = stream total mass transfer is 28.76 tph) EA Registration s.2.4.2, p. 35 and Worley Parsons Mill design criteria Table 3-27, filtration design criteria allowable moisture in final concentrate is 8-10%
	On-spec Concentrate Stockpile Load	material transfer rate		21.57 tonnes/hour on-spec product	From mill design criteria App B stream total mass transfer is 28.76 tph PFS s.17.5.3, p. 17-193 main stockpile will contain ~ 15,000 tonnes on-spec material. Off-spec stockpile ~ 5000 tonnes. Total 20,000 tonnes product - 75% on-spec
		operating hours per day (hours/day)		24 hours/day	
		material moisture content (%)		8% moisture	
	Off-spec Concentrate Stockpile Load	material transfer rate		7.19 tonnes/hour off-spec product	From mill design criteria App B stream total mass transfer is 28.76 tph PFS s.17.5.3, p. 17-193 main stockpile will contain ~ 15,000 tonnes on-spec material. Off-spec stockpile ~ 5000 tonnes. Total 20,000 tonnes product - 25% off-spec
		operating hours per day (hours/day)		24 hours/day	
		material moisture content (%)		8% moisture	
	Haul Truck Loading for Concentrate Transport to Marine Terminal	material transfer rate (tonnes/hour)		500 tonnes/hour	EA Registration s.2.4.8, p. 41 - assumed truck loading is same as loading rate of ship feeder
		empty vehicle weight (tonnes)		15 tonnes empty truck weight	assumed truck weight and capacity based on similar operations
		capacity of one truck (tonnes)	50 tonnes carried per trip		truck payload provided by CFI
		operating hours per day	20 hours/day		based on info from CFI that 10,000 tpd would be loaded at a rate of 500 tph. Loading would then need to occur for 20 hours/day.
	Emergency Diesel Generator at Mill	power rating (kW)		250 kW	EA Registration Table 2-8

Area	Source	Parameter	Known Value	Assumed Value	Notes (source of data/ rationale for assumption)
Unpaved Haul Roads	Road Dust	emissions control factor (%)		75% control	EA Registration s.7.2.2 states appropriate BMPs will be implemented same as for construction phase. 75% control (Australian NPI Emissions Estimation Technique Manual for Mining)
		silt content (%)		silt content = 8.3 %	silt content from AP-42 Table 13.2.2-1 for stone quarrying and processing haul
	Road - GNP In-Pit	road length (km)	1.25 km		road length from GIS and EA Registration figures
		empty vehicle weight (tonnes)		15 tonnes empty vehicle weight	assumed empty vehicle weight
		capacity of one truck (tonnes)	37.8 tonnes carried per trip		EA Registration s.2.3.5, p. 25; PFS s.18.1.16, p. 18-205; PFS s.16.4.5, p. 16-175 capacity of the CAT 740B; PFS Table 16-7, p. 16-172
		ore haulage rate (tonnes/day)	1900 tonnes/day		PFS Study s.22.1 average tonnes per day mined from the AGS mine
		number of trips per day		101 trips per day	Based on 1900 tonnes hauled per day/37.8 tonnes carried per trip, multiplied by 2 to account for travel both out and back into pit
	GNP Haul Road to North Dump	road length (km)	1.18 km		road length from GIS and EA Registration figures
		waste rock haulage rate (tonnes/day)		7142 tonnes/day	EA Registration s.2.2.2 and Figure 2-11 - approx maximum waste rock generated from the GNP 2.5 M tonnes in 2023, assumed as the worst case annual generation rate. converted to tonnes/day based on 350 operating days/year
		empty vehicle weight (tonnes)		15 tonnes empty vehicle weight	assumed empty vehicle weight
		capacity of one truck (tonnes)	57.5 tonnes carried per trip		capacity of the waste haul truck; PFS Table 16-7, p. 16-172
		number of trips per day		248 trips per day	based on 7142 tonnes hauled per day/57.5 tonnes carried per trip, multiplied
	Surface Haul Road - GNP Pit Exit to Mill	road length (km)	2.42 km		estimated road length from EA Registration figures
		empty vehicle weight (tonnes)		15 tonnes empty vehicle weight	assumed empty vehicle weight
		capacity of one truck (tonnes)	49.3 tonnes carried per trip		CAT 773G; PFS Table 16-7, p. 16-172
		ore haulage rate (tonnes/day)	1900 tonnes/day		PFS Study s.22.1 average tonnes per day mined from the AGS mine
		number of trips per day		77 trips per day	based on 1900 tonnes hauled per day/49.3 tonnes carried per trip, multiplied by 2 to account for travel to and from pit

Area	Source	Parameter	Known Value	Assumed Value	Notes (source of data/ rationale for assumption)
	Haul Road from Mill Site to Marine Terminal	road length (km)	5.45 km		road length from GIS and EA Registration figures
		empty vehicle weight (tonnes)		15 tonnes empty vehicle weight	assumed empty vehicle weight
		capacity of one truck (tonnes)	50 tonnes carried per trip		truck payload provided by CFI
		concentrate transport rate (tonnes/hour)		500 tonnes/hour	EA Registration s.2.4.8, p. 41 - assumed concentrate transport rate is same as loading rate of ship feeder
		hours of haulage per day (hours/day)	20 hours/day		based on info from CFI that 10,000 tpd would be loaded at a rate of 500 tph. Transport would then need to occur for 20 hours/day.
		number of days per year that material is hauled (days/year)	40 days/year		Per CFI, there will only be 40 days out of the year where materials will be hauled and loaded onto ships
				400 trips/day	calculated from truck capacity and 10,000 tonnes hauled per day
Tailings Management Facility	Tailings Pond	pH of tails	8.2		provided by CFI. The tailings leaving the mill will be alkaline, estimated at pH 8.2 from testwork
		potassium amyl xanthate discharge rate		0.01 kg/hr	assuming there will be residual xanthate present in tailings from the flotation circuit. Assume ~1% of xanthates used in flotation will be discharged in tailings based on Australian NPI Emissions Estimation Technique Manual for Mining
		xanthate solution concentration (%)		10% PAX	assumed same as concentration of solution added to flotation process, which was assumed based on July 7 conference call with CFI - chemicals are added as liquids to the process, between 5-10% concentrate
		xanthate solution density (g/cm3)		1 g/cm3	
Ancillary Offices, Assay Lab, Maintenance/ Warehouse, Security Building, Mine/Mill	no emissions	It is assumed that these are heated by electricity. Assuming Lab is for QA/QC purposes only			Per EA Registration Report, main power will come from the electrical grid. Confirmed by CFI

APPENDIX F

Emissions Summary Table

Emissions Summary Table

Source ID	Source Description	Compound	1 - hr		24 - hr			Annual		
			ER [g/s]	% of Overall g/s Emissions for Scenario	ER [g/s]	ER [kg/day]	% of Overall kg/day Emissions for Scenario	ER [g/s]	ER [kg/year]	% of Overall kg/year Emissions for Scenario
Scenario 1 - Project Construction Phase										
OB_MH	Overburden Material Handling	PM	0.02	<1%	0.02	1.31	<1%	0.005	157.34	<1%
		PM10	0.007	<1%	0.007	0.62	<1%	0.002	74.42	<1%
		PM2.5	0.001	<1%	0.001	0.09	<1%	3.57E-04	11.27	<1%
OB_BD	Overburden Dump Bulldozing	PM	0.50	10%	0.50	43.14	12%	0.16	5,181.21	8%
		PM10	0.09	5%	0.09	8.13	6%	0.03	976.39	3%
		PM2.5	0.05	4%	0.05	4.53	5%	0.02	544.03	2%
C_WR	Waste Rock Material Handling	PM	0.15	3%	0.15	12.63	3%	0.05	1,517.42	2%
		PM10	0.07	3%	0.07	5.98	4%	0.02	717.70	2%
		PM2.5	0.01	<1%	0.01	0.90	1%	0.003	108.68	<1%
		Antimony	6.73E-07	4%	6.73E-07	5.81E-05	6%	2.21E-07	0.01	4%
		Arsenic	1.90E-05	4%	1.90E-05	0.002	6%	6.26E-06	0.20	4%
		Barium	1.39E-04	4%	1.39E-04	0.01	6%	4.57E-05	1.44	4%
		Beryllium	2.63E-06	4%	2.63E-06	2.27E-04	6%	8.66E-07	0.03	4%
		Cadmium	3.66E-06	4%	3.66E-06	3.16E-04	6%	1.20E-06	0.04	4%
		Chromium	1.61E-05	4%	1.61E-05	0.001	6%	5.29E-06	0.17	4%
		Cobalt	2.92E-06	4%	2.92E-06	2.53E-04	6%	9.62E-07	0.03	4%
		Lithium	4.09E-05	4%	4.09E-05	0.004	6%	1.35E-05	0.42	4%
		Copper	2.34E-05	4%	2.34E-05	0.002	6%	7.70E-06	0.24	4%
		Lead	2.19E-04	7%	2.19E-04	0.02	12%	7.22E-05	2.28	7%
		Manganese	2.05E-04	4%	2.05E-04	0.02	6%	6.74E-05	2.12	4%
		Mercury	7.31E-08	4%	7.31E-08	6.32E-06	6%	2.41E-08	7.59E-04	4%
		Nickel	6.43E-06	4%	6.43E-06	5.56E-04	6%	2.12E-06	0.07	4%
		Selenium	1.46E-07	4%	1.46E-07	1.26E-05	6%	4.81E-08	0.002	4%
		Silver	1.01E-07	4%	1.01E-07	8.72E-06	6%	3.32E-08	0.001	4%
		Vanadium	1.42E-05	4%	1.42E-05	0.001	6%	4.67E-06	0.15	4%
		Zinc	7.31E-04	7%	7.31E-04	0.06	10%	2.41E-04	7.59	6%
WR_BD	Waste Rock Dump Bulldozing	PM	0.50	10%	0.50	43.14	12%	0.16	5,181.21	8%
		PM10	0.09	5%	0.09	8.13	6%	0.03	976.39	3%
		PM2.5	0.05	4%	0.05	4.53	5%	0.02	544.03	2%
		Antimony	2.30E-06	15%	2.30E-06	1.98E-04	20%	7.56E-07	0.02	15%
		Arsenic	6.49E-05	15%	6.49E-05	0.01	20%	2.14E-05	0.67	15%
		Barium	4.74E-04	15%	4.74E-04	0.04	20%	1.56E-04	4.92	15%
		Beryllium	8.99E-06	15%	8.99E-06	7.77E-04	20%	2.96E-06	0.09	15%
		Cadmium	1.25E-05	15%	1.25E-05	0.001	20%	4.11E-06	0.13	15%
		Chromium	5.49E-05	15%	5.49E-05	0.005	20%	1.81E-05	0.57	15%
		Cobalt	9.99E-06	15%	9.99E-06	8.63E-04	20%	3.29E-06	0.10	15%
		Lithium	1.40E-04	15%	1.40E-04	0.01	20%	4.60E-05	1.45	15%
		Copper	7.99E-05	15%	7.99E-05	0.01	20%	2.63E-05	0.83	15%
		Lead	7.49E-04	25%	7.49E-04	0.06	41%	2.46E-04	7.77	25%
		Manganese	6.99E-04	15%	6.99E-04	0.06	20%	2.30E-04	7.25	15%
		Mercury	2.50E-07	15%	2.50E-07	2.16E-05	20%	8.21E-08	0.003	15%
		Nickel	2.20E-05	15%	2.20E-05	0.002	20%	7.23E-06	0.23	15%
		Selenium	4.99E-07	15%	4.99E-07	4.31E-05	20%	1.64E-07	0.01	15%
		Silver	3.45E-07	15%	3.45E-07	2.98E-05	20%	1.13E-07	0.004	15%
		Vanadium	4.84E-05	15%	4.84E-05	0.004	20%	1.59E-05	0.50	15%
		Zinc	0.002	22%	0.002	0.22	34%	8.21E-04	25.91	22%

Source ID	Source Description	Compound	1 - hr		24 - hr			Annual		
			ER [g/s]	% of Overall g/s Emissions for Scenario	ER [g/s]	ER [kg/day]	% of Overall kg/day Emissions for Scenario	ER [g/s]	ER [kg/year]	% of Overall kg/year Emissions for Scenario
TP_BD	Topsoil Bulldozing	PM	0.50	10%	0.50	43.14	12%	0.16	5,181.21	8%
		PM10	0.09	5%	0.09	8.13	6%	0.03	976.39	3%
		PM2.5	0.05	4%	0.05	4.53	5%	0.02	544.03	2%
TP_MH	Topsoil Material Handling	PM	0.003	<1%	0.003	0.22	<1%	0.001	26.22	<1%
		PM10	0.001	<1%	0.001	0.10	<1%	3.93E-04	12.40	<1%
		PM2.5	1.81E-04	<1%	1.81E-04	0.02	<1%	5.96E-05	1.88	<1%
P_DEV	Surface Drilling and Blasting (Portal Development)	PM	0.16	3%	0.16	14.16	4%	0.17	5,329.00	8%
		PM10	0.08	4%	0.08	7.08	5%	0.08	2,664.50	7%
		PM2.5	0.04	3%	0.04	3.54	4%	0.04	1,332.25	5%
		Antimony	7.54E-07	5%	7.54E-07	6.51E-05	7%	7.77E-07	0.02	16%
		Arsenic	2.13E-05	5%	2.13E-05	0.002	7%	2.20E-05	0.69	16%
		Barium	1.56E-04	5%	1.56E-04	0.01	7%	1.61E-04	5.06	16%
		Beryllium	2.95E-06	5%	2.95E-06	2.55E-04	7%	3.04E-06	0.10	16%
		Cadmium	4.10E-06	5%	4.10E-06	3.54E-04	7%	4.22E-06	0.13	16%
		Chromium	1.80E-05	5%	1.80E-05	0.002	7%	1.86E-05	0.59	16%
		Cobalt	3.28E-06	5%	3.28E-06	2.83E-04	7%	3.38E-06	0.11	16%
		Lithium	4.59E-05	5%	4.59E-05	0.004	7%	4.73E-05	1.49	16%
		Copper	2.62E-05	5%	2.62E-05	0.002	7%	2.70E-05	0.85	16%
		Lead	2.46E-04	8%	2.46E-04	0.021	14%	2.53E-04	7.99	26%
		Manganese	2.29E-04	5%	2.29E-04	0.02	7%	2.37E-04	7.46	16%
		Mercury	8.19E-08	5%	8.19E-08	7.08E-06	7%	8.45E-08	0.003	16%
		Nickel	7.21E-06	5%	7.21E-06	6.23E-04	7%	7.44E-06	0.23	16%
		Selenium	1.64E-07	5%	1.64E-07	1.42E-05	7%	1.69E-07	0.01	16%
		Silver	1.13E-07	5%	1.13E-07	9.77E-06	7%	1.17E-07	0.004	16%
		Vanadium	1.59E-05	5%	1.59E-05	0.001	7%	1.64E-05	0.52	16%
		Zinc	8.19E-04	7%	8.19E-04	0.07	11%	8.45E-04	26.65	23%
		CO	0.06	<1%	0.005	0.46	<1%	0.005	167.90	<1%
		NOX	0.006	<1%	4.63E-04	0.04	<1%	4.63E-04	14.60	<1%
PIT_DEV	Surface Drilling and Blasting (Open Pit Development)	PM	0.93	18%	0.16	14.16	4%	0.20	6,385.88	9%
		PM10	0.46	22%	0.08	7.08	5%	0.10	3,192.94	9%
		PM2.5	0.23	19%	0.04	3.54	4%	0.05	1,596.47	6%
		Antimony	4.26E-06	28%	7.54E-07	6.51E-05	7%	9.31E-07	0.03	19%
		Arsenic	1.20E-04	28%	2.13E-05	0.002	7%	2.63E-05	0.83	19%
		Barium	8.80E-04	28%	1.56E-04	0.01	7%	1.92E-04	6.07	19%
		Beryllium	1.67E-05	28%	2.95E-06	2.55E-04	7%	3.64E-06	0.11	19%
		Cadmium	2.32E-05	28%	4.10E-06	3.54E-04	7%	5.06E-06	0.16	19%
		Chromium	1.02E-04	28%	1.80E-05	0.002	7%	2.23E-05	0.70	19%
		Cobalt	1.85E-05	28%	3.28E-06	2.83E-04	7%	4.05E-06	0.13	19%
		Lithium	2.59E-04	28%	4.59E-05	0.004	7%	5.67E-05	1.79	19%
		Copper	1.48E-04	28%	2.62E-05	0.002	7%	3.24E-05	1.02	19%
		Lead	0.001	47%	2.46E-04	0.02	14%	3.04E-04	9.58	31%
		Manganese	0.001	28%	2.29E-04	0.02	7%	2.83E-04	8.94	19%
		Mercury	4.63E-07	28%	8.19E-08	7.08E-06	7%	1.01E-07	0.003	19%
		Nickel	4.08E-05	28%	7.21E-06	6.23E-04	7%	8.91E-06	0.28	19%
		Selenium	9.27E-07	28%	1.64E-07	1.42E-05	7%	2.02E-07	0.01	19%
		Silver	6.39E-07	28%	1.13E-07	9.77E-06	7%	1.40E-07	0.004	19%
		Vanadium	8.99E-05	28%	1.59E-05	0.001	7%	1.96E-05	0.62	19%
		Zinc	0.005	42%	8.19E-04	0.07	11%	0.001	31.93	27%
		CO	3.19	44%	0.13	11.50	3%	0.13	4,197.50	3%
		NOX	0.28	2%	0.01	1.00	<1%	0.01	365.00	<1%

Source ID	Source Description	Compound	1 - hr		24 - hr			Annual		
			ER [g/s]	% of Overall g/s Emissions for Scenario	ER [g/s]	ER [kg/day]	% of Overall kg/day Emissions for Scenario	ER [g/s]	ER [kg/year]	% of Overall kg/year Emissions for Scenario
GNP_DWP	Diesel Powered Dewatering Pump	PM	0.04	<1%	0.04	3.60	<1%	0.04	1,312.42	2%
		DPM	0.04	6%	0.04	3.60	6%	0.04	1,312.42	6%
		PM10	0.04	2%	0.04	3.60	2%	0.04	1,312.42	4%
		PM2.5	0.04	3%	0.04	3.49	4%	0.04	1,273.05	5%
		CO	0.13	2%	0.13	10.92	3%	0.13	3,984.99	3%
		NOX	0.59	5%	0.59	50.67	5%	0.59	18,493.24	5%
		SO2	8.96E-05	<1%	8.96E-05	0.01	<1%	8.96E-05	2.82	<1%
C_GEN	Portable Diesel Powered Generators (3 units total)	PM	0.02	<1%	0.02	2.08	<1%	0.01	379.88	<1%
		DPM	0.02	3%	0.02	2.08	3%	0.01	379.88	2%
		PM10	0.02	1%	0.02	2.08	1%	0.01	379.88	1%
		PM2.5	0.02	2%	0.02	2.01	2%	0.01	368.49	1%
		CO	0.13	2%	0.13	11.66	3%	0.07	2,133.68	2%
		NOX	0.40	3%	0.40	34.60	3%	0.20	6,331.40	2%
		SO2	8.01E-04	4%	8.01E-04	0.07	4%	4.01E-04	12.66	2%
C_UPR	Construction Phase Unpaved Roads Fugitive Dust	PM	1.54	31%	1.54	132.91	36%	0.51	15,962.36	24%
		PM10	0.44	21%	0.44	37.79	26%	0.14	4,539.12	12%
		PM2.5	0.04	4%	0.04	3.78	4%	0.01	453.91	2%
		Antimony	7.08E-06	47%	7.08E-06	6.11E-04	61%	2.33E-06	0.07	46%
		Arsenic	2.00E-04	47%	2.00E-04	0.02	61%	6.58E-05	2.08	46%
		Barium	0.001	47%	0.001	0.13	61%	4.81E-04	15.16	46%
		Beryllium	2.77E-05	47%	2.77E-05	0.002	61%	9.11E-06	0.29	46%
		Cadmium	3.85E-05	47%	3.85E-05	0.003	61%	1.27E-05	0.40	46%
		Chromium	1.69E-04	47%	1.69E-04	0.01	61%	5.57E-05	1.76	46%
		Cobalt	3.08E-05	47%	3.08E-05	0.003	61%	1.01E-05	0.32	46%
		Lithium	4.31E-04	47%	4.31E-04	0.04	61%	1.42E-04	4.47	46%
		Copper	2.46E-04	47%	2.46E-04	0.02	61%	8.10E-05	2.55	46%
		Lead	3.54E-04	12%	3.54E-04	0.03	20%	1.16E-04	3.67	12%
		Manganese	0.002	47%	0.002	0.19	61%	7.09E-04	22.35	46%
		Mercury	7.69E-07	47%	7.69E-07	6.65E-05	61%	2.53E-07	0.01	46%
		Nickel	6.77E-05	47%	6.77E-05	0.006	61%	2.23E-05	0.70	46%
		Selenium	1.54E-06	47%	1.54E-06	1.33E-04	61%	5.06E-07	0.02	46%
		Silver	1.06E-06	47%	1.06E-06	9.17E-05	61%	3.49E-07	0.01	46%
		Vanadium	1.49E-04	47%	1.49E-04	0.01	61%	4.91E-05	1.55	46%
		Zinc	0.002	22%	0.002	0.21	34%	8.10E-04	25.54	22%
C_TP	Construction Phase Vehicle Tailpipe Emissions	PM	0.66	13%	0.66	57.22	16%	0.66	20886.65	31%
		DPM	0.66	91%	0.66	57.22	91%	0.66	20886.65	93%
		PM10	0.66	32%	0.66	57.22	39%	0.66	20886.65	57%
		PM2.5	0.64	54%	0.64	55.51	64%	0.64	20260.05	75%
		CO	3.70	51%	3.70	319.49	90%	3.70	116612.36	92%
		NOX	11.46	90%	11.46	990.34	92%	11.46	361474.66	93%
		SO2	0.02	96%	0.02	1.87	96%	0.02	683.24	98%

Source ID	Source Description	Compound	1 - hr		24 - hr			Annual		
			ER [g/s]	% of Overall g/s Emissions for Scenario	ER [g/s]	ER [kg/day]	% of Overall kg/day Emissions for Scenario	ER [g/s]	ER [kg/year]	% of Overall kg/year Emissions for Scenario
Scenario 2 - Project Operations Phase										
PIT_DB	Open Pit Drilling and Blasting	PM	0.93	3%	0.14	11.80	<1%	0.13	4,130.00	3%
		PM10	0.46	5%	0.07	5.90	<1%	0.07	2,065.00	4%
		PM2.5	0.23	13%	0.03	2.95	3%	0.03	1,032.50	8%
		Antimony	4.26E-06	12%	6.28E-07	5.43E-05	2%	6.02E-07	0.02	6%
		Arsenic	1.20E-04	12%	1.78E-05	0.002	2%	1.70E-05	0.54	6%
		Barium	8.80E-04	12%	1.30E-04	0.01	2%	1.24E-04	3.92	6%
		Beryllium	1.67E-05	12%	2.46E-06	2.12E-04	2%	2.36E-06	0.07	6%
		Cadmium	2.32E-05	12%	3.41E-06	2.95E-04	2%	3.27E-06	0.10	6%
		Chromium	1.02E-04	12%	1.50E-05	0.001	2%	1.44E-05	0.45	6%
		Cobalt	1.85E-05	12%	2.73E-06	2.36E-04	2%	2.62E-06	0.08	6%
		Lithium	2.59E-04	12%	3.82E-05	0.003	2%	3.67E-05	1.16	6%
		Copper	1.48E-04	12%	2.19E-05	0.002	2%	2.10E-05	0.66	6%
		Lead	0.001	41%	2.05E-04	0.02	10%	1.96E-04	6.20	20%
		Manganese	0.001	12%	1.91E-04	0.02	2%	1.83E-04	5.78	6%
		Mercury	4.63E-07	12%	6.83E-08	5.90E-06	2%	6.55E-08	0.002	6%
		Nickel	4.08E-05	12%	6.01E-06	5.19E-04	2%	5.76E-06	0.18	6%
		Selenium	9.27E-07	12%	1.37E-07	1.18E-05	2%	1.31E-07	0.004	6%
		Silver	6.39E-07	12%	9.42E-08	8.14E-06	2%	9.04E-08	0.003	6%
		Vanadium	8.99E-05	12%	1.32E-05	0.001	2%	1.27E-05	0.40	6%
		Zinc	0.005	28%	6.83E-04	0.06	6%	6.55E-04	20.65	14%
		CO	3.19	48%	0.13	11.50	6%	0.13	4,025.00	9%
		NOX	0.28	1%	0.01	1.00	<1%	0.01	350.00	<1%
PIT_EQUIP	Open Pit Mining Equipment	PM	0.24	<1%	0.20	17.41	<1%	0.19	6,091.83	4%
		DPM	0.24	38%	0.20	17.41	52%	0.19	6,091.83	90%
		PM10	0.24	3%	0.20	17.41	3%	0.19	6,091.83	13%
		PM2.5	0.23	14%	0.20	16.88	17%	0.19	5,909.08	47%
		CO	1.49	22%	1.24	107.38	56%	1.19	37,581.68	81%
		NOX	4.81	24%	4.01	346.52	29%	3.85	121,282.04	77%
		SO2	0.008	<1%	0.006	0.56	<1%	0.006	196.22	2%
U_PH	Propane-fired Underground Mine Heating	PM	0.008	<1%	0.007	0.59	<1%	0.007	206.47	<1%
		PM10	0.008	<1%	0.007	0.59	<1%	0.007	206.47	<1%
		PM2.5	0.008	<1%	0.007	0.59	<1%	0.007	206.47	2%
		CO	0.09	1%	0.07	6.32	3%	0.07	2,212.19	5%
		NOX	0.15	<1%	0.13	10.96	<1%	0.12	3,834.47	2%
		SO2	2.11E-04	<1%	1.76E-04	0.02	<1%	1.68E-04	5.31	<1%
U_EPG	Underground Mine Standby Diesel Generator	PM	0.12	<1%	0.005	0.43	<1%	6.75E-04	21.29	<1%
		DPM	0.12	19%	0.005	0.43	1%	6.75E-04	21.29	<1%
		PM10	0.12	1%	0.005	0.43	<1%	6.75E-04	21.29	<1%
		PM2.5	0.11	7%	0.005	0.41	<1%	6.55E-04	20.65	<1%
		CO	0.93	14%	0.04	3.35	2%	0.005	167.27	<1%
		NOX	4.06	20%	0.17	14.60	1%	0.02	729.92	<1%
		SO2	0.002	<1%	8.54E-05	0.01	<1%	1.17E-05	0.37	<1%

Source ID	Source Description	Compound	1 - hr		24 - hr			Annual		
			ER [g/s]	% of Overall g/s Emissions for Scenario	ER [g/s]	ER [kg/day]	% of Overall kg/day Emissions for Scenario	ER [g/s]	ER [kg/year]	% of Overall kg/year Emissions for Scenario
ORE_MH	Above-Ground Ore Material Handling	PM	0.04	<1%	0.04	3.07	<1%	0.01	369.12	<1%
		PM10	0.02	<1%	0.02	1.45	<1%	0.01	174.58	<1%
		PM2.5	0.003	<1%	0.003	0.22	<1%	0.001	26.44	<1%
		Antimony	1.64E-07	<1%	1.64E-07	1.41E-05	<1%	5.38E-08	0.002	<1%
		Arsenic	4.62E-06	<1%	4.62E-06	4.00E-04	<1%	1.52E-06	0.05	<1%
		Barium	3.38E-05	<1%	3.38E-05	0.003	<1%	1.11E-05	0.35	<1%
		Beryllium	6.40E-07	<1%	6.40E-07	5.53E-05	<1%	2.11E-07	0.01	<1%
		Cadmium	8.89E-07	<1%	8.89E-07	7.68E-05	<1%	2.93E-07	0.01	<1%
		Chromium	3.91E-06	<1%	3.91E-06	3.38E-04	<1%	1.29E-06	0.04	<1%
		Cobalt	7.11E-07	<1%	7.11E-07	6.15E-05	<1%	2.34E-07	0.01	<1%
		Lithium	9.96E-06	<1%	9.96E-06	8.61E-04	<1%	3.28E-06	0.10	<1%
		Copper	5.69E-06	<1%	5.69E-06	4.92E-04	<1%	1.87E-06	0.06	<1%
		Lead	5.34E-05	2%	5.34E-05	0.005	3%	1.76E-05	0.55	2%
		Manganese	4.98E-05	<1%	4.98E-05	0.004	<1%	1.64E-05	0.52	<1%
		Mercury	1.78E-08	<1%	1.78E-08	1.54E-06	<1%	5.85E-09	1.85E-04	<1%
		Nickel	1.57E-06	<1%	1.57E-06	1.35E-04	<1%	5.15E-07	0.02	<1%
		Selenium	3.56E-08	<1%	3.56E-08	3.07E-06	<1%	1.17E-08	3.69E-04	<1%
		Silver	2.45E-08	<1%	2.45E-08	2.12E-06	<1%	8.08E-09	2.55E-04	<1%
		Vanadium	3.45E-06	<1%	3.45E-06	2.98E-04	<1%	1.14E-06	0.04	<1%
		Zinc	1.78E-04	1%	1.78E-04	0.02	2%	5.85E-05	1.85	1%
OP_WR	Waste Rock Material Handling	PM	0.10	<1%	0.10	8.45	<1%	0.03	1,015.21	<1%
		PM10	0.05	<1%	0.05	4.00	<1%	0.02	480.17	1%
		PM2.5	0.007	<1%	0.007	0.61	<1%	0.002	72.71	<1%
		Antimony	4.50E-07	1%	4.50E-07	3.89E-05	2%	1.48E-07	0.005	2%
		Arsenic	1.27E-05	1%	1.27E-05	0.001	2%	4.18E-06	0.13	2%
		Barium	9.29E-05	1%	9.29E-05	0.008	2%	3.06E-05	0.96	2%
		Beryllium	1.76E-06	1%	1.76E-06	1.52E-04	2%	5.79E-07	0.02	2%
		Cadmium	2.45E-06	1%	2.45E-06	2.11E-04	2%	8.05E-07	0.03	2%
		Chromium	1.08E-05	1%	1.08E-05	9.30E-04	2%	3.54E-06	0.11	2%
		Cobalt	1.96E-06	1%	1.96E-06	1.69E-04	2%	6.44E-07	0.02	2%
		Lithium	2.74E-05	1%	2.74E-05	0.002	2%	9.01E-06	0.28	2%
		Copper	1.57E-05	1%	1.57E-05	0.001	2%	5.15E-06	0.16	2%
		Lead	1.47E-04	4%	1.47E-04	0.01	7%	4.83E-05	1.52	5%
		Manganese	1.37E-04	1%	1.37E-04	0.01	2%	4.51E-05	1.42	2%
		Mercury	4.89E-08	1%	4.89E-08	4.23E-06	2%	1.61E-08	5.08E-04	2%
		Nickel	4.30E-06	1%	4.30E-06	3.72E-04	2%	1.42E-06	0.04	2%
		Selenium	9.78E-08	1%	9.78E-08	8.45E-06	2%	3.22E-08	0.001	2%
		Silver	6.75E-08	1%	6.75E-08	5.83E-06	2%	2.22E-08	7.00E-04	2%
		Vanadium	9.49E-06	1%	9.49E-06	8.20E-04	2%	3.12E-06	0.10	2%
		Zinc	4.89E-04	3%	4.89E-04	0.04	4%	1.61E-04	5.08	3%

Source ID	Source Description	Compound	1 - hr		24 - hr			Annual		
			ER [g/s]	% of Overall g/s Emissions for Scenario	ER [g/s]	ER [kg/day]	% of Overall kg/day Emissions for Scenario	ER [g/s]	ER [kg/year]	% of Overall kg/year Emissions for Scenario
ROM	Run-Of-Mine Ore Transfer to Stationary Grizzly	PM	0.04	<1%	0.04	3.46	<1%	0.04	1,210.44	<1%
		PM10	0.02	<1%	0.02	1.64	<1%	0.02	572.51	1%
		PM2.5	0.003	<1%	0.003	0.25	<1%	0.003	86.69	<1%
		Antimony	1.84E-07	<1%	1.84E-07	1.59E-05	<1%	1.77E-07	0.006	2%
		Arsenic	5.20E-06	<1%	5.20E-06	4.50E-04	<1%	4.99E-06	0.16	2%
		Barium	3.80E-05	<1%	3.80E-05	0.003	<1%	3.65E-05	1.15	2%
		Beryllium	7.21E-07	<1%	7.21E-07	6.23E-05	<1%	6.91E-07	0.02	2%
		Cadmium	1.00E-06	<1%	1.00E-06	8.65E-05	<1%	9.60E-07	0.03	2%
		Chromium	4.40E-06	<1%	4.40E-06	3.80E-04	<1%	4.22E-06	0.13	2%
		Cobalt	8.01E-07	<1%	8.01E-07	6.92E-05	<1%	7.68E-07	0.02	2%
		Lithium	1.12E-05	<1%	1.12E-05	9.68E-04	<1%	1.07E-05	0.34	2%
		Copper	6.40E-06	<1%	6.40E-06	5.53E-04	<1%	6.14E-06	0.19	2%
		Lead	6.00E-05	2%	6.00E-05	0.01	3%	5.76E-05	1.82	6%
		Manganese	5.60E-05	<1%	5.60E-05	0.005	<1%	5.37E-05	1.69	2%
		Mercury	2.00E-08	<1%	2.00E-08	1.73E-06	<1%	1.92E-08	6.05E-04	2%
		Nickel	1.76E-06	<1%	1.76E-06	1.52E-04	<1%	1.69E-06	0.05	2%
		Selenium	4.00E-08	<1%	4.00E-08	3.46E-06	<1%	3.84E-08	0.001	2%
		Silver	2.76E-08	<1%	2.76E-08	2.39E-06	<1%	2.65E-08	8.35E-04	2%
		Vanadium	3.88E-06	<1%	3.88E-06	3.35E-04	<1%	3.72E-06	0.12	2%
		Zinc	2.00E-04	1%	2.00E-04	0.02	2%	1.92E-04	6.05	4%
DC	Crushing Circuit Dust Collector	PM	0.15	<1%	0.15	13.25	<1%	0.15	4,636.80	3%
		PM10	0.08	<1%	0.08	6.62	1%	0.07	2,318.40	5%
		PM2.5	0.038	2%	0.038	3.31	3%	0.037	1,159.20	9%
		Antimony	7.05E-07	2%	7.05E-07	6.09E-05	3%	6.76E-07	0.02	7%
		Arsenic	1.99E-05	2%	1.99E-05	0.002	3%	1.91E-05	0.60	7%
		Barium	1.46E-04	2%	1.46E-04	0.01	3%	1.40E-04	4.40	7%
		Beryllium	2.76E-06	2%	2.76E-06	2.38E-04	3%	2.65E-06	0.08	7%
		Cadmium	3.83E-06	2%	3.83E-06	3.31E-04	3%	3.68E-06	0.12	7%
		Chromium	1.69E-05	2%	1.69E-05	0.001	3%	1.62E-05	0.51	7%
		Cobalt	3.07E-06	2%	3.07E-06	2.65E-04	3%	2.94E-06	0.09	7%
		Lithium	4.29E-05	2%	4.29E-05	0.004	3%	4.12E-05	1.30	7%
		Copper	2.45E-05	2%	2.45E-05	0.002	3%	2.35E-05	0.74	7%
		Lead	2.30E-04	7%	2.30E-04	0.02	12%	2.21E-04	6.96	22%
		Manganese	2.15E-04	2%	2.15E-04	0.02	3%	2.06E-04	6.49	7%
		Mercury	7.67E-08	2%	7.67E-08	6.62E-06	3%	7.35E-08	0.002	7%
		Nickel	6.75E-06	2%	6.75E-06	5.83E-04	3%	6.47E-06	0.20	7%
		Selenium	1.53E-07	2%	1.53E-07	1.32E-05	3%	1.47E-07	0.005	7%
		Silver	1.06E-07	2%	1.06E-07	9.14E-06	3%	1.01E-07	0.003	7%
		Vanadium	1.49E-05	2%	1.49E-05	0.001	3%	1.43E-05	0.45	7%
		Zinc	7.67E-04	5%	7.67E-04	0.07	7%	7.35E-04	23.18	15%

Source ID	Source Description	Compound	1 - hr		24 - hr			Annual		
			ER [g/s]	% of Overall g/s Emissions for Scenario	ER [g/s]	ER [kg/day]	% of Overall kg/day Emissions for Scenario	ER [g/s]	ER [kg/year]	% of Overall kg/year Emissions for Scenario
FINE	Fine Ore Transfer from Storage Bin to Feed Conveyor for Dense M	PM	0.04	<1%	0.04	3.46	<1%	0.04	1,210.67	<1%
		PM10	0.02	<1%	0.02	1.64	<1%	0.02	572.61	1%
		PM2.5	0.003	<1%	0.003	0.25	<1%	0.003	86.71	<1%
		Antimony	1.84E-07	<1%	1.84E-07	1.59E-05	<1%	1.77E-07	0.01	2%
		Arsenic	5.20E-06	<1%	5.20E-06	4.50E-04	<1%	4.99E-06	0.16	2%
		Barium	3.80E-05	<1%	3.80E-05	0.003	<1%	3.65E-05	1.15	2%
		Beryllium	7.21E-07	<1%	7.21E-07	6.23E-05	<1%	6.91E-07	0.02	2%
		Cadmium	1.00E-06	<1%	1.00E-06	8.65E-05	<1%	9.60E-07	0.03	2%
		Chromium	4.40E-06	<1%	4.40E-06	3.80E-04	<1%	4.22E-06	0.13	2%
		Cobalt	8.01E-07	<1%	8.01E-07	6.92E-05	<1%	7.68E-07	0.02	2%
		Lithium	1.12E-05	<1%	1.12E-05	9.69E-04	<1%	1.07E-05	0.34	2%
		Copper	6.41E-06	<1%	6.41E-06	5.53E-04	<1%	6.14E-06	0.19	2%
		Lead	6.01E-05	2%	6.01E-05	0.005	3%	5.76E-05	1.82	6%
		Manganese	5.60E-05	<1%	5.60E-05	0.005	<1%	5.37E-05	1.69	2%
		Mercury	2.00E-08	<1%	2.00E-08	1.73E-06	<1%	1.92E-08	6.05E-04	2%
		Nickel	1.76E-06	<1%	1.76E-06	1.52E-04	<1%	1.69E-06	0.05	2%
		Selenium	4.00E-08	<1%	4.00E-08	3.46E-06	<1%	3.84E-08	0.001	2%
		Silver	2.76E-08	<1%	2.76E-08	2.39E-06	<1%	2.65E-08	8.35E-04	2%
		Vanadium	3.88E-06	<1%	3.88E-06	3.36E-04	<1%	3.72E-06	0.12	2%
		Zinc	2.00E-04	1%	2.00E-04	0.02	2%	1.92E-04	6.05	4%
SULPH	Sink Product Sulphide Flotation	Carbon Disulphide	0.05	99%	0.05	4.31	99%	0.05	1,510.12	99%
		Pentanol	0.06	99%	0.06	5.00	99%	0.06	1,751.54	99%
ONSPEC	On-spec Concentrate Stockpile Loading	PM	0.004	<1%	0.004	0.32	<1%	0.004	111.06	<1%
		PM10	0.002	<1%	0.002	0.15	<1%	0.002	52.53	<1%
		PM2.5	2.63E-04	<1%	2.63E-04	0.02	<1%	2.52E-04	7.95	<1%
OFFSPEC	Off-spec Concentrate Stockpile Loading	PM	0.001	<1%	0.001	0.11	<1%	0.001	37.02	<1%
		PM10	5.79E-04	<1%	5.79E-04	0.05	<1%	5.55E-04	17.51	<1%
		PM2.5	8.77E-05	<1%	8.77E-05	0.01	<1%	8.41E-05	2.65	<1%
TL	Haul Truck Loading for Transport to Marine Terminal	PM	0.09	<1%	0.09	6.13	<1%	0.01	294.22	<1%
		PM10	0.04	<1%	0.04	2.90	<1%	0.00	139.16	<1%
		PM2.5	0.006	<1%	0.006	0.44	<1%	0.001	21.07	<1%
MAR_TD	Transfer from Trucks into Ship Feeder	PM	0.09	<1%	0.09	6.13	<1%	0.01	294.22	<1%
		PM10	0.04	<1%	0.04	2.90	<1%	0.00	139.16	<1%
		PM2.5	0.006	<1%	0.006	0.44	<1%	0.001	21.07	<1%
MAR_CONV	Loading onto Ship via Covered Conveyor	PM	0.010	<1%	0.010	0.70	<1%	0.001	33.60	<1%
		PM10	0.005	<1%	0.004	0.35	<1%	0.001	16.80	<1%
		PM2.5	0.002	<1%	0.002	0.18	<1%	0.000	8.40	<1%
MILL_EPG	Emergency Diesel Generator at Mill	PM	0.09	<1%	0.004	0.33	<1%	5.30E-04	16.73	<1%
		DPM	0.09	15%	0.004	0.33	<1%	5.30E-04	16.73	<1%
		PM10	0.09	<1%	0.004	0.33	<1%	5.30E-04	16.73	<1%
		PM2.5	0.09	5%	0.004	0.32	<1%	5.15E-04	16.23	<1%
		CO	0.28	4%	0.01	1.02	<1%	0.002	50.79	<1%
		NOX	1.31	7%	0.05	4.71	<1%	0.007	235.70	<1%
		SO2	2.00E-04	<1%	8.34E-06	0.00	<1%	1.14E-06	0.04	<1%

Source ID	Source Description	Compound	1 - hr		24 - hr			Annual		
			ER [g/s]	% of Overall g/s Emissions for Scenario	ER [g/s]	ER [kg/day]	% of Overall kg/day Emissions for Scenario	ER [g/s]	ER [kg/year]	% of Overall kg/year Emissions for Scenario
UPR1	Road - GNP In-Pit	PM	1.21	4%	1.01	86.88	4%	0.33	10434.73	7%
		PM10	0.34	4%	0.29	24.71	4%	0.09	2967.26	6%
		PM2.5	0.03	2%	0.03	2.47	2%	0.01	296.73	2%
		Antimony	5.55E-06	16%	4.63E-06	4.00E-04	18%	1.52E-06	0.05	16%
		Arsenic	1.57E-04	16%	1.31E-04	0.01	18%	4.30E-05	1.36	16%
		Barium	0.001	16%	9.55E-04	0.08	18%	3.14E-04	9.91	16%
		Beryllium	2.17E-05	16%	1.81E-05	0.002	18%	5.96E-06	0.19	16%
		Cadmium	3.02E-05	16%	2.51E-05	0.002	18%	8.27E-06	0.26	16%
		Chromium	1.33E-04	16%	1.11E-04	0.01	18%	3.64E-05	1.15	16%
		Cobalt	2.41E-05	16%	2.01E-05	0.002	18%	6.62E-06	0.21	16%
		Lithium	3.38E-04	16%	2.82E-04	0.02	18%	9.26E-05	2.92	16%
		Copper	1.93E-04	16%	1.61E-04	0.01	18%	5.29E-05	1.67	16%
		Lead	2.78E-04	8%	2.31E-04	0.02	12%	7.61E-05	2.40	8%
		Manganese	0.002	16%	0.001	0.12	18%	4.63E-04	14.61	16%
		Mercury	6.03E-07	16%	5.03E-07	4.34E-05	18%	1.65E-07	0.01	16%
		Nickel	5.31E-05	16%	4.42E-05	0.004	18%	1.46E-05	0.46	16%
		Selenium	1.21E-06	16%	1.01E-06	8.69E-05	18%	3.31E-07	0.01	16%
		Silver	8.33E-07	16%	6.94E-07	5.99E-05	18%	2.28E-07	0.01	16%
		Vanadium	1.17E-04	16%	9.75E-05	0.008	18%	3.21E-05	1.01	16%
		Zinc	0.002	12%	0.002	0.14	15%	5.29E-04	16.70	11%
UPR2	GNP Haul Road to North Dump	PM	3.15	10%	2.63	227.04	10%	0.86	27267.58	20%
		PM10	0.90	9%	0.75	64.56	10%	0.25	7753.92	16%
		PM2.5	0.09	5%	0.07	6.46	6%	0.02	775.39	6%
		Antimony	1.45E-05	42%	1.21E-05	0.001	46%	3.98E-06	0.13	41%
		Arsenic	4.10E-04	42%	3.42E-04	0.03	46%	1.12E-04	3.54	41%
		Barium	0.003	42%	0.002	0.22	46%	8.21E-04	25.90	41%
		Beryllium	5.68E-05	42%	4.73E-05	0.004	46%	1.56E-05	0.49	41%
		Cadmium	7.88E-05	42%	6.57E-05	0.01	46%	2.16E-05	0.68	41%
		Chromium	3.47E-04	42%	2.89E-04	0.02	46%	9.51E-05	3.00	41%
		Cobalt	6.31E-05	42%	5.26E-05	0.005	46%	1.73E-05	0.55	41%
		Lithium	8.83E-04	42%	7.36E-04	0.06	46%	2.42E-04	7.63	41%
		Copper	5.05E-04	42%	4.20E-04	0.04	46%	1.38E-04	4.36	41%
		Lead	7.25E-04	21%	6.04E-04	0.05	31%	1.99E-04	6.27	20%
		Manganese	0.004	42%	0.004	0.32	46%	0.001	38.17	41%
		Mercury	1.58E-06	42%	1.31E-06	1.14E-04	46%	4.32E-07	0.01	41%
		Nickel	1.39E-04	42%	1.16E-04	0.01	46%	3.80E-05	1.20	41%
		Selenium	3.15E-06	42%	2.63E-06	2.27E-04	46%	8.65E-07	0.03	41%
		Silver	2.18E-06	42%	1.81E-06	1.57E-04	46%	5.97E-07	0.02	41%
		Vanadium	3.06E-04	42%	2.55E-04	0.02	46%	8.39E-05	2.64	41%
		Zinc	0.01	31%	0.004	0.36	39%	0.001	43.63	29%

Source ID	Source Description	Compound	1 - hr		24 - hr			Annual		
			ER [g/s]	% of Overall g/s Emissions for Scenario	ER [g/s]	ER [kg/day]	% of Overall kg/day Emissions for Scenario	ER [g/s]	ER [kg/year]	% of Overall kg/year Emissions for Scenario
UPR3	Surface Haul Road - GNP Pit Exit to Mill	PM	1.92	6%	1.60	138.44	6%	0.53	16627.02	12%
		PM10	0.55	6%	0.46	39.37	6%	0.15	4728.13	10%
		PM2.5	0.05	3%	0.05	3.94	4%	0.01	472.81	4%
		Antimony	8.84E-06	25%	7.37E-06	6.37E-04	28%	2.43E-06	0.08	25%
		Arsenic	2.50E-04	25%	2.08E-04	0.02	28%	6.85E-05	2.16	25%
		Barium	0.002	25%	0.002	0.132	28%	5.01E-04	15.80	25%
		Beryllium	3.46E-05	25%	2.88E-05	0.002	28%	9.49E-06	0.30	25%
		Cadmium	4.81E-05	25%	4.01E-05	0.003	28%	1.32E-05	0.42	25%
		Chromium	2.12E-04	25%	1.76E-04	0.02	28%	5.80E-05	1.83	25%
		Cobalt	3.85E-05	25%	3.20E-05	0.003	28%	1.05E-05	0.33	25%
		Lithium	5.38E-04	25%	4.49E-04	0.04	28%	1.48E-04	4.66	25%
		Copper	3.08E-04	25%	2.56E-04	0.02	28%	8.44E-05	2.66	25%
		Lead	4.42E-04	13%	3.69E-04	0.03	19%	1.21E-04	3.82	12%
		Manganese	0.003	25%	0.002	0.19	28%	7.38E-04	23.28	25%
		Mercury	9.61E-07	25%	8.01E-07	6.92E-05	28%	2.64E-07	0.01	25%
		Nickel	8.46E-05	25%	7.05E-05	0.006	28%	2.32E-05	0.73	25%
		Selenium	1.92E-06	25%	1.60E-06	1.38E-04	28%	5.27E-07	0.02	25%
		Silver	1.33E-06	25%	1.11E-06	9.55E-05	28%	3.64E-07	0.01	25%
		Vanadium	1.87E-04	25%	1.55E-04	0.01	28%	5.11E-05	1.61	25%
		Zinc	0.003	19%	0.003	0.22	24%	8.44E-04	26.60	18%
UPR4	Haul Road from Mill Site to Marine Terminal	PM	22.56	73%	18.80	1624.48	75%	2.06	64979.11	47%
		PM10	6.42	67%	5.35	461.94	71%	0.59	18477.72	39%
		PM2.5	0.64	37%	0.53	46.19	46%	0.06	1847.77	15%
TAILS	Tailings Pond	Carbon Disulphide	4.99E-04	<1%	4.99E-04	0.04	<1%	4.79E-04	15.10	<1%
		Pentanol	5.79E-04	<1%	5.79E-04	0.05	<1%	5.55E-04	17.52	<1%
SHIP_1	Auxiliary Engine 1	CO	0.24	4%	0.24	21.12	11%	0.03	844.80	2%
		NOx	3.09	16%	3.09	266.88	23%	0.34	10675.20	7%
		PM	0.06	<1%	0.06	5.18	<1%	0.01	207.36	<1%
		DPM	0.06	9%	0.06	5.18	15%	0.01	207.36	3%
		PM10	0.06	<1%	0.06	5.18	<1%	0.01	207.36	<1%
		PM2.5	0.05	3%	0.05	4.61	5%	0.01	184.32	1%
		SO2	0.93	33%	0.93	80.64	33%	0.10	3225.60	33%
SHIP_2	Auxiliary Engine 2	CO	0.24	4%	0.24	21.12	11%	0.03	844.80	2%
		NOx	3.09	16%	3.09	266.88	23%	0.34	10675.20	7%
		PM	0.06	<1%	0.06	5.18	<1%	0.01	207.36	<1%
		DPM	0.06	9%	0.06	5.18	15%	0.01	207.36	3%
		PM10	0.06	<1%	0.06	5.18	<1%	0.01	207.36	<1%
		PM2.5	0.05	3%	0.05	4.61	5%	0.01	184.32	1%
		SO2	0.93	33%	0.93	80.64	33%	0.10	3225.60	33%
SHIP_3	Auxiliary Engine 3	CO	0.24	4%	0.24	21.12	11%	0.03	844.80	2%
		NOx	3.09	16%	3.09	266.88	23%	0.34	10675.20	7%
		PM	0.06	<1%	0.06	5.18	<1%	0.01	207.36	<1%
		DPM	0.06	9%	0.06	5.18	15%	0.01	207.36	3%
		PM10	0.06	<1%	0.06	5.18	<1%	0.01	207.36	<1%
		PM2.5	0.05	3%	0.05	4.61	5%	0.01	184.32	1%
		SO2	0.93	33%	0.93	80.64	33%	0.10	3225.60	33%

APPENDIX G

Fuel Consumption and GHG Emission Estimates

Construction Phase - Stationary Diesel Consumption

Dewatering Pump and Portable Generator

Diesel consumption was estimated based on maximum power rating of the dewatering pump and portable generator, and using the default high heat value for diesel fuel provided in table 20-1 of the Ontario Ministry of the Environment Publication entitled Guideline for Greenhouse Gas Emissions Reporting (February 2012, PIBs 8024e01). More details on the assumed equipment and operating scenario are provided in the "Air Emissions Inventory Report" dated September 21, 2015.

Source ID	Source Description	Total Maximum HP Rating	Operating Hours Per Year
GNP_DWP	Diesel Powered Dewatering Pump	150	8760
C_GEN	Portable Diesel Powered Generators (3 units)	1341	4392

Sample Calculation

GNP_DWP Annual Diesel Usage = Maximum Rating [hp] x Maximum Operating Time [hrs/yr] ÷ Default High Heat Value for Diesel Fuel [GJ/kL] x Conversion to [L/yr]

GNP_DWP Annual Diesel Usage =	150 hp	8,760 hrs	1 kL	746 J	3,600 s	1 GJ	1000 L
		yr	38.3 GJ	1 hp-s	hr	1,000,000,000 J	kL

GNP_DWP Annual Diesel Usage =	92,138 L
	yr

The following table summarizes the estimated diesel fuel consumption from stationary equipment

Stationary Equipment Type	Annual Diesel Usage [L/yr]
Diesel Powered Dewatering Pump	92138
Portable Diesel Powered Generators (3 units)	412984
TOTAL	505,122

Construction Phase - Mobile Diesel Consumption

Mobile vehicle diesel consumption was calculated for the mobile equipment which were assumed for the facility using the fuel consumption rate per vehicle, total annual operating hours per vehicle, and the number of vehicle type used. More details on the estimated liter-per-hour fuel usage of mobile equipment and the operating scenarios are provided in the "Air Emissions Inventory Report" dated July 20, 2015.

Mobile Equipment Type	Number of Vehicles	Total Fuel Consumption (all vehicles) [L/hr]	Daily Operating Hours [hrs/day]	Annual Operating Days [day/yr]	Annual Operating Hours (all vehicles) [hrs/yr]
Rigid haul truck waste CAT 773G	3	267	24	365	8,760
Articulated Haul truck CAT 740B	1	56	24	365	8,760
Drill rig ore AC DTH	1	19	24	365	8,760
Drill rig waste AC DTH	1	48	24	365	8,760
Bob Cat CAT C15	2	113	24	365	8,760
Wheel Loader CAT 980K	6	231	24	365	8,760
Wheel Dozer CAT 844H	1	72	24	365	8,760
Track Dozer CAT D9	1	50	24	365	8,760
Track Dozer CAT D8	2	101	24	365	8,760
Motor Grader CAT 14M	1	30	24	365	8,760
Wheel Backho/Loader CAT 420E	3	13	24	365	8,760
Water/Sander Truck (oil highway truck)	3	124	24	365	8,760
Hydraulic excavator CAT 320E L	6	96	24	365	8,760
Tandem truck CAT CT680	10	544	24	365	8,760
Tow Truck CAT 740B	1	56	24	365	8,760
Tow low boy LPM (120-48-20)	1	42	24	365	8,760
Fuel/ Lube Truck	1	23	24	365	8,760
Service Truck CT660	1	41	24	365	8,760
Bulk ANFO Explosives Truck (Kalmar DCD200-12lb)	1	41	24	365	8,760
Mini Bus	3	125	24	365	8,760
Pick Up Truck Ford E series	20	832	24	365	8,760
Crane LTM 110-4.2	2	80	24	365	8,760
Scissorlift Getman A64	2	23	24	365	8,760
Grader AARD Mining LP	3	42	24	365	8,760
Compaction Roller (CAT)	3	10	24	365	8,760
Pallet Handler/Tractor	1	6	24	365	8,760

Sample Calculation

Rigid haul truck waste CAT 773Gs Annual Diesel Usage = Total Fuel Consumption (all vehicles) [L/hr] x Annual Operating Hours (all vehicles) [hrs/year]

Rigid haul truck waste CAT 773Gs Annual Diesel Usage = $\frac{267 \text{ L}}{\text{hr}} \Big| \frac{8{,}760 \text{ hrs}}{\text{yr}}$

Rigid haul truck waste CAT 773Gs Annual Diesel Usage = $\frac{2{,}335{,}094 \text{ L}}{\text{yr}}$

The following Table Summarizes the estimated diesel fuel consumption from mobile equipment

Mobile Equipment Type	Annual Diesel Usage [L/yr]
Rigid haul truck waste CAT 773G	2,335,094
Articulated Haul truck CAT 740B	491,528
Drill rig ore AC DTH	167,728
Drill rig waste AC DTH	419,319
Bob Cat CAT C15	988,978
Wheel Loader CAT 980K	2,026,107
Wheel Dozer CAT 844H	630,233
Track Dozer CAT D9	437,662
Track Dozer CAT D8	883,403
Motor Grader CAT 14M	259,904
Wheel Backho/Loader CAT 420E	112,205
Water/Sander Truck (oil highway truck)	1,086,748
Hydraulic excavator CAT 320E L	841,704
Tandem truck CAT CT680	4,767,146
Tow Truck CAT 740B	491,528
Tow low boy LPM (120-48-20)	364,409
Fuel/ Lube Truck	201,998
Service Truck CT660	362,249
Bulk ANFO Explosives Truck (Kalmar DCD200-12lb)	362,249
Mini Bus	1,093,226
Pick Up Truck Ford E series	7,288,171
Crane LTM 110-4.2	698,866
Scissorlift Getman A64	201,673
Grader AARD Mining LP	371,676
Compaction Roller (CAT)	83,244
Pallet Handler/Tractor	49,246
TOTAL	27,016,290

Construction Phase - Industrial Process

Explosives Detonation

The total quantity of explosives used in one year was calculated based on the number of blasts performed per day and the tonnes of explosives used per blast. More details on the assumed explosives usage are provided in the "Air Emissions Inventory Report" dated July 20, 2015.

Parameter	Bulk Emulsion Explosives Usage per Blast [Mg]	Number of Blasts Per Day	Number of Days Per Year Blasts Occur	Bulk Emulsion Explosives Usage Per Year [Mg]
Portal Development	0.1	2	365	73
Open Pit Development (Ore Blasting)	0.7	1	365	256
Open Pit Development (Waste Rock Blasting)	4.3	1	365	1,570
			TOTAL	1,898

Construction Phase - Summary of GHG Estimate Inputs

Consumption Data

Category	Parameter	Annual Consumption Estimate Unit	Annual Consumption Estimate	Comment
Combustion in Stationary Sources	Diesel	L	505,122	See calculation sheet entitled "Construction Phase - Stationary Diesel Consumption"
On-Site Transportation	Diesel	L	27,016,290	See calculation sheet entitled "Construction Phase - Mobile Diesel Consumption"
Industrial Process	Bulk Emulsion Explosives	tonnes	1,898	See calculation sheet entitled "Construction Phase - Explosives Consumption"
Purchased Electricity	Electricity Consumption	MWh	4,392	Per CFI - 1 MW generated through grid electricity for 6 months out of the year; operating 24 h/day, 183 d/year

GHG Emission Factors for Fuel Combustion

Fuel Type	Stationary Combustion						Non Stationary Combustion					
	CO_2 Emission Factor		CH_4 Emission Factor		N_2O Emission Factor		CO_2 Emission Factor		CH_4 Emission Factor		N_2O Emission Factor	
	Value	Unit	Value	Unit	Value	Unit	Value	Unit	Value	Unit	Value	Unit
Diesel	2.663	kg CO_2/L	0.133	g CH_4/L	0.4	g N_2O/L	2.663	kg CO_2/L	0.15	g CH_4/L	1.1	g N_2O/L

GHG Emission Factor for Purchased Electricity

Purchased Electricity	CO_2 Emission Factor	
	Value	Unit
CO_2 emissions from Purchased Electricity	0.020	t CO2e / MWh

Construction Phase - GHG Emission Estimate Calculation

GHG EMISSION CALCULATION SUMMARY

Component	GHG emissions (metric tonnes CO_2e)			
	CO_2	CH_4	N_2O	Total Emissions
1.1 - Combustion in Stationary Sources	1,345	2	60	1,407
1.2 - On-Site Transportation	71,944	101	8,856	80,902
1.3 - Industrial Process - Explosives	383	—	—	383
2.1 - Consumption of Purchased Electricity	88	—	—	88

EMISSIONS SCOPE 1

1.1 - Combustion in Stationary Sources

A - Calculation of CO_2 Emissions

Source		Fuel type	Step 1 - Quantities		Step 2 - CO_2 Emission Factors			Step 3
			A	B	C	D	E	F
			Quantity of fuel combusted	Units for A	CO_2 emission factor	Units for C	Unit conversion factor to tonne	CO_2 Emissions (tonnes)
								F = A*C*E
	Facility wide	Diesel	505,122	L	2.663	kg CO_2/L	0.001	1,345
							TOTAL	1,345

B - Calculation of CH_4 and N_2O Emissions

GWP Values	
25	298

Source		Fuel type	Step 4 - CH_4 and N_2O Emission Factors					Step 5 - CH_4 and N_2O Emissions			
			G	H	I	J	K	L	M	N	O
			CH_4 Emission factor	Units for G	N_2O Emission factor	Units for I	Unit conversion factor to tonne	CH_4 emissions (tonnes)	N_2O emissions (tonnes)	CH_4 emissions (t CO_2e)	N_2O emissions (t CO_2e)
								L = A*G*K	M = A*I*K	N = L*GWP	O = M*GWP
	Facility wide	Diesel	0.133	g CH_4/L	0.4	g N_2O/L	1.0E-06	6.7E-02	2.0E-01	1.7E+00	60
							TOTAL	6.7E-02	2.0E-01	1.7E+00	6.0E+01

Step 6
P
Total Emissions (t CO_2e)
P = F + N + O
1,407
1,407

Construction Phase - GHG Emission Estimate Calculation

1.2 - On-Site Transportation

A - Calculation of CO_2 Emissions

Fossil Fuels

Source		Fuel type	Step 1 - Quantities		Step 2 - CO_2 Emission Factors			Step 3
			A	B	C	D	E	F
			Quantity of fuel combusted	Units for A	CO_2 emission factor	Units for C	Unit conversion factor to tonne	CO_2 Emissions (tonnes)
								F = A*C*E
	Diesel vehicles	Diesel	27,016,290	L	2.663	kg CO_2/L	0.001	71,944
							TOTAL	71,944

GWP Values	
25	298

B - Calculation of CH_4 and N_2O Emissions

Fossil Fuels

Source		Fuel type	Step 4 - CH_4 and N_2O Emission Factors					Step 5 - CH_4 and N_2O Emissions				Step 6
			G	H	I	J	K	L	M	N	O	P
			CH_4 Emission factor	Units for G	N_2O Emission factor	Units for I	Unit conversion factor to tonne	CH_4 emissions (tonnes)	N_2O emissions (tonnes)	CH_4 emissions (t CO_2e)	N_2O emissions (t CO_2e)	Total Emissions (t CO_2e)
								L = A*G*K	M = A*I*K	N = L*GWP	O = M*GWP	P = F + N + O
	Diesel vehicles	Diesel	0.15	g CH_4/L	1.1	g N_2O/L	1.0E-06	4.1	29.7	101.3	8856	80,902
							TOTAL	4.1	29.7	101.3	8856	80,902

1.3 - Industrial Process - Explosives

Materials		Process	Step 1 - Quantities		Step 2		Step 3	Step 4	Step 5	
			A	B	C	D	E	F	G	H
			Quantity of material consumed	Units for A	Carbon content factor	Units for C	Unit conversion factor to tonnes	Total Carbon (tonnes)	Carbon to CO_2 Conversion Factor	CO_2 emissions in metric tonnes
								F = A*C*E		H = F*G
	Bulk Emulsion	Explosives	1,898	tonnes	0.055	% / 100	1	104.39	3.67	383
									TOTAL	383

EMISSIONS SCOPE 2

2.1 - Consumption of Purchased Electricity

Source Description		A	B	C	D
		Source of Electricity	Total Electricity Consumed (MWh)	CO_2 Emission Factor (t CO_2e / MWh)	Indirect CO_2 Emissions (t CO_2e)
					D = B*C
1	Facility wide	Newfoundland Labrador Grid	4,392	0.020	88

Operations Phase - Propane Combustion

Total annual propane consumption for the assumed propane-fired underground mine heating has been estimated based on the assumed BTU rating of the heater, operating hours and days in a year, and the default high heat value for liquefied petroleum gas provided in table 20-1a of the Ontario Ministry of the Environment and Climate Change Publication entitled Guideline for Greenhouse Gas Emissions Reporting (as set out under Ontario Regulation 452/09 under the Environmental Protection Act) (February 2012, PIBs 8024e01). More details on the assumed BTU input and operating scenario for the heater are provided in the "Air Emissions Inventory Report" dated July 20, 2015.

Source ID	Source Description	BTU Rating	Operating Hours per Day	Days per Year	Total Operating Hours per Year
U_PH1	Propane-fired underground Mine Heating	8,500,000	20	350	7,000

Sample Calculation:

Total Annual Propane Consumption = BTU Input [BTU/hr] x Total Operating Hours per Year [hr/yr] ÷ Default High Heat Value for Propane as Liquefied Petroleum Gas [GJ/kL] x Conversion to [L/yr]

Total Annual Propane Consumption =

$$\frac{8{,}500{,}000\ \text{BTU}}{\text{hr}} \;\Big|\; \frac{7{,}000\ \text{hr}}{\text{yr}} \;\Big|\; \frac{1\ \text{kL}}{25.66\ \text{GJ}} \;\Big|\; \frac{1\ \text{GJ}}{947{,}817\ \text{BTU}} \;\Big|\; \frac{1000\ \text{L}}{\text{kL}}$$

Total Annual Propane Consumption =

$$\frac{2{,}446{,}447\ \text{L}}{\text{yr}}$$

Operations Phase - Stationary Diesel Consumption

Standby Generators

Diesel consumption was estimated based on maximum power rating of the generators and using the default high heat value for diesel fuel provided in table 20-1 of the Ontario Ministry of the Environment Publication entitled Guideline for Greenhouse Gas Emissions Reporting (February 2012, PIBs 8024e01). A testing scenario of 1 hour per day, 50 days per year was used in the fuel consumption estimation for each generator. More details on the assumed generator equipment and operating scenarios are provided in the "Air Emissions Inventory Report" dated July 20, 2015.

Source ID	Source Description	Maximum HP Rating	Operating Hours Per Year
MILL_EPG	Emergency Diesel Generator at Mill	335	50
U_EPG	Underground Mine Standby Diesel Generator	1341	50

Sample Calculation

MILL_EPG Annual Diesel Usage = Maximum Rating [hp] x Maximum Operating Time [hrs/yr] ÷ Default High Heat Value for Diesel Fuel [GJ/kL] x Conversion to [L/yr]

$$\text{MILL\_EPG Annual Diesel Usage} = 335\ \text{hp} \times \frac{50\ \text{hrs}}{\text{yr}} \times \frac{1\ \text{kL}}{38.3\ \text{GJ}} \times \frac{746\ \text{J}}{1\ \text{hp-s}} \times \frac{3{,}600\ \text{s}}{\text{hr}} \times \frac{1\ \text{GJ}}{1{,}000{,}000{,}000\ \text{J}} \times \frac{1000\ \text{L}}{\text{kL}}$$

$$\text{MILL\_EPG Annual Diesel Usage} = \frac{1175\ \text{L}}{\text{yr}}$$

Generator ID	Annual Diesel Usage [L/yr]
MILL_EPG	1175
U_EPG	4702

Dewatering Pumps

Dewatering pump diesel consumption was calculated using an estimated fuel consumption rate per unit, total annual operating hours per unit, and the number of units. More details on the estimated liter-per-hour fuel usage of dewatering pumps and the operating scenarios are provided in the "Air Emissions Inventory Report" dated July 20, 2015.

Equipment Description	Number of Units	Fuel Usage per Unit [L/hr]	Daily Operating Hours [hrs/day]	Annual Operating Days [day/yr]	Annual Operating Hours per Unit [hrs/yr]	Annual Diesel Usage [L/yr]
Dewatering Pumps	3	75	20	350	7,000	1,575,000

Sample Calculation

Dewatering Pump Annual Diesel Usage = Fuel Use per Unit [L/hr] x Annual Operating Hours per Unit [hrs/year] x Number of Units

$$\text{Dewatering Pump Annual Diesel Usage} = \frac{75.0\ \text{L}}{\text{hr}} \times \frac{7{,}000\ \text{hrs}}{\text{yr}} \times 3\ \text{units}$$

$$\text{Dewatering Pump Annual Diesel Usage} = \frac{1{,}575{,}000\ \text{L}}{\text{yr}}$$

The following table summarizes the estimated fuel consumption from stationary equipment

Stationary Equipment Type	Annual Diesel Usage [L/yr]
Emergency Diesel Generator at Mill	1175
Underground Mine Standby Diesel Generator	4702
Dewatering Pumps	1,575,000
TOTAL	1,580,876

Operations Phase - Mobile Diesel Consumption

Mobile vehicle diesel consumption was calculated for the 20 types of mobile equipment which were assumed for the facility using the fuel consumption rate per vehicle, total annual operating hours per vehicle, and the number of vehicle type used. More details on the estimated liter-per-hour fuel usage of mobile equipment and the operating scenarios are provided in the "Air Emissions Inventory Report" dated July 20, 2015.

Mobile Equipment Type	Number of Vehicles	Fuel per Vehicle [L/hr]	Daily Operating Hours [hrs/day]	Annual Operating Days [day/yr]	Annual Operating Hours per Vehicle [hrs/yr]
Hydraulic Excavator ore/waste CAT 390FL	1	56	20	350	7,000
Hydraulic Excavator ovb/ore CAT 374FL	1	62	20	350	7,000
Rigid Haul Truck ore/waste CAT 773G	3	57	20	350	7,000
Articulated Haul Truck ovb/ore CAT 740B	1	46	20	350	7,000
Drill rig ore AC DTH	1	22	20	350	7,000
Drill rig waste AC DTH	1	65	20	350	7,000
Wheel Loader CAT 980K	1	25	20	350	7,000
Wheel Dozer CAT 844H	1	56	20	350	7,000
Track Dozer CAT D9	1	46	20	350	7,000
Motor Grader CAT 14M	1	18	20	350	7,000
Water/Sander Truck (oil highway truck)	1	57	20	350	7,000
Hydraulic Excavator CAT 320E L	1	18	20	350	7,000
Tow Truck CAT	1	56	20	350	7,000
Tow Low Boy LPM (120-48-20)	1	57	20	350	7,000
Fuel/Lube Truck CT660	1	28	20	350	7,000
Service Truck Kalmar DCD200-12lb	1	50	20	350	7,000
Bulk ANFO Explosives Truck	1	28	20	350	7,000
Mini Bus Ford E Series	1	10	20	350	7,000
Pick Up Truck 4x4 crew cab Chevrolet	1	6	20	350	7,000
Light Tower	3	2	20	350	7,000

Sample Calculation

Hydraulic Excavator ore/waste CAT 390FL Annual Diesel Usage = Fuel Use per Vehicle [L/hr] x Annual Operating Hours per Vehicle [hrs/year] x Number of Vehicles

Hydraulic Excavator ore/waste CAT 390FL Annual Diesel Usage = $\frac{56.0\ L}{hr}$ $\frac{7{,}000\ hrs}{yr}$ 1 vehicles total

Hydraulic Excavator ore/waste CAT 390FL Annual Diesel Usage = $\frac{392{,}000\ L}{yr}$

The following Table Summarizes the estimated fuel consumption from mobile equipment

Mobile Equipment Type	Annual Diesel Usage [L/yr]
Hydraulic Excavator ore/waste CAT 390FL	392,000
Hydraulic Excavator ovb/ore CAT 374FL	434,000
Rigid Haul Truck ore/waste CAT 773G	1,197,000
Articulated Haul Truck ovb/ore CAT 740B	322,000
Drill rig ore AC DTH	154,000
Drill rig waste AC DTH	455,000
Wheel Loader CAT 980K	175,000
Wheel Dozer CAT 844H	392,000
Track Dozer CAT D9	322,000
Motor Grader CAT 14M	126,000
Water/Sander Truck (oil highway truck)	399,000
Hydraulic Excavator CAT 320E L	126,000
Tow Truck CAT	392,000
Tow Low Boy LPM (120-48-20)	399,000
Fuel/Lube Truck CT660	197,400
Service Truck Kalmar DCD200-12lb	350,000
Bulk ANFO Explosives Truck	197,400
Mini Bus Ford E Series	70,000
Pick Up Truck 4x4 crew cab Chevrolet	42,000
Light Tower	42,000
TOTAL	6,183,800

Operations Phase - Marine Vessel Stationary Combustion

Fuel consumption from marine vessels (ships) were estimated for an operating scenario where a ship is docked at the port with auxiliary engines running for the duration of the time that the spends docked. Estimates of auxiliary engine number and size, marine gas oil [MGO] consumption, docking time and number of trips were provided by CFI.

Equipment Type	Engine Description	Engine Size [kW]	MGO Consumption [tonnes/day]	Time Ship Spends Docked Per Trip [hours]	Ship Trips Per Year
Marine Vessel	Auxiliary Engine 1	800	2.8	30	20
	Auxiliary Engine 2	800	2.8		
	Auxiliary Engine 3	800	2.8		

Sample Calculation

Auxiliary Engine 1 MGO Usage = Fuel Use per Vehicle [tonne/day] / Fuel Density [kg/L] x docking time [hour trip] x annual number of trips [trip/yr] x conversion factors

$$\text{Auxiliary Engine 1 MGO Usage} = \frac{2.8\ \text{tonne}}{\text{day}} \times \frac{\text{L}}{0.870\ \text{kg}} \times \frac{30\ \text{hr}}{\text{trip}} \times \frac{20\ \text{trip}}{\text{yr}} \times \frac{1\ \text{day}}{24\ \text{hr}} \times \frac{1{,}000\ \text{kg}}{\text{tonne}}$$

$$\text{Auxiliary Engine 1 MGO Usage} = \frac{80{,}460\ \text{L}}{\text{yr}}$$

The following Table Summarizes the estimated fuel consumption from mobile equipment

Equipment Type	Annual Diesel Usage [L/yr]
Auxiliary Engine 1	80,460
Auxiliary Engine 2	80,460
Auxiliary Engine 3	80,460
TOTAL	241,379

Operations Phase - Industrial Process

Explosives Detonation

The total quantity of explosives used in one year was calculated based on the number of blasts performed per day and the tonnes of explosives used per blast. More details on the assumed explosives usage are provided in the "Air Emissions Inventory Report" dated July 20, 2015.

Parameter	Bulk Emulsion Explosives Usage per Blast [Mg]	Number of Blasts Per Day	Number of Days Per Year Blasts Occur	Bulk Emulsion Explosives Usage Per Year [Mg]
Ore Blasting	0.7	1	350	245
Waste Rock Blasting	4.3	1	350	1,505
			TOTAL	1,750

Operations Phase - Summary of GHG Estimate Inputs

Consumption Data

Category	Parameter	Annual Consumption Estimate Unit	Annual Consumption Estimate	Comment
Combustion in Stationary Sources	Propane	L	2,446,447	See calculation sheet entitled "Operation Phase - Propane Consumption"
Combustion in Stationary Sources	Diesel	L	1,580,876	See calculation sheet entitled "Operation Phase - Stationary Diesel Consumption"
Combustion in Stationary Sources	Marine Vessels	L	241,379	See calculation sheet entitled "Operation Phase - Marine Vessel Stationary Combustion"
On-Site Transportation	Diesel	L	6,183,800	See calculation sheet entitled "Operation Phase - Mobile Diesel Consumption"
Industrial Process	Bulk Emulsion Explosives	tonnes	1,750	See calculation sheet entitled "Operation Phase - Explosives Consumption"
Purchased Electricity	Electricity Consumption	MWh	48,180	Per s.2.4.6 of EA Registration (dated June 2015) - 4.3 MW for mill, 1.2 MW for mine; operating hours 24 h/day, 365 d/year

GHG Emission Factors for Fuel Combustion

Fuel Type	Stationary Combustion						Non Stationary Combustion					
	CO_2 Emission Factor		CH_4 Emission Factor		N_2O Emission Factor		CO_2 Emission Factor		CH_4 Emission Factor		N_2O Emission Factor	
	Value	Unit	Value	Unit	Value	Unit	Value	Unit	Value	Unit	Value	Unit
Propane	1.510	kg CO_2/L	0.024	g CH_4/L	0.108	g N_2O/L	N/A	N/A	N/A	N/A	N/A	N/A
Diesel	2.663	kg CO_2/L	0.133	g CH_4/L	0.4	g N_2O/L	2.663	kg CO_2/L	0.15	g CH_4/L	1.1	g N_2O/L
Marine Vessels	3.124	kg CO_2/L	0.28	g CH_4/L	0.079	g N_2O/L	N/A	N/A	N/A	N/A	N/A	N/A

GHG Emission Factor for Purchased Electricity

Purchased Electricity	CO_2 Emission Factor	
	Value	Unit
CO_2 emissions from Purchased Electricity	0.020	t CO2e / MWh

Operations Phase - GHG Emission Estimate Calculation

GHG EMISSION CALCULATION SUMMARY

Component	GHG emissions (metric tonnes CO_2e)			
	CO_2	CH_4	N_2O	Total Emissions
1.1 - Combustion in Stationary Sources	8,658	8	272	8,938
1.2 - On-Site Transportation	16,467	23	2,027	18,518
1.3 - Industrial Process - Explosives	353	—	—	353
2.1 - Consumption of Purchased Electricity	964	—	—	964

EMISSIONS SCOPE 1

1.1 - Combustion in Stationary Sources

A - Calculation of CO_2 Emissions

Source		Fuel type	Step 1 - Quantities		Step 2 - CO_2 Emission Factors			Step 3
			A	B	C	D	E	F
			Quantity of fuel combusted	Units for A	CO_2 emission factor	Units for C	Unit conversion factor to tonne	CO_2 Emissions (tonnes)
								F = A*C*E
	Facility wide	Propane	2,446,447	L	1.510	kg CO_2/L	0.001	3,694
	Facility wide	Diesel	1,580,876	L	2.663	kg CO_2/L	0.001	4,210
	Facility wide	Marine Vessels	241,379	L	3.124	kg CO_2/L	0.001	754
							TOTAL	8,658

GWP Values	
25	298

B - Calculation of CH_4 and N_2O Emissions

Source		Fuel type	Step 4 - CH_4 and N_2O Emission Factors					Step 5 - CH_4 and N_2O Emissions			
			G	H	I	J	K	L	M	N	O
			CH_4 Emission factor	Units for G	N_2O Emission factor	Units for I	Unit conversion factor to tonne	CH_4 emissions (tonnes)	N_2O emissions (tonnes)	CH_4 emissions (t CO_2e)	N_2O emissions (t CO_2e)
								L = A*G*K	M = A*I*K	N = L*GWP	O = M*GWP
	Facility wide	Propane	0.024	g CH_4/L	0.1	g N_2O/L	1.0E-06	0.1	0.3	1.5	77
	Facility wide	Diesel	0.133	g CH_4/L	0.4	g N_2O/L	1.0E-06	2.1E-01	6.3E-01	5.3E+00	188
	Facility wide	Marine Vessels	0.28	g CH_4/tonne	0.079	g N_2O/L	1.0E-06	6.8E-02	1.9E-02	1.7E+00	6
							TOTAL	3.4E-01	9.1E-01	8.4E+00	2.7E+02

Step 6
P
Total Emissions (t CO_2e)
P = F + N + O
3,773
4,404
761
8,938

Operations Phase - GHG Emission Estimate Calculation

1.2 - On-Site Transportation

A - Calculation of CO_2 Emissions

Fossil Fuels

Source		Fuel type	Step 1 - Quantities		Step 2 - CO_2 Emission Factors			Step 3
			A	B	C	D	E	F
			Quantity of fuel combusted	Units for A	CO_2 emission factor	Units for C	Unit conversion factor to tonne	CO_2 Emissions (tonnes)
								F = A*C*E
	Diesel vehicles	Diesel	6,183,800	L	2.663	kg CO_2/L	0.001	16,467
							TOTAL	16,467

GWP Values	
25	298

B - Calculation of CH_4 and N_2O Emissions

Fossil Fuels

Source		Fuel type	Step 4 - CH_4 and N_2O Emission Factors					Step 5 - CH_4 and N_2O Emissions				Step 6
			G	H	I	J	K	L	M	N	O	P
			CH_4 Emission factor	Units for G	N_2O Emission factor	Units for I	Unit conversion factor to tonne	CH_4 emissions (tonnes)	N_2O emissions (tonnes)	CH_4 emissions (t CO_2e)	N_2O emissions (t CO_2e)	Total Emissions (t CO_2e)
								L = A*G*K	M = A*I*K	N = L*GWP	O = M*GWP	P = F + N + O
	Diesel vehicles	Diesel	0.15	g CH_4/L	1.1	g N_2O/L	1.0E-06	0.9	6.8	23.2	2027	18,518
							TOTAL	0.9	6.8	23.2	2027	18,518

1.3 - Industrial Process - Explosives

Materials		Process	Step 1 - Quantities		Step 2		Step 3	Step 4	Step 5	
			A	B	C	D	E	F	G	H
			Quantity of material consumed	Units for A	Carbon content factor	Units for C	Unit conversion factor to tonnes	Total Carbon (tonnes)	Carbon to CO_2 Conversion Factor	CO_2 emissions in metric tonnes
								F = A*C*E		H = F*G
	Bulk Emulsion	Explosives	1,750	tonnes	0.055	% / 100	1	96.25	3.67	353
									TOTAL	353

EMISSIONS SCOPE 2

2.1 - Consumption of Purchased Electricity

Source Description		A	B	C	D
		Source of Electricity	Total Electricity Consumed (MWh)	CO_2 Emission Factor (t CO_2e / MWh)	Indirect CO_2 Emissions (t CO_2e)
					D = B*C
1	Facility wide	Newfoundland Labrador Grid	48,180	0.020	964

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APPENDIX L

Radon Technical Memo

MEMORANDUM

TO	Canada Fluorspar Inc.	**DATE**	July 17, 2015
FROM	Ernest Becker, Ph.D.; Jeffrey Fleming, P.Geo., CRPA(R)	**PROJECT No.**	1407707-0051 (Rev0)

RADON EMISSIONS FROM PROPOSED AGS FLUORSPAR PROJECT

1.0 INTRODUCTION

The purpose of this Technical Memorandum is to provide an overview of the potential release of radon gas into the mine workings and surrounding environment from the operation of the proposed AGS Fluorspar Project (the Project) as described in the Canada Fluorspar Inc. (CFI) Registration Document (CFI 2015).

Radon is not normally associated with fluorspar mining; however, the St. Lawrence, Newfoundland and Labrador region mines are an exception. The commercial mining of fluorspar in this area began with open pit operations in 1933 and underground operations beginning in 1936. By the 1940s, it was noticed that many fluorspar miners were suffering from a lung disease (Paul Villeneuve, Howard Morrison 2005).

In November 1959, it was discovered that the St. Lawrence mines air contained radon gas in concentrations that vastly exceeded permissible levels of that time. Unlike other miners (e.g., uranium) occupationally exposed to radon, the source of exposure in the fluorspar mines was from the release from groundwater that seeped into the mine. It is presumed that the groundwater leached radon or radon precursors from natural uranium deposits in the region (Paul Villeneuve, Howard Morrison 2005).

In 1960, mechanical ventilation systems were installed in the mines, and radon exposures fell to well below the permissible standards at the time. Mining continued until the close of the mines.

This memo will consider the potential radon releases from the proposed Project using information obtained from the historical fluorspar mine in the area and from the experience at uranium mines in Canada.

2.0 PROJECTED ENVIRONMENTAL RELEASES OF RADON

As was the case for the historical mines, it is projected that groundwater flowing into open pits and the underground mine workings will carry radon gas. The radon gas will be released into the atmosphere as the mine water depressurizes.

The air flowing out of the open pits and from the underground ventilation exhaust will be released to the surrounding environment where it will be diluted as the radon gas moves downwind.

2.1 Underground Radon Levels

Radon progeny readings were obtained from the 1988-89 records of historical underground mines. The average underground radon progeny reading as obtained from the mine records was 0.16 Working Levels (WL) (Frank Pitman 2015, pers. comm.).

To calculate the radon gas released from the underground mine, the units must be converted from WL, a measure of radon progeny exposure, to radon concentration. To do this, we must assume a radon equilibrium factor for the radon gas in the mine which reflects the fraction of alpha decay products that would have been collected when the radon progeny levels were measured. Given the amount and nature of air flow under ventilation, a radon Equilibrium Factor (EF) of 0.2 was selected. The conversion from WL to Radon Concentration, Rn$_{[]}$ in becquerel per cubic metre [Bq/m^3] is:

$$WL = 0.00027 \text{ x Rn[] x EF}$$

Therefore, the measured radon progeny levels translate into a radon gas concentration within the mine of approximately 3000 Bq/m^3.

The precise ventilation rate within the historical underground mine is not known. It is known that the main ventilation circuit contained two 200,000 cubic feet per minute (cfm) fans (Frank Pitman 2015, pers. comm.). Assuming that one of the fans was operating at maximum capacity, we obtain a nominal ventilation flow of 200,000 cfm or ~94 cubic metres per second (m^3/s) in metric units. This equates to a radon release from the main mine exhaust of 280,000 Bq/s.

2.2 Open Pit Radon Levels

Mine open pits are subject to natural ventilation as the air within the open pits exchanges with the air in the atmosphere above it. As is the case for underground mines, the groundwater flowing into the open pit will carry radon which will be released as the water enters the open pit. The radon will disperse throughout the open pit and be carried into the atmosphere above the open pit by air convection currents.

There are no radon measurements available for open pit mines in the St. Lawrence region, and given the properties of outdoor airflow, it is reasonable to infer that the radon concentration within the open pits will be substantially lower than for the underground mine, except perhaps during short-term weather inversions.

However, depending on the groundwater inflows, the total radon release rate from the open pits is likely to be higher than from the underground mine because the volume of groundwater inflow into an open pit is larger than the inflow into the underground workings.

3.0 WORKER SAFETY

3.1 Radiation Safety Standards

Any inhalation of radon gas and its associated short-lived radon progeny will deliver a radiation exposure to the lung of someone breathing the air.

Canada has two standards for the exposure of workers from ionizing radiation. The first standard is Federal and it is the *Nuclear Safety and Control Act*. This Act applies to activities primarily within the nuclear fuel cycle (i.e., from uranium mining through to nuclear power plants) and is regulated by the Canadian Nuclear Safety Commission. This standard does not apply to naturally occurring radioactivity that is not part of the nuclear fuel cycle (i.e., non-uranium mining).

The second standard, the Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials (NORM) (Health Canada 2011) is administered by Health Canada with consultation of each province under Federal Provincial Territorial Radiation Protection Committee (FPTRPC). This standard applies to all radiation from naturally occurring materials related activities that are not part of the nuclear fuel cycle.

Fluorspar is not used for generating nuclear power and hence, the Project will be subject to the standards described in the Health Canada (2011) NORM Guidelines. These guidelines prescribe increasingly stringent radiation protection measures with increasing worker radiation exposures.

3.2 Application of the Health Canada NORM Guidelines to the Project

As described in Section 2.1, the measured radon progeny levels in a historical St. Lawrence region underground mine were found to be approximately 0.16 WL. A common occupational hazard assumption is that workers will be subjected to 2000 h/year, therefore, the projected annual worker radiation exposures are ~ 2 WL Months or 10 milliSievert per year [mSv/year]. As described in Section 3.3.3.4 of the Health Canada (2011) NORM Guidelines, workers subject to radiation exposures at this level should be provided with a comprehensive radiation safety protection program, with expectations that the program be comparable to that provided for uranium miners.

Workers in the open pits and those engaged in the surface operations will be subject to lower levels of radiation than the workers in the underground. Nonetheless, the environmental radon levels in the open pits and in the immediate vicinity of the mine will be elevated relative to the general background radon levels. The experience in Saskatchewan open pit uranium mines is that radon levels are generally low but that weather inversions can lead to elevated radon levels within the open pits and occasional work stoppages until the radon dissipates.

It is anticipated that larger industrial process buildings on site will be actively ventilated as per the usual ventilation standards for large industrial buildings. Consequently, any radon entering the buildings directly from the sub-surface is unlikely to be an issue. Smaller ancillary buildings may not be actively ventilated and may require special consideration in their construction, similar to residential buildings in areas of known elevated radon (e.g., Faraday Township, Ontario).

It is recommended that the Canada Building Code specifications to reduce radon ingress for buildings in radon prone areas be adhered to. This will reduce the possibility of elevated radon levels within the buildings, particularly in poorly ventilated lower levels.

Apart from radon ingress through the subsurface of buildings, the elevated atmospheric radon levels and the radon in the water pumped to surface will necessitate a surface radon monitoring program and, potentially, measures to control and minimize the radon levels within the surface facilities. In Golder's experience on similar projects elsewhere, such remedial actions are relatively simple and cost effective.

4.0 COMMUNITY SAFETY

4.1 Radon Source Term

As discussed previously, the development of the open pits and underground workings in the St. Lawrence region will lead to the release of radon gas from the groundwater that will, effectively, be exposed to the atmosphere. The projected radon release rate from the underground workings is on the order of 280,000 Bq/s and is comparable to the radon release rate from the Saskatchewan uranium mines. Although these other mines are uranium mines, the majority of radon in the Saskatchewan uranium mines is also from the ingress of radon laden groundwater.

Radon gas released from the mine will mix with, and be added to, the naturally occurring radon gas present in the area. Naturally occurring radon is released from the earth's surface as part of the soil gas moving though pore spaces in the soil and is present in the atmosphere everywhere on earth. A 1990 survey of outdoor radon levels in the St. Lawrence region found the levels of naturally occurring radon to be ~16 Bq/m^3 (R.L. Grasty 1994).

4.2 Dispersion of Radon from Mine Site

The radon released from the mine into the atmosphere will disperse rapidly as it moves downwind from the mine.

A detailed calculation of the radon dispersion from the proposed Project is beyond the scope of this preliminary review document. As discussed, the projected radon release from the proposed mine is likely to be similar to the amount of radon released from the uranium mines in Saskatchewan. For the purposes of this report, the environmental radon measurements around the Key Lake uranium mine were used to provide an indication of the radon dispersion anticipated for a mine in the St. Lawrence region. The Key Lake measurements of environmental radon levels found that the ambient radon concentrations reached natural background levels at about 5 kilometres (km) from the mine site (Cameco 2005).

The dissipation of radon gas to natural background levels within about 5 km of the source is consistent with measurements obtained by Golder at decommissioned uranium mines in Ontario and provides a reasonable indication of the radon dispersion to be anticipated at the Project.

5.0 CLOSURE

We trust this technical memorandum meets your requirements at this time. Please do not hesitate to contact the undersigned should any questions arise.

Yours very truly,

GOLDER ASSOCIATES LTD.

Ernest Beck

Ernest Becker
Senior Radiation Specialist

Jeff Fleming
HSE Specialist - Radiation

Daryl Johannesen
Principal

M:\Actif\2014\1250\1407707 Canada Fluorspar-EA-AGS mine St-Lawrence\3 Phase 3-Preparation of EA Registration\Government Comments on EA Registration\Appendix B - Radon Report\CFI Radon Assessment - JDF_EB_dj_EB.docx

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APPENDIX M

Preliminary Noise Assessment

TECHNICAL MEMORANDUM

DATE September 21, 2015 **PROJECT No.** 1407707

TO Michel Wawrzkow and Frank Pitman
Canada Fluorspar (NL) Inc.

CC Elisabeth Luther, Golder Associates Ltd.

FROM Joe Tomaselli, Golder Associates Ltd. **EMAIL** joe_tomaselli@golder.com

PRELIMINARY NOISE ASSESSMENT – AGS FLUORSPAR PROJECT, ST. LAWRENCE, NL

Golder Associates Ltd. (Golder) was retained by Canada Fluorspar (NL) Inc. (CFI) to carry out a preliminary noise assessment of the proposed AGS Fluorspar project (the Project) on noise sensitive Point(s) of Reception (POR[s]) in the vicinity of the Project. This preliminary noise assessment was prepared to support the Environmental Assessment (EA) process, and to address questions raised by the regulators in their initial review of the EA Registration (CFI 2015). This technical memorandum is based on Golder's current understanding of the Project and presents the findings of the preliminary noise assessment, and summarizes CFI's commitment with respect to future noise studies.

Background

The Project will include construction, operation, rehabilitation and closure of a surface and underground Mine, a Mill, a Tailings Management Facility (TMF), ancillary infrastructure, and a Marine Terminal. The proposed Project will be located partly on a brownfield site used historically for mining. The Project site is located entirely within the municipal boundaries of the Town of St. Lawrence, on the southern tip of the Burin Peninsula in Newfoundland.

Regulatory Guidance and Criteria

Limited noise specific guidance is provided by the Province of Newfoundland and Labrador (NL) for the assessment of potential noise effects from projects. However, guidance is available from federal sources. Health Canada issued various documents, which provide guidance on the noise assessment of existing or proposed projects in Canada. Health Canada's '*Useful Information for Environmental Assessments*' (Health Canada 2010) was developed to provide assistance to regulating bodies in the review and approval of EAs. Health Canada does not have noise guidelines or enforceable noise thresholds, standards or limits by which to assess compliance of a project, but rather, the Health Canada guidance examines the aspects to consider in the preparation of a noise assessment.

Among other items identified in the guidance document, Health Canada (2010) recommends that a noise assessment consider:

- The identification of potential noise sensitive receptors;
- Information of the distance from the project activities to potential noise receptors;
- The identification/assessment of expected baseline sound levels;
- The identification of potential noise sources associated with the project;
- A description of methods used to complete the noise assessment;
- The comparison of baseline conditions to expected noise levels associated with the project;
- An evaluation of severity of predicted changes;
- A description of mitigation, if required; and
- A description of a management or monitoring program.

The Health Canada (2010) guidance document forms the basis of this preliminary noise assessment.

Noise Sensitive Points of Reception

Noise sensitive POR(s), which could include; permanent or seasonal residences, hotels/motels, nursing/retirement homes, rental residences, hospitals, camp grounds, and noise sensitive buildings such as schools and places of worship are located to the north, east and south of the Project site. The largest number and highest density of PORs are located in the Town of St. Lawrence. Four PORs were selected to be representative of all noise sensitive PORs in the vicinity of the Project site, and summarized in Table 1. Figure 1 illustrates the buildings in the vicinity of the Project, which could be sensitive PORs, and the four identified representative PORs.

Table 1: Identified Representative Noise Sensitive Points of Reception

POR ID	Description	Direction	Approximate Distance to the Project (m)
POR1	Residence within the Town of St. Lawrence	North of the Project	470 (Haul Road to Marine Terminal)
POR2	Residence at the southern area of the Town of St. Lawrence	North of the Project	340 (Haul Road to Marine Terminal)
POR3	Residence along Director Drive	North of the Project	1,000 (Haul Road to Marine Terminal)
POR4	Cabin	South of the Project	1,900 (Haul Road within the Mine Site)

PORs located in the southern portion of the Town of St. Lawrence (i.e., POR1 and POR2) are expected to be the nearest PORs to the Project infrastructure. A POR located south of the Project site (i.e., POR4) represents the POR closest to the Project mining and processing activities.

Baseline noise levels at POR1, POR2 and to a lesser extent POR3, are expected to be made up of anthropogenic noise and sounds of nature, having a characteristic of being fairly rural in nature. The Ontario Ministry of the Environment and Climate Change (MOECC) recently developed a noise guide, NPC-300 *'Environmental Noise Guideline – Stationary and Transportation Sources – Approval and Planning'* (MOECC 2013) that describes typical background noise levels applicable to projects in urban and rural areas. Noise levels between 40 and 45 A-weighted decibels (dBA) are often deemed representative of rural areas throughout various periods of the day. It would not be unreasonable to expect baseline levels would be higher when local anthropogenic activities were to occur in the vicinity of the POR.

POR4 is in a more remote/undeveloped area where the baseline noise environment is expected to be comprised of natural sounds with infrequent sounds associated with human activities. Based on previous experience with projects located in remote areas, average baseline noise levels of 35 dBA or higher, depending on the amount of local activity, could be expected at these remote PORs (Health Canada 2005).

Project Description / Noise Emissions

The Project will include construction, operation, rehabilitation and closure phases. All Project phases are expected to include activities with the potential to generate noise emissions, which could affect the environment.

Based on previous experience with similar projects, the construction and operation phases are expected to be the phases with the potential for the highest noise emissions that could occur for an extended period of time. Although noise emissions associated with the construction phase are expected to be similar in magnitude as those expected during operations, they are expected to be more intermittent, and be limited in duration (i.e., approximately two years). Accordingly, the potential noise effect of the construction phase on the receiving environment is expected to be similar to, or less than those expected for the operation phase. Therefore, the operation phase was further considered in this preliminary noise assessment.

The Project will include surface and underground mining activities, a Mill, a TMF, ancillary infrastructure, and a Marine Terminal. Table 2 summarizes a partial list of potentially acoustically substantial noise sources that could be utilized during the operation phase. These potential noise sources are based on preliminary information provided to-date and are assumed to represent equipment/activities associated with the worst case scenario for operations. It is expected that the mining equipment and associated personnel will operate during two 10-hour shifts per day (resulting in 20 hours of operation in a 24-hour period) for up to 350 days per year.

Table 2: Potential Project Noise Sources

Equipment	Location
Mill	Mine Site
Crushing Equipment	Mine Site
Dust Collector	Mine Site
Drill	Mine Site
Ventilation Fans – Fresh Air Raises	Mine Site
Generators	Mine Site

Equipment	Location
Pumps	Mine Site
Air Compressors	Mine Site
Compactors	Mine Site
Bulldozers	Mine Site
Excavators	Mine Site
Mobile Equipment	Mine Site
Haul Trucks	Mine Site and haul road between the Mine Site and Marine Terminal
Conveyors	Mine Site and Marine Terminal
Ship	Marine Terminal

Various noise control programs will be implemented as part of the Project design. These include, but are not limited to:

- Noise controls will be designed inherent in the Project, which may include selection of quieter equipment, enclosures, and silencers;
- Best management practices to control noise emissions from vehicles on haul roads will be implemented;
- Equipment noise control systems will be maintained;
- Blasting will be intermittent and of short duration; and
- Marine vessels will travel and be anchored approximately 900 metres (m) from noise sensitive PORs.

Methodology

The potential noise effects of the proposed Project on identified noise sensitive PORS was assessed through a combination of a qualitative assessment, based on experience with other similar projects, and a semi-quantitative assessment consistent with internationally accepted practices.

The semi-quantitative assessment of likely effects of the Project on ambient noise levels were evaluated in accordance with the ISO 9613 Acoustics: *Attenuation of Sound during Propagation Outdoors (International Organization for Standardization 1993 and 1996)* (ISO 1993, 1996) noise prediction algorithm. The ISO 9613 prediction method is conservative, as it assumes that all PORs are downwind from the noise source or a moderate ground based temperature inversion always exists. It is understood that the prevailing wind direction is west/southwest (i.e., POR4 is upwind of the Project Mine Site). In completing this preliminary noise assessment, Golder conservatively did not include foliage attenuation from trees or shrubs in the intervening lands between the Project and the PORs.

In assessing the magnitude of effect of a project, it is common to determine the potential change in ambient noise levels relative to existing noise levels. Table 3 summarizes the magnitude criteria often used in assessing similar projects.

Table 3: Human Perception to Change in Noise Levels

Increase from Existing Noise Levels	Typical Human Response	Magnitude
Up to 3 dB	Hardly perceptible	Negligible
>3 dB to 6 dB	Noticeable	Low
>6 dB to 10 dB	Readily noticeable	Moderate
> 10 dB	Disturbing	High

Changes in noise levels at PORs that would be hardly perceptible (i.e., less than or equal to 3 decibels [dB]) are often not considered to result in an adverse effect and are generally assigned a negligible magnitude. A noticeable change at PORs (i.e., greater than 3 dB, but less than or equal to 6 dB change) are generally considered as having a low magnitude. Readily noticeable changes at PORs (i.e., greater than 6 dB, but less than or equal to 10 dB) are often considered of moderate magnitude. Disturbing changes in the noise levels at PORs (i.e., greater than 10 dB) are generally classified as having a high magnitude.

Findings

The PORs represented by POR1 and POR2 are expected to be acoustically most affected by Project activities associated with the operations occurring at the Marine Terminal. The specific activities associated with the Marine Terminal with the potential to affect these PORs include shipping activities, including loading, and trucking activities along the road used to access the Marine Terminal. POR1 will be more than 800 m from the ship loading activities, and POR2 will be approximately 350 m from truck traffic along the Marine Terminal Access Road. It is expected, during the operations phase, that there will be less than 40 ships loaded with product from the Project activities in a given year. POR1 and POR2 will be located further than 4 km from the Mine processing (crushing/milling) activities. As it is understood that limited activities will occur at the Marine Terminal when a ship is not there, and when ship loading activities are not occurring, it is not expected that Project activities will be readily discernable at these PORs. Table 4 summarizes the findings of the preliminary semi-quantitative noise assessment of worst case scenarios during operations with the shipping activities.

The PORs represented by POR3 are expected to be acoustically most affected by noise emissions associated with trucking traffic along the proposed Access Road between the Mine Site and the Marine Terminal. These PORs are located more than 950 m north of the Access Road and approximately 2.5 km from the Mine processing (crushing/milling) activities. Table 4 summarizes the findings of the preliminary semi-quantitative noise assessment of worst case scenarios during operations with the shipping activities.

The PORs represented by POR4 are expected to be acoustically most affected by noise emissions associated with the Mine Site, including mining activities and Mine processing (crushing/milling) activities. These PORs are located approximately 2 km south of the Processing Plant and haul routes on the Mine Site. Table 4 summarizes the findings of the preliminary semi-quantitative noise assessment of worst case scenarios during operations.

Table 4: Preliminary Evaluation of Project Noise Levels and Effect

POR	Baseline Noise Levels (dBA)	Potential Project Noise Levels (dBA)**	Potential Future Ambient Noise Levels (dBA)	Potential Change in Noise Levels (dB)	Potential Magnitude***
POR1	40 – 45 *	~ 40	~ 43	3	Negligible to Low
POR2	40 – 45 *	~ 44	~ 45	5	Low
POR3	40 – 45 *	~ 40	~ 43	3	Negligible to Low
POR4	35 – 40 *	~ 35	~ 38	3	Negligible to Low

Notes:
*: In preparing a conservative assessment, the lower of the range was conservatively used for the preliminary noise assessment.

**: Based on a preliminary semi-quantitative noise assessment of equipment/activities associated with the Project during the worst case scenarios during operations.

***: Based on Table 3: Human Perception to Changes in Noise Levels.

Based on the preliminary noise assessment, it is expected that there is a potential for Project noise emissions to result in a ‘negligible’ to ‘low’ change in average noise levels at the identified representative PORs. For POR1 through POR3, the Project activities associated with the most substantial potential noise effect will be limited to activities associated with the Marine Terminal, specifically truck traffic along the Mine and Marine Terminal access roads. As these activities are expected to be intermittent throughout the year, this potential change in ambient noise levels is expected to be intermittent. For POR4, the noise levels from the Project activities are expected to lower when the POR is not in a downwind condition, or when a temperature inversion does not exist.

Future Consideration

It is understood that CFI will carry-out a follow-up noise assessment/monitoring program once the Project is commissioned to verify the findings of this preliminary noise assessment. This follow-up noise assessment will be used to verify that mitigation measures implemented into the design of the Project are effective once implemented, and to determine whether there is a need for additional mitigation measures. This follow-up noise assessment/monitoring program will form part of a more comprehensive environmental monitoring program, which will include implementing a complaints-based recording and resolution program where regulating authorities and/or members of the public will have the opportunity to work with CFI to log and resolve concerns.

Closure

We trust this provides the required information at this time. Please feel free to contact the above with any questions and/or concerns.

References

CFI (Canada Fluorspar (NL) Inc.) 2015. AGS Fluorspar Mine, Environmental Assessment Registration Pursuant to the Newfoundland and Labrador Environmental Protection Act. Submitted to the Newfoundland and Labrador Department of Environment and Conservation, 230 pp.

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The Ontario Ministry of the Environment and Climate Change, 2013 *'Environmental Noise Guideline - Stationary and Transportation Sources – Approval and Planning, Publication NPC-300',* Ontario

Joe Tomaselli, M.Eng., P.Eng.

Associate, Acoustics, Noise and Vibrations Engineer

Daryl Johannesen, M.Sc., P.Biol.,

Principal, Project Director

PRN/JT/EL/

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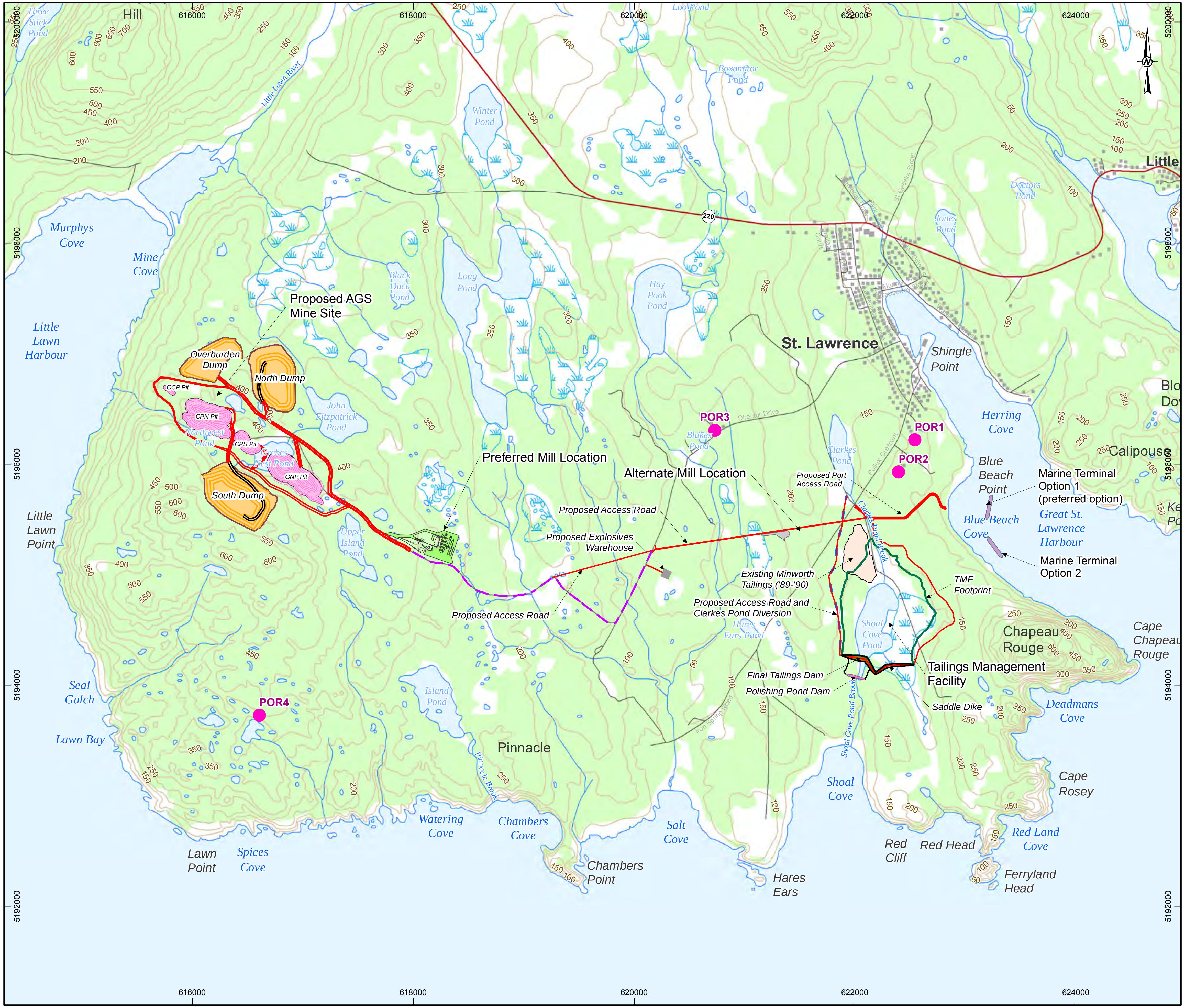

LEGEND

● Point of Reception

PROJECT COMPONENTS

- Clarkes Pond Diversion Channel
- Proposed Road
- Proposed Upgraded Road
- TMF Footprint
- Final Tailings Dam
- Setting Pond Dam
- Saddle Dike
- Existing Minworth Tailings
- Mine Dump Option
- Pit

TOPOGRAPHY

- Building
- Highway
- Existing Road
- Contour Line (interval: 50 ft)
- Watercourse
- Waterbody
- Wetland

0 1 2

Kilometres

1:35,000

REFERENCE

SOURCE(S): DEVELOPMENT REGULATIONS 2011 LAND USE ZONING MAP 1, JAN. 19, 2013, TOWN OF ST. LAWRENCE; CANVEC & CANVEC+, 1: 50 000 SCALE, NRCAN.

DATUM: NAD 83. PROJECTION: UTM ZONE 21.

CLIENT

CANADA FLUORSPAR INC.

PROJECT

AGS MINE PROJECT ST. LAWRENCE NL

TITLE

PROJECT SITE PLAN AND POINT OF RECEPTION LOCATIONS

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-09-21
DESIGN	CG
GIS	ED/JB
REVIEW	EL
APPROVED	DJ

PROJECT No.	Rev.	FIGURE
14-07707	0	1

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APPENDIX N

Minworth Tailings Dam Safety Analysis

TECHNICAL MEMORANDUM

DATE September 18 2015 **PROJECT No.** 1407707

TO Elisabeth Luther
Golder Associates Ltd.

CC Ken Been, Ph.D, P.Eng.

FROM Andrew Peach, P.Geo., EP **EMAIL** andrew_peach@golder.com

ENVIRONMENTAL PREVIEW REPORT – MINWORTH DAM, ST. LAWRENCE, NL

On September 4, 2015 Golder Associates Ltd. was contacted by Canada Fluorspar Inc. and asked to provide comment on whether the proponent's (Canada Fluorspar Inc.) tailings pond level would impact the toe of the former Minworth tailings dam and if so, does it affect the stability of the former tailings dam. To answer these questions two representative cross sections through the former Minworth tailings dam were analysed, one through the western section of the dam and the other through the central section. The nomenclature for the Minworth tailings dam follows the system that was recently established by SNC-Lavalin during the 2015 Dam Safety Review (DSR) for the Minworth tailings dam.

To facilitate the assessment, an analytical model of each cross section was generated in order to conduct a series of slope stability analyses. The details of the cross section used to generate the model as well as the material properties assigned were strictly based on the information provided in the 2015 DSR. The slope stability analyses were performed using *Slide 6.0*, which is a comprehensive slope stability analysis program. The results of the assessment were used to assess the stability of the dam under static conditions and the results were compared with acceptance criteria published by the Canadian Dam Association. As previously mentioned the analyses focused on two different dam sections in order to capture the range of conditions present.

Table 1 presents the various geotechnical parameters used in the slope stability analyses. The factors of safety presented in Table 2 and in the stability analyses attached were calculated using the Morgenstern-Price method. This method was selected, as it is the method that Worley Parsons used in their Pre-feasibility Design Report for the proposed Tailings Management Facility (TMF). Pore pressures in each model were automatically calculated in the analysis program. The unit weight of water used in these calculations was 9.81 kN/m^3.

The detailed results of the stability analysis are attached and a summary of the results has been presented in Table 2. Three different conditions were analysed for each cross-section:

- the existing condition;
- TMF condition, with increased water levels to reflect the proposed TMF operations; and,
- rapid drawdown condition, if for some reason the proposed TMF water levels were suddenly lowered.

For the analyses performed for the current conditions (existing conditions) the results were filtered to show all slip surfaces with a Factor of Safety (FOS) less than 1.5. The FOS value that is shown for each analysis is for the lowest overall factor of safety that was calculated. For example, the analysis of the western section under current conditions shows that the slip surface with the lowest FOS corresponds to a rotational failure, however, by filtering the data to show all slip surfaces with a FOS less than 1.5, it is easy to see that there are many more rotational failure slip surfaces present as well.

For the analyses performed for the TMF condition, which is meant to illustrate the effect that the proponents TMF water levels would have on the stability of the Minworth tailings dam, the results were again filtered to show all slip surfaces with a Factor of Safety (FOS) less than 1.5. The FOS value that is shown on those analyses is for the lowest overall factor of safety that was calculated. The water elevation along the downstream slope is 26.5 m which is based on the information presented in the Worley Parson design document previously mentioned.

A third analysis was performed to illustrate a situation where a rapid drawdown occurs from the water elevation of 26.5 m to the water elevation under current conditions, which is based on the results present in the 2015 DSR prepared by SNC-Lavalin. For this analysis, the data has been filtered to show all slip surfaces with a Factor of Safety (FOS) less than 1.3. Again the FOS value that is shown on those analyses is for the lowest overall factor of safety that was calculated.

The results of the slope stability analyses show that the downstream slopes along the Minworth Dam currently do not meet the required FOS as advocated by the Canadian Dam Association. The results also show that there is insignificant impact on the existing Minworth tailings dam due to the proponents TMF water levels along the downstream slope of the Minworth tailings dam. During a rapid drawdown situation there is also no notable change in the FOS since the critical failure surfaces are above the water levels in the current and rapid drawdown conditions.

It should be noted that the results of the analyses are only specific to the sections of the downstream slopes used in the model and for the design water elevations used.

Table 1: Summary Table of Slope Stability Parameters Used

Material	**Till (Dam Fill)**	**Cycloned Sand**	**Mine Waste Rock**	**Reject Gravel (Drain)**	**Variable Fill**	**Reject Gravel / Sand Mixture**	**Tailings**	**Rock Fill (Outer Shell)**	**Road Surface**	**Till (*In Situ*)**	**Bedrock (Granite)**
Unsaturated Unit Weight (kN/m^3)	18.5	17	20	18	17	17.5	16	20	18	22	26
Saturated Unit Weight (kN/m^3)	20	20	22	19	19	19.5	18	21	19.5	23	26
Cohesion (MPa)	0	0	0	0	0	0	0	0	0	0	5
Friction Angle (°)	34	32	36	32	30	34	26	45	32	40	25
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb

Table 2: Summary Table of Stability Results and Factors of Safety

Modelled Condition		Overall Downstream Slope H:V	Water Elevation Downstream Slope (m)	Calculated FOS (minimum)	*Required FOS (minimum)
Western	Current Conditions (Static)	1.7H:1.0V	25.50	1.2	1.5*
	TMF Condition (Static)	1.7H:1.0V	26.50	1.2	1.5*
	TMF Condition Rapid Drawdown (Static)	1.7H:1.0V		1.2	1.3*
Central	Current Conditions (Static)	1.4H:1.0V (upper) 1.4H:1.0V (lower)	24.50	1.3	1.5*
	TMF Condition (Static)	1.4H:1.0V (upper) 1.4H:1.0V (lower)	26.50	1.3	1.5*
	TMF Condition Rapid Drawdown (Static)	1.4H:1.0V (upper) 1.4H:1.0V (lower)		1.3	1.3*

** Required FOS as per CDA, 2007, 2013.*

If you have any further questions please do not hesitate to contact the undersigned at your convenience.

Yours truly,

KBeen

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