**INFORMATION REQUEST RESPONSE**

**EA No: 0809-001** **Information Request No: Environment Canada #14**

**Date Received**

February 28, 2011

**Linkage to Other IRs**

Environment Canada IR #12, 13

**Date of this Response**

June 17, 2011

**Request**

***Question**:*

1. Environment Canada requests the following:
   a. A map of all of the gridded and discrete receptors including spatial extent and density used in the air quality modeling;
   b. An assessment of the potential air quality impacts from the increased load on the Jackfish Power Plant as a result of the project power demand; and
   c. Total area of exceedance outside the disturbed mine site for each species assessed.

2. *(Supplemental question from Environment Canada)*
   The DAR and the response to Question 1 both evaluated the air quality implications of emissions associated with the incremental power requirements of the Remediation Project (i.e., 3 MW of electricity produced by the Jackfish Power Plant).

   Through direct communications with INAC, Environment Canada subsequently requested that an additional round of dispersion modeling be conducted to evaluate NOx concentrations in the event the Jackfish Power Plant is operated at its total generating capacity (i.e., a total of 27 MW of electricity instead of the incremental 3 MW of demand associated with the Remediation Project).

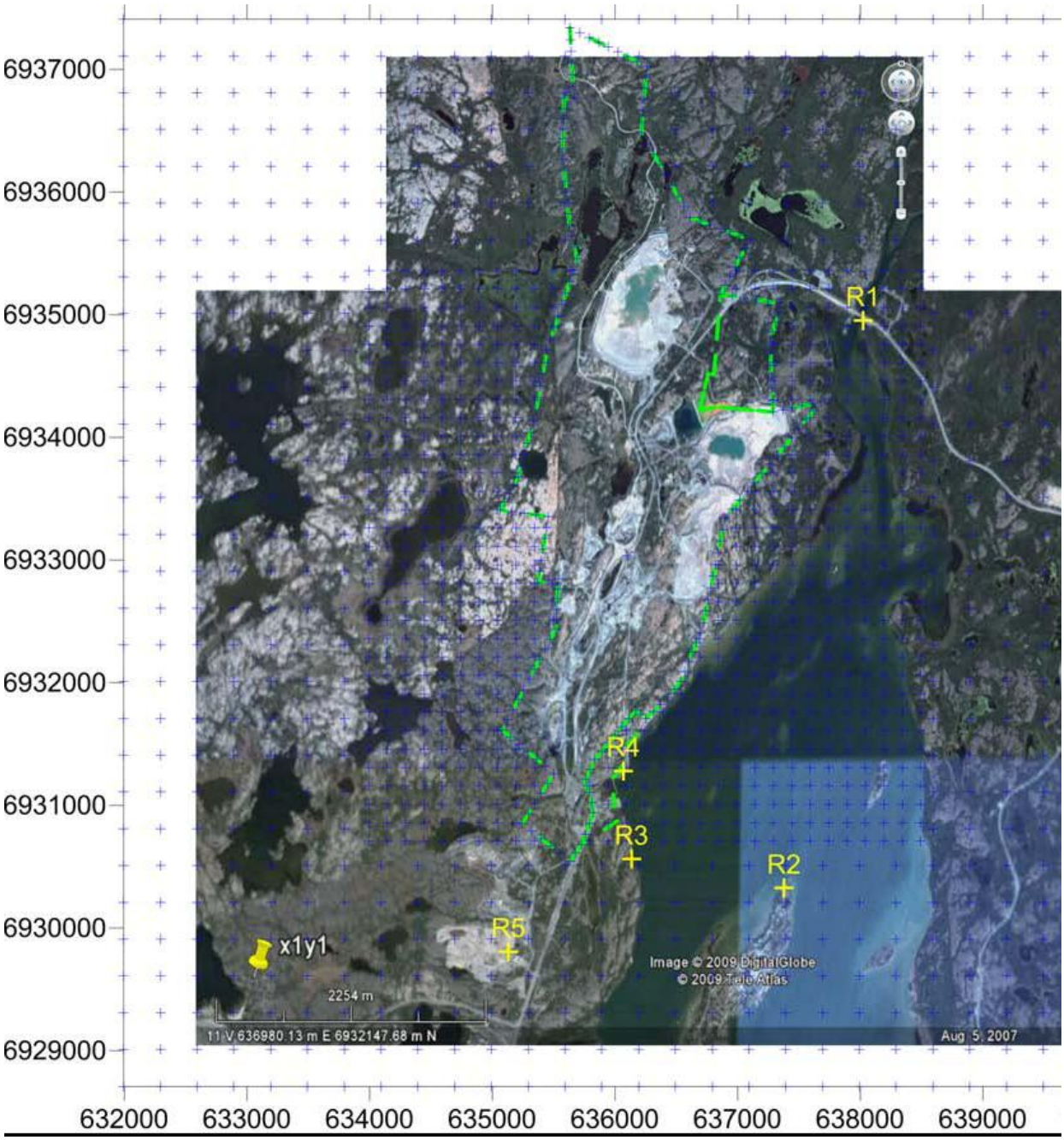
**Reference to DAR (relevant DAR Sections)**
s.8.6.2 Air Quality

**Reference to the EA Terms of Reference**
s 3.6 Monitoring, Evaluation and Management

**Response 1a**

Please refer to Figure 1 below. The gridded modeling locations, which are indicated by a "+" on the figure, were on a 150 m by 150 m spacing interval.

**Figure 1 – Map of Gridded and Discrete Receptors Used in Air Quality Modeling (150 m spacing)**



**Response 1b**

As noted in Section 8.6.2.3 of the Developer's Assessment Report (DAR), the assessment of potential air quality impacts from the 3 MW of incremental load on the Jackfish Power Plant as a result of the Giant Mine Remediation Project (Remediation Project) has already been included in the DAR. An example of the calculations used in the assessment is provided below.

***Source: Jackfish Power Plant 3MW Diesel Generator Combustion Emissions***

The AP-42 Chapter 3.4 - Large Stationary Diesel Engines, Table 3.4-1 outlines emission factors for diesel combustion in internal combustion engines greater than 600 hp. The input capacity of the diesel generator is as follows:

3 MW = 4023 hp
4023 hp

**Sample Calculations:**

Below is a sample calculation for NOx emissions from the diesel generator

NOx Emission =
$$power(hp)\times\frac{0.024lb}{hp-hr}\times\left(\frac{1hr}{3{,}600\sec}\right)\times\left(\frac{1kg}{2.2lb}\right)\times\left(\frac{1000g}{kg}\right)\times 45\%\,NO/NO_2\ Ratio$$

Emission Rate =
$$4023(hp)\times\frac{0.024lb}{hp-hr}\times\left(\frac{1hr}{3{,}600\sec}\right)\times\left(\frac{1kg}{2.2lb}\right)\times\left(\frac{1000g}{kg}\right)\times 45\% = 5.486\,gNOx/\sec$$

**The following table outlines the emission rates for Diesel Generator emissions:**

| Source ID | Description | Power Rating (hp) | Contaminant | Emission Factor (lb/hp-hr) | Emission Rate (g/s) |
|---|---|---|---|---|---|
| DG | Yellow Knife Diesel Generators | 4,023 | NOx | 0.024 | 5.486 |
| | | | $PM_{2.5}$ | 0.0007 | 0.356 |
| | | | CO | 0.0055 | 2.794 |
| | | | SOx | 0.00006 * | 0.031 |

Note: * Golder Assumption of 0.0485% sulphur and half is converted to SO2

**Response 1c**

Total area of exceedance outside the disturbed mine site for each species assessed:

| Parameter | Averaging Period | Area of Off-Property Exceedances |
|---|---|---|
| Arsenic | 24-hr | 0.02 km² |
| Particulate Matter | 24-hr | 0.13 km² |
| $PM_{10}$ | 24-hr | 0.68 km² |
| $PM_{2.5}$ | 24-hr | 0.93 km² |
| $NO_2$ | 1-hr | 0.40 km² |
| $SO_2$ | 1-hr | 0.04 km² |

Note: Other contaminants and averaging periods not listed were not predicted to have off-site exceedances of applicable criteria.

**Response 2 Summary**

The current screening level assessment by SENES determined that the Remediation Project would be a relatively small contributor to total nitrogen dioxide concentrations at the receptor locations if the Jackfish Power Plant is simultaneously operated at full capacity. However, consistent with a previous study for the Northwest Territories Power Corporation (NTPC) (Golder 2002), the current assessment also concluded that the operation of the Jackfish Power Plant at full capacity may result in exceedances of the 1-hour $NO_2$ Ambient Air Quality Criteria under certain meteorological conditions. The conclusions reached in both assessments could be refined by conducting a more detailed assessment of the NTPC facility. Such an assessment is not within the scope of the current Environmental Assessment (EA).

**Response 2**

As noted in the response to Question 1, the approach used in the DAR was to include Jackfish Power Plant emissions associated with the 3 MW of incremental load requirement for the Remediation Project. The assumption was that diesel generator emissions associated with other electrical production requirements from the Jackfish Power Plant would be included in existing background concentrations, which were added to model predicted contaminant concentrations. Background contaminant concentrations were developed from the air quality monitoring station located adjacent to École Sir John Franklin High School (ÉSJFHS) in central Yellowknife, which is closer to the Jackfish Power Plant than the Giant Mine Site.

During the Information Request (IR) process, Environment Canada requested that additional air dispersion modelling be performed based on the assumption that the Jackfish Power Plant is operating at its maximum rated capacity of 27 MW, not just the incremental 3 MW power requirements for the freeze plant. The supplemental Environment Canada request provides an example for $NO_x$ emission rates, which is the primary contaminant of concern from the combustion of diesel fuel. The current IR response therefore focuses on determining $NO_x$ emissions under a scenario in which the Jackfish Plant is operating at full capacity.

*Estimating $NO_2$ Emissions From Diesel Generators*

$NO_x$ is a combination of $NO_2$ and NO, however, ambient air quality criteria are based on $NO_2$ concentrations. When discharged into the atmosphere, NO will oxidize with available ozone ($O_3$) under certain meteorological conditions to form $NO_2$ (and $O_2$). When carrying out air dispersion modelling to estimate ground level $NO_2$ concentrations resulting from diesel generator $NO_x$ emissions, it is important to consider the ratio of $NO_2$ in total $NO_x$ emissions. There are two common methods for estimating ground level $NO_2$ concentrations: (1) applying a $NO_2$ / $NO_x$ ratio to modelled $NO_x$ concentrations based on $NO_2$ and NO monitoring data; and, (2) allowing an air dispersion model that includes chemical

conversion to calculate $NO_2$ concentrations based on monitored ozone concentrations available for the conversion of NO to $NO_2$. The first approach was used in the DAR, based on $NO_2$ and NO monitoring data from the ÉSJFHS monitoring station, resulting in a $NO_2/NO_x$ ratio of 45%. In general, the second method is considered to be the most realistic (if sufficient data for modelling parameters are available), while the first method is more conservative because the assumption is that NO emitted from the diesel generator stack will react quickly to form $NO_2$ in ratios typically measured at the monitoring site.

*Previous Studies of Diesel Generator Emissions From the Jackfish Power Plant*

A separate study was completed by Golder Associates for the NTPC to determine potential health risks related to atmospheric emissions from their facilities, including the Jackfish Power Plant (Air Quality and Health Assessment for NTPC Generating Stations, Golder Associates, December 2002). This report was provided to SENES by NTPC during the preparation of the DAR to be used to develop diesel generator stack details at the Jackfish Power Plant, which are required for air dispersion modelling. In the Air Quality and Health Assessment completed for NTPC, the CALPUFF air dispersion model was used to estimate ground level $NO_2$ concentrations resulting from the Jackfish Power Plant based on monitored ozone concentrations. The report concluded that 1-hr exceedances of $NO_2$ criteria may be expected and that further assessment would be required to obtain a more accurate estimate of $NO_x$ emissions and model predicted $NO_2$ concentrations resulting from Jackfish Power Plant operations. The maximum predicted 1-hour ground level $NO_2$ concentrations from the Jackfish Power Plant was 1,922 $\mu g/m^3$.

*Assessment of Total Emissions from Diesel Generators at the Jackfish Power Plant*

In response to the supplemental request from Environment Canada, SENES conducted a screening level modelling of $NO_x$ emissions from the Jackfish Power Plant for three different scenarios:

Scenario 1. Worst case Giant Mine remediation activities with 3 MW of incremental power for the freeze plant (as presented in the DAR);

Scenario 2. Maximum operations of the Jackfish Power Plant minus 3 MW incremental power for the freeze plant (i.e., 27 MW maximum operations minus 3 MW incremental power = 24 MW). This scenario is intended to represent "maximum baseline" conditions for scenario 3; and,

Scenario 3. Worst case Giant Mine remediation activities and maximum operations of the Jackfish Power Plant (i.e., 27 MW, which would include the 3 MW consumed by the freeze plant).

A comparison of model results for scenarios 1 and 2 with the results for scenario 3 was used to differentiate between the impacts resulting from Giant Mine remediation activities versus the impacts resulting from maximum operations at the Jackfish Power Plant.

Model results are presented in the tables below for six (6) receptor locations: the five (5) sensitive receptors identified in the DAR and ÉSJFHS, which is the location of the Environment Canada monitoring station used to develop background concentrations for $NO_2$.

**TABLE 1**
**MODEL PREDICTED 1-HOUR $NO_2$ CONCENTRATIONS**

| Receptor | Scenario 1. | Scenario 2. | Scenario 3. |
|---|---|---|---|
| | ($\mu g/m^3$) | ($\mu g/m^3$) | ($\mu g/m^3$) |
| R1 - Yellowknife River Park | 98 | 742 | 834 |
| R2 - N'Dilo Residential Receptor | 127 | 499 | 560 |
| R3 - Back Bay Residential Receptor | 150 | 1157 | 1301 |
| R4 - Boat Launch Recreational Receptor | 194 | 1135 | 1276 |
| R5 - Municipal Landfill Receptor | 220 | 1714 | 1928 |
| R6 - Sir John Franklin High School | 156 | 1206 | 1357 |
| **NAAQO** | **400** | | |
| **Background** | **6** | | |

Note: NAAQO – National Ambient Air Quality Objective (NWT does not have an Air Quality Standard for $NO_2$; therefore, national objectives are used.)
Background concentration for $NO_2$ from the DAR; estimated as median 2005/2006 values from the Sir John Franklin High School.

**TABLE 2**
**MODEL PREDICTED 24-HOUR $NO_2$ CONCENTRATIONS**

| Receptor | Scenario 1. | Scenario 2. | Scenario 3. |
|---|---|---|---|
| | ($\mu g/m^3$) | ($\mu g/m^3$) | ($\mu g/m^3$) |
| R1 - Yellowknife River Park | 14 | 71 | 79 |
| R2 - N'Dilo Residential Receptor | 15 | 65 | 72 |
| R3 - Back Bay Residential Receptor | 16 | 85 | 95 |
| R4 - Boat Launch Recreational Receptor | 29 | 156 | 179 |
| R5 - Municipal Landfill Receptor | 29 | 193 | 217 |
| R6 - Sir John Franklin High School | 44 | 313 | 351 |
| **NAAQO** | **200** | | |
| **Background** | **6** | | |

Note: NAAQO – National Ambient Air Quality Objective (NWT does not have an Air Quality Standard for $NO_2$; therefore, national objectives are used.)
Background concentration for $NO_2$ from the DAR; estimated as median 2005/2006 values from the Sir John Franklin High School.

The results presented in Tables 1 and 2 indicate that the primary source of ground level nitrogen dioxide concentrations at the receptor locations is anticipated to be the Jackfish Power Plant (assuming it is operating at full capacity). Table 1 also predicts that exceedances of the 1-hour $NO_2$ Ambient Air Quality Criteria (AAQC) may occur. However, it should be noted that the results presented in Tables 1 and 2 are considered conservative based on SENES' assumption that NO emitted from the diesel generator stack will react quickly to form $NO_2$ in ratios measured at the ÉSJFHS monitoring site ($NO_2/NO_x$ ratio of 45%). It should also be noted that SENES model predicted 1-hour $NO_2$ concentrations in the vicinity of the Jackfish Power Plant (approximately 2,680 $\mu g/m^3$) are comparable to those predicted by Golder Associates in their December 2002 assessment.

The conservative nature of this NO to $NO_2$ conversion assumption can also be demonstrated based on a comparison of the model predicted $NO_2$ concentrations at Sir John Franklin High School with monitoring results at the same location. Monitoring results at the ÉSJFHS monitoring station from 2005 and 2006 indicate a maximum 1-hour $NO_2$ concentration of 103 $\mu g/m^3$ (55 ppb) (data is available from: http://www.etc-cte.ec.gc.ca/publications/napsreports_e.html), compared to the model predicted

maximum concentration of 1,206 µg/$m^3$ (based on 24 MW power production from the Jackfish Power Plant). This order of magnitude difference can be primarily attributed to two factors:

1. The conservative assumption for the conversion of NO to $NO_2$ outlined above; and,
2. The Jackfish Power Plant does not typically operate at full capacity, whereas modelling for Scenario 2 is based on the assumption that 24 MW of power are generated continuously 365 days of the year 24 hours/day to ensure that the worst case operating scenario corresponds with the worst case meteorological conditions. The Jackfish Power Plant likely did not operate at 24 MW power production during the worst case 1-hour meteorological conditions in 2005 and 2006.

The conclusions reached in the current evaluation, as well as the previous study for the NTPC, could be refined by conducting a more detailed assessment of the NTPC facility. Such an assessment is not within the scope of the current EA.