

Class I Area Air Dispersion Modeling

NorthMet Project

***Prepared for
PolyMet Mining Inc***

May 2012

Version 2

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1.0 Introduction and Executive Summary

The requested air quality analysis conducted for the proposed NorthMet Project (Project) near Hoyt Lakes, Minnesota demonstrates that the Project will not deteriorate air quality and also concludes that the Project will not have an adverse effect on flora and fauna or terrestrial or aquatic ecosystems. When compared to pristine conditions, visibility impacts are below “presumptive no adverse impact” criteria when using conservative modeling procedures.

Air emission permits for Prevention of Significant Deterioration (PSD) major sources require that an air quality analysis be conducted to demonstrate that national ambient air quality standards will not be exceeded and that the Project will not significantly deteriorate air quality. PolyMet Mining Inc (PolyMet) plans to request limits to allow the Project to be permitted as a synthetic minor source, but PolyMet has agreed to complete dispersion modeling that is generally consistent with what would be required for a major source permit. The general proposed approach to limit emissions below the major source level is described in version 2 of NorthMet Proposed Synthetic Minor Limits, submitted November 4, 2011.

For air quality purposes, areas are generally divided into two classes based on local land use. These are referred to as Class I and Class II areas. Wilderness and national park areas are designated as Class I areas. All other areas are designated as Class II areas.

Each classification differs in terms of the amount of growth that is allowed. When developing the air permitting regulations, Congress anticipated that increases in ambient air concentrations would be necessary in order for economic growth to occur. Ambient air concentrations are capped at the National Ambient Air Quality Standards, which are set to protect human health. No increases are allowed that would cause ambient air concentrations to go above these standards. The air permitting regulations were also designed to keep ambient air concentrations relatively unchanged from where they were at the time of the baseline, except for small increases to allow for growth. In the area around the Project, the major source baseline was set in 1975 for PM_{10} and the minor source baseline date for PM_{10} was set in 1979 for St Louis County and 1999 for Lake County.

The allowed growth, or increase in ambient air concentrations, is referred to as increment. In addition to growth allowed for in terms of the increment that was set aside in the regulations, growth can also be accommodated for through decreases in ambient air concentrations resulting from reductions in air emissions from sources in an area since the baseline. In addition to growth, potential impacts to Air Quality Related Values (AQRVs) such as visibility and impacts on flora and fauna are required to be assessed for Class I areas.

This report describes the Class I area air quality impacts assessment that was conducted for the proposed Project. The air quality assessment for Class II areas will be prepared and reported separately. The Class I area analysis provides an assessment of air quality impacts at the following Class I areas:

- Boundary Waters Canoe Area Wilderness (BWCAW),
- Rainbow Lake Wilderness,
- Voyageurs National Park, and
- Isle Royale National Park.

Federal Land Managers (FLMs) have responsibility for protecting air quality in the Class I areas. The US Forest Service (USFS) has responsibility for the BWCAW and Rainbow Lake Wilderness. The National Park Service has responsibility for Voyageurs National Park and Isle Royale National Park. This report is being submitted to the above FLMs, the state air permitting authority (the Minnesota Pollution Control Agency (MPCA)) and the Co-lead and Cooperating Agencies preparing the Project Supplemental Draft Environmental Impact Statement (SDEIS)¹. The following conclusions were drawn from the modeling analysis conducted for the Project; additional details of the conclusions are discussed in Sections 4, 5 and 6:

¹ The U.S. Forest service is both the FLM for BWCAW and Rainbow Lake and a co-lead agency for the SDEIS.

- No adverse impact on flora and fauna is expected.
- Deposition values were below the “Green Line Values” set by the USFS and National Park Service. Therefore, no adverse impact on terrestrial and aquatic ecosystems is expected.
- When compared to pristine conditions as prescribed in current guidance, no adverse visibility impacts are indicated.
- The Class I increment analysis demonstrates that air quality will not be deteriorated as a result of the Project. The increase in criteria pollutant ambient air concentrations are all below the Significant Impact Levels (SILs) except for PM₁₀ in the BWCAW. When modeled concentrations are greater than the SIL, a cumulative increment analysis is required. Based on increment modeling conducted, the Project, along with other projects, has not consumed the available increment for PM₁₀ in the BWCAW. This conclusion is also supported by the fact that monitored concentrations have decreased in this area, indicating an increase in the increment concentration available for growth.

2.0 Project Description

PolyMet plans to construct and operate a mine area near the town of Babbitt, MN, to reactivate portions of the LTV Steel Mining Company (LTVSMC) Taconite Processing Plant and Tailing Basin near Hoyt Lakes, MN and to build an ore processing facility at the former LTVSMC site. The proposed project is referred to as the NorthMet Project (Project). The Project description is provided in the March, 2011 Draft Alternative Summary for the NorthMet Project environmental impact statement (Reference (1)) and the NorthMet Project Description (Reference (2)). The impact statement Co-lead Agencies, Minnesota Department of Natural Resources (MDNR), US Army Corps of Engineers (USACE), and USFS, have concluded the Project requires a Supplemental Draft Environmental Impact Statement (SDEIS).

The Final Air Impact Assessment Planning Summary Memo for the SDEIS requires an updated assessment of the cumulative potential effects on visibility in Northeastern Minnesota (Reference (3)).

This document is being provided as a stand-alone document for review and it will be integrated into the NorthMet Project Air Data Package after approval. Any discrepancy between this document and the NorthMet Project Air Data Package will be resolved in favor of this document.

2.1 Air Emissions

The Project's controlled potential air emissions are shown in Table 2-1.

Table 2-1 Project Air Emissions (Controlled Potential to Emit)

Project AIR EMISSIONS	Plant Site Stationary Source Emissions (tons/yr)	Mine Site Stationary Source Emissions (tons/yr)(a)	Mobile Source Emissions (tons/yr)(b)
Total PM ₁₀ Point Source Emissions	216.4	4.27	7.76
Total Fugitive PM ₁₀ Emissions	305.8	454.0	NA
Total Point Source Plus Fugitive PM ₁₀ Emissions	522.2	458.2	7.76
Total SO ₂ Emissions	7.0	1.9	0.51
Total NO _x Emissions	89.4	12.0	309.2

Source: NorthMet emission calculation spreadsheets last submitted to MPCA March 21, 2012 (Mine Site) and March 5, 2012 (Plant Site). Totals in table may reflect values updated since last submittal, but the complete supporting calculations for the Class I modeling will be provided for review and comment.

(a) Based on Year 13 of Mine operation (higher of two worst-case years evaluated).

(b) Exhaust emissions from mining vehicles, locomotives and Tailings Basin construction equipment. Not listed as "fugitive" because stationary fugitive sources were not included in the Class I impacts analysis.

The emissions data presented in Table 2-1 include all point sources. Emergency generators and other sources not operated during normal, full capacity source operation were not included in the Class I impact analysis as is standard practice (see modeling protocol (Appendix B) for additional details). Fugitive dust emissions were also not included in the Class I analysis as is standard practice (see modeling protocol (Appendix B)). Furthermore, for the source categories associated with the project, fugitive emissions are not included in the determination of the source status with respect to PSD regulations nor are mobile source emissions.

The emissions listed in Table 2-1 represent the worst case over the Project life, which was modeled in the updated increment evaluation. For the updated AQRV modeling, the project was divided into multiple scenarios to represent different time periods of project operation. These scenarios only affect the mobile source emissions. Table 2-2 briefly describes the scenarios and Table 2-3 lists the mobile source emissions associated with each scenario.

Table 2-2 Mobile Source Emission Scenario Assumptions

Scenario	Description	Tailing Basin Mobile Sources	Mine Site Mobile Sources
1	Years 1 to 5	Maximum number of haul trucks (28) – all meet Tier 4 Standards. Auxiliary vehicles emissions based on currently available engine Tier levels.	Seven Tier 2 haul trucks, 1 Tier 4. Other equipment reflects currently available equipment engine Tier levels. Max fuel usage = year 5 + 5% safety factor.
2	Years 6 to 8	Maximum haul trucks is 12 – all Tier 4. Other vehicles same as 1.	Four Tier 4 haul trucks, five Tier 2. Other equipment same as 1. Max fuel usage = year 7.
3	Years 9 to 10	Maximum haul trucks is 12 – all Tier 4. Other vehicles same as 1.	Same as 2, except one tracked dozer meets final Tier 4 standard. Max fuel usage = year 10.
4	Years 11 to 20	Maximum haul trucks is 16 – all Tier 4. Other vehicles same as 1.	All vehicles meet final Tier 4 standards – maximum fuel usage (Year 11).

Table 2.3 Mobile Source Scenario Emissions (tons/yr)

Mobile Source Emissions	Scenario 1 (1 to 5)	Scenario 2 (6 to 8)	Scenario 3 (9 to 10)	Scenario 4 (11 to 20)
Total PM ₁₀ Emissions	7.76	6.82	7.05	3.97
Total SO ₂ Emissions	0.46	0.45	0.47	0.51
Total NO _x Emissions	309.2	286.8	291.4	228.2

The emission values presented in Tables 2.1 and 2.3 reflect measures taken to reduce visibility impacts in the BWCAW. The measures include the decisions to upgrade the insulation in the existing Crusher and Concentrator Buildings and to purchase low-NO_x space heating equipment such that overall NO_x emissions are reduced by at least 50% below that with all conventional

equipment. A plan for phasing in vehicles that meet Tier 4 emission standards has also been developed and is utilized in Table 2.2 – Mobile Source Emission Scenario Assumptions. These reductions were in addition to those previously adopted such as the use of efficient gen-set locomotives, the recirculation of dust collector exhaust to reduce heating demand, the use of appropriate pollution control equipment and the use of lower emitting fuels where feasible.

3.0 Class I Areas Assessment of Potential Impacts to Air Quality Related Values (AQRVs)

3.1 Class I Areas

Four Class I areas were identified in the modeling protocol as falling within an approximate 300 km radius and are assessed for potential impacts from the Project emissions using the CALPUFF modeling system. The areas are:

- 1) BWCAW,
- 2) Isle Royale National Park,
- 3) Rainbow Lake Wilderness, and
- 4) Voyageurs National Park.

The nearest part of the BWCAW is located approximately 34 km (21 miles) northeast of the Hoyt Lakes facility and it extends to 167 km (104 miles) east-northeast of the site. The Rainbow Lake Wilderness is located approximately 142 km (88 miles) southeast of Hoyt Lakes in Wisconsin. Both the BWCAW and the Rainbow Lake Wilderness are managed by the **USFS**.

Isle Royale National Park is located on Isle Royale in the northern part of Lake Superior (in the state of Michigan) approximately 218 km (135 miles) east and slightly north of the Project.

Voyageurs National Park is located just east of International Falls, Minnesota and stretches east along the northern border of Minnesota. The nearest part of Voyageurs National Park is approximately 82 km (51 miles) north of the Project location. Both parks are managed by the National Park Service.

3.2 Air Quality Related Values (AQRVs)

AQRVs are features or properties of Class I areas that could be adversely affected by air pollution. The Clean Air Act requires that potential AQRV impacts be reviewed for all major sources near Class I areas. The Project is not a major source, but, in general, the standard procedures for major sources were followed in the assessment of Class I impacts.

Although AQRVs are not well defined in the Act, AQRVs are generally considered by the FLMs to include visibility impairment and acid deposition. In addition, an assessment of the Class I increment has also been prepared based on MPCA guidance.

PolyMet has performed an analysis of projected AQRV impacts from the Project on acid deposition, visibility, and Class I increment. The methodology for these computations of potential impact are as outlined in the FLM Recommendations on Class I Area Analyses (Reference (4)), which also references the following documents:

- a) the USFS's "Screening Procedures to Evaluate Effects of Air Pollution on Eastern Wildernesses Cited as Class I Air Quality Areas" for flora and fauna and acid deposition; (Reference (5))
- b) the "Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Guidance for Modeling Impacts on Visibility"(Reference (6)), and
- c) the "Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Guidance" (Reference (7), Reference (8)).

3.3 CALPUFF Modeling System

The CALPUFF Modeling System is the required model for determining visual impacts at long distances from sources. This model was used in accordance with the guidelines found in the *Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts* (Reference (6)) and the 2010 revisions to Federal Land Managers' Air Quality Related Values Work Group guidance (Reference (8)). The Class I Modeling Protocol approved by the FLMs, MPCA and the Co-lead and Cooperating Agencies for the SDEIS is included in Appendix B. The protocol specifies all of the model options and user-selected fields for the analysis.

The CALPUFF system consists of three main components (CALMET, CALPUFF and CALPOST) and a number of pre-processing programs. These pre-processing programs are designed to prepare available meteorological and geophysical data for input into CALMET. Each of these modeling components is described below:

- CALMET is a meteorological model that develops hourly wind and temperature fields on a three-dimensional gridded modeling domain. Associated two-dimensional fields such as mixing heights, terrain elevations, land use categories and dispersion properties are also included in the file produced by CALMET.
- CALPUFF is a transport and dispersion model that follows the “puffs” of material emitted from one or more sources as they travel downwind. CALPUFF simulates dispersion and chemical transformations as each puff moves away from the source, using the multi-dimensional grids generated by CALMET.
- CALPUFF produces an output file containing hourly concentrations of pollutants which are processed by CALPOST to yield estimates of ambient air concentrations to determine increment consumptions, estimates of sulfur and nitrogen deposition, and estimates of extinction coefficients and related measures of visibility impairment at selected averaging times and locations.

3.3.1 CALMET

Three years (2002-2004) of MM5 prognostic mesoscale meteorological data, surface weather data, precipitation data, and upper air data were used to generate the CALMET data set for use in the CALPUFF model. The CALMET computational grid for the greater domain was 132 grid cells (east-west) by 90 grid cells (north-south) with a grid spacing of 4 km. US Geological Survey (USGS) digital elevation maps (DEMs) and land use land cover (LULC) files required by CALMET were obtained from the WebMET and WebGIS websites hosted by Lakes Environmental and the GeoBase website hosted by Natural Resources Canada.

The CALMET grid used in the cumulative PM₁₀ increment analysis described in Section 6 required the use of an expanded CALMET grid to cover the additional sources and with the CALMET grid spacing increased to 12 km to make the model run times practical. This approach is reasonable because the terrain in northern Minnesota is fairly uniform and moving to a 12 km grid will not result in modeling inaccuracies for long-range transport from these more distant sources. A sensitivity run was conducted and confirmed this to be the case.

3.3.2 CALPUFF

CALPUFF model input files were set up for each year of CALMET data. Inputs to the CALPUFF modeling system included 3 years of MM5 weather data, 3 years of hourly surface weather data, 3 years of upper air data, 3 years of hourly precipitation data, Project emission rates, source locations, receptor locations, land elevation data, and land use data. Model parameters were set to IWAQM Phase 2 recommended values followed by US Environmental Protection Agency (USEPA) regulatory default values where available, followed by the default values recommended in the model input file. The selection of model parameters is fully detailed in the modeling protocol (Appendix B).

The CALPUFF modeling considered the emission of SO₂, NO_x, PMC (coarse particulate matter), PMF (fine particulate matter), EC (elemental carbon), SOA (secondary organic aerosols) and sulfates (SO₄). The Project emission rates used in the CALPUFF modeling are provided in Table 3-1. Detailed emission rate calculations for each modeled source are included in Appendix A and in the emission inventory spreadsheets.

Table 3-1 Modeled Project Emission Rates (g/sec)

Species	Increment run	AQRV Scenario 1	AQRV Scenario 2	AQRV Scenario 3	AQRV Scenario 4
SO ₂	0.32	0.32	0.32	0.32	0.32
NO _x	12.03	12.03	10.40	10.54	8.94
PMC	0.06	0.06	0.06	0.06	0.06
PMF	5.22	5.22	5.21	5.21	5.18
EC	0.15	0.15	0.14	0.14	0.10
SOA	0.21	0.21	0.20	0.20	0.18
SO ₄	0.14	0.14	0.14	0.14	0.14

PMC represents the portion of PM₁₀ greater than 2.5 μm in diameter; EC was represented by the carbon content of filterable PM₁₀; SOA was represented by the organic condensable fraction of the PM₁₀; SO₄ is represented by the sulfuric acid emissions; PMF is the remainder of the non-carbon filterable and non-organic and non-SO₄ portions of the condensable fraction of the PM₁₀. Emitted PM₁₀ is thus the summation of PMC, PMF, EC, SOA and SO₄.

The CALPUFF modeling also tracked SO₄, NO₃, and HNO₃, which are generated by the chemical transformation of the emitted SO₂ and NO_x. The IWAQM recommended MESOPUFF II algorithms were selected to describe the rates of transformation. The MESOPUFF II transformation rates are a function of the background ozone and ammonia concentrations. The default CALPUFF libraries were used to characterize the wet and dry deposition of the modeled particulate and gaseous species.

Per guidance included in a May 4, 2012 e-mail from MPCA (Reference (9)), transformation chemistry and the associated secondary particulate formation was not included in the evaluation of PM₁₀ increment consumption.

Both dry and wet deposition were modeled for all nine species (PMC, PMF, EC, SOA, SO₄ and NO₃ were modeled as dry deposition of particles; NO_x, HNO₃, and SO₂ were modeled as dry deposition of gases) to obtain total sulfur and nitrogen deposition.

The CALPUFF modeling used the receptors for the BWCAW, Rainbow Lake Wilderness, Voyageurs National Park, and the Isle Royale National Park obtained from the National Park Service's web site (<http://nature.nps.gov/air/Maps/Receptors/>).

3.3.3 Post-processing

The CALPUFF output of hourly concentration values requires different postprocessing methods to generate the AQRV estimates of deposition, visibility, and increment. The postprocessing used the two program modules: CALPOST and POSTUTIL

POSTUTIL recalculates the hourly concentration values produced by CALPUFF to reflect ammonia scavenging chemistry in the model. The ammonia values used by POSTUTIL are independent of the ammonia value used in the MESOPUFF II chemical transformation algorithm in CALPUFF. A background ammonia concentration of 1 ppb was used. POSTUTIL also is used to sum the individual species contributions of wet and dry deposition to calculate total sulfur and nitrogen deposition.

CALPOST processes the hourly concentration files generated by CALPUFF to develop the estimates of deposition, air pollutant concentrations, and visibility impairment resulting from facility emissions. For visibility calculations, CALPOST uses relative humidity data in

conjunction with the hourly concentration files to calculate 24-hour average light extinction coefficients. Two sets of relative humidity data were used in the postprocessing corresponding to the Method 8 and Method 2 CALPOST visibility processing options. Method 8 follows the visibility calculation procedures in the 2010 revision of the FLAG guidance. Method 8 uses Class I area-specific monthly average relative humidity data provided in the updated guidance. Method 2 (Reference (7)) uses the CALPUFF generated hourly relative humidity data (VISB.DAT) in the visibility calculations, and is included for comparison with prior modeling efforts.

4.0 Acid Deposition Impacts Analysis

An evaluation of potential impacts to species (flora and fauna) and ecosystems (terrestrial and aquatic) resulting from Project SO₂ and NO_x emissions was conducted according to the methodology outlined in the USFS publication entitled “Screening Procedures to Evaluate Effects of Air Pollution on Eastern Wildernesses Cited as Class I Air Quality Areas” (Reference (5)). The USFS methodology uses a “Green-Yellow-Red” screening procedure in which the acid deposition impact on terrestrial and aquatic ecosystems is judged to be acceptable if ambient air concentrations and/or deposition is not above the respective “Green Line Concentration”.

4.1 Background Deposition Values

Data characterizing the Class I areas for ambient air concentrations of selected pollutants and for sulfur and nitrogen deposition are provided in Table 4-1. Assumptions and data applications were made for the four Class I areas in order to complete the AQRV analysis. Some of the major assumptions and data applications are listed below. Other assumptions and data applications, particularly estimating dry sulfur and dry nitrogen deposition, are included in the footnotes to Table 4-1.

- Isle Royale: Sulfur and nitrogen deposition data for Isle Royale are limited. The National Atmospheric Deposition Program (NADP) operates a precipitation monitoring site on Isle Royale during the ice-free season and provides seasonal deposition values for sulfur and nitrogen. However, average annual deposition data are needed for the AQRV analysis. Average annual deposition data from the Hovland, Minnesota site, which is located within the Lake Superior basin approximately 22 miles south and west of Isle Royale, were subsequently used to estimate annual average deposition for Isle Royale.
- Rainbow Lake Wilderness: The Rainbow Lake Wilderness is located in northwest Wisconsin. The NADP operates a monitoring site near Spooner, Wisconsin. Wet sulfate and wet nitrate deposition data from the Spooner NADP site were applied to the Rainbow Lake Wilderness.

Table 4-1 Existing and Estimated Background Values For Selected Class I Areas

Characteristic	BWCAW	Isle Royale	Rainbow Lake	Voyageurs Park
Mean SO ₂ Concentration, annual (µg/m ³) ^(a)	1.2	2.0	1.6	0.7
Max SO ₂ Concentration, 3-hour (µg/m ³) ^(b)	10.8	18	14.4	6.3
Ozone Concentration, 2 nd -high hourly (ppb _v) ^(c)	68	68	90	71
Annual Sulfur Deposition				
Wet deposition (kg S/ha/yr) ^(d)	2.42	1.72	2.55	1.41
Dry deposition (kg S/ha/yr) ^(e)	0.43	0.43	0.43	0.43
Total deposition(kg S/ha/yr)	2.85	2.15	2.98	1.84
Annual Nitrogen Deposition				
Wet deposition (kg N/ha/yr) ^(d)	4.07	3.17	5.20	3.19
Dry deposition (kg N/ha/yr) ^(e)	0.68	0.68	0.68	0.68
Total deposition (kg N/ha/yr)	4.75	3.85	5.88	3.87

(a) Mean annual SO₂ concentrations (µg/m³):

Annual average SO₂ (µg/m³) concentrations calculated from data (1991-1993) in Table 1 (Reference (5)):

BWCAW: data from Ely, MN site applied to BWCAW.

Isle Royale National Park: data from the Finland, MN site applied to Isle Royale National Park.

Rainbow Lake Wilderness: data from the Sandstone, MN site applied to Rainbow Lake Wilderness.

Voyageurs National Park: data from Annual Data Summary, Voyageurs National Park 2002, National Park Service, Gaseous Air Pollutant Monitoring Network, Report No. NPS D-139.

(b) Highest 3-hour SO₂ set equal to annual average SO₂ x 9.0, in accordance with USEPA Guideline (see Table 4-3)

(c) Ozone concentrations:

BWCAW: data from USEPA AirData, Lake County, MN (2003)

Isle Royale National Park: data from USEPA AirData, Lake County, MN (2003)

Rainbow Lake Wilderness: data from USEPA AirData, Polk County, WI (1998)

Voyageurs National Park: data from Annual Data Summary, Voyageurs National Park 2001, National Park Service, Gaseous Air Pollutant Monitoring Network, Report No. NPS D-134.

(d) Annual wet deposition data from NAPD data base (<http://nadp.sws.uiuc.edu>)

BWCAW: data for Hovland Site, Cook County, MN (1997-2003)

Isle Royale National Park: data for Fernberg Site, Lake County, MN (1997-2003)

Rainbow Lake Wilderness: data for Spooner Site, Washburn County, WI (1997-2003)

Voyageurs National Park: data for Voyageurs National Park, Sullivan Bay, St. Louis County, MN (2000-2003)

(e) Annual dry deposition data from CASTnet data base (<http://www.epa.gov/castnet>) for Voyageurs National Park. (1996-2002)

4.2 Flora and Fauna

Adverse effects to flora (plants) and fauna (animals) are generally accepted to mean any changes in growth, reproduction, mortality, and diversity of native plant and animal species caused by anthropogenic activities. In evaluating potential adverse effects to flora and fauna, lichen species are generally used as a threshold indicator of potential air pollution damage because they are especially susceptible to air pollution and show adverse effects before other plant species and animal species. If pollutant concentrations in a Class I area are sufficiently low that no damage

occurs to native lichens, then it can reasonably be concluded that all other flora and fauna species are protected. The most sensitive lichen species are only present when annual average SO₂ concentrations are less than 40 µg/m³.^[2] Table 4-2 compares the sum of background SO₂ concentrations plus modeled ambient air SO₂ concentrations to the Project emissions for all AQRV scenarios modeled (i.e., maximum modeling result for all scenarios). As can be seen in Table 4-2, all estimated SO₂ ambient air concentrations are substantially lower than 40 µg/m³, and they are also well below the Green Line Concentration of 5 µg/m³, indicating that there will be no adverse effects from the Project emissions on flora or fauna in the Class I areas.

Table 4-2 Class I Screening Analysis for Effects on Flora and Fauna from Sulfur Dioxide Total Annual Average Ambient Air Concentrations – All AQRV Scenario Maximum

Location	Background Air Concentration [a] (µg/m ³)	Modeled Project Contribution [b] (µg/m ³)	Total Projected Air Concentration (µg/m ³)	Green Line Concentration [c] (µg/m ³)
BWCA Wilderness	1.2	0.001	1.2	5
Isle Royale National Park	2.0	0.000	2.0	5
Rainbow Lake Wilderness	1.6	0.000	1.6	5
Voyageurs National Park	0.7	0.000	0.7	5

[a] Mean annual SO₂ concentrations (µg/m³):

Annual average SO₂ (µg/m³) concentrations calculated from data (1991-1993) in Table 1 (Reference (5)):

BWCAW: data from Ely, MN site applied to BWCAW

Isle Royale National Park: data from the Finland, MN site applied to Isle Royale National Park.

Rainbow Lake Wilderness: data from the Sandstone, MN site applied to Rainbow Lake Wilderness.

Voyageurs National Park: data from Annual Data Summary, Voyageurs National Park 2002, National Park Service, Gaseous Air Pollutant Monitoring Network, Report No. NPS D-139.

[b] Maximum modeled ambient air concentration in a Class I area using the CALPUFF modeling system.

[c] Green line concentration from (Reference (5))

4.3 Terrestrial and Aquatic Ecosystems

4.3.1 Deposition Thresholds

Adverse effects to terrestrial and aquatic ecosystems are evaluated slightly differently by the National Park Service and the USFS. The National Park Service uses deposition analysis

thresholds (DATs) to evaluate if the incremental impact of the Project for deposition is acceptable, whereas the **USFS** considers the total concentration or deposition, including background in their Green Line analysis.

For the National Park Service sites (Voyageurs National Park and Isle Royale National Park), the DATs were calculated for total sulfur and total nitrogen. DATs have been developed by the National Park Service and the U.S. Fish and Wildlife Service (**Reference (10)**) to evaluate the contribution of additional nitrogen (N) or sulfur (S) to deposition within Class I areas. The definition of a DAT is “the additional amount of nitrogen or sulfur deposition within a Class I area, below which estimated impacts from a proposed new or modified source are considered insignificant”. The DATs that have been developed are intended to distinguish where deposition increases may result in potentially adverse ecosystem stresses, as well as where the deposition increases are likely to have negligible impact on AQRVs. The National Park Service has calculated the following DATs:

- N = 0.01 kg/ha/yr
- S = 0.01 kg/ha/yr

The DAT is the additional amount of deposition (i.e., deposition threshold) that triggers a management concern, not necessarily the amount that constitutes an adverse impact to the environment. Adverse impact determinations are considered on a case-by-case basis, taking into consideration the best available scientific information to assess existing as well as potential future deposition impacts. The magnitude of the estimated deposition and the sensitivity of the ecosystem are also considered. Site-specific information for each Class I area are also taken into account, including evaluating the potential deposition impacts from a source not just in relation to the DAT, but with other factors as well, such as whether an adverse impact resulting from deposition have been documented, or suspected, in that specific Class I area.

While formulated slightly differently than the National Park Service DATs, the **USFS** Green Line values for BWCAW and Rainbow Lake account for the soil conditions and lake water chemistry of these wilderness areas. The Green Line values represent the total pollutant loading below which there are no adverse impacts.

4.3.2 Terrestrial Impacts

The pollutant values required for the terrestrial impacts evaluation are the Project-related nitrogen and sulfur deposition and SO₂ ambient air concentrations. The **maximum** modeling results **across all** Project **scenarios** are provided in Table 4-3. As discussed above, because the **USFS** considers the total concentration or deposition, including background in their Green Line analysis, comparison for the BWCAW and Rainbow Lake Wilderness should be made between the column titled “Total Concentration or Deposition” and the column titled “Green Line Value or Deposition Analysis Threshold”. Similarly, because the National Park Service considers the incremental impact of the Project for deposition (i.e., not including background), deposition comparisons for Isle Royale National Park and Voyageurs National Park should be made between the column titled “Modeled Air Concentration or Calculated Project-Related Deposition” and the column titled “Green Line Value or Deposition Analysis Threshold”. The green line values or DATs for terrestrial effects are not exceeded for the Class I areas.

Table 4-3 Class I Area Screening Analysis Results for Potential Terrestrial Impacts –All AQRV Scenario Maximums

Location ^[b]	Pollutant	Background Data ^[a]	Model Air Concentration or Calculated Project-Related Deposition ^[c]	Total Concentration or Deposition	Green Line Value Or Deposition Analysis Threshold ^{[d] [e]}
BWCAW – Ely	Ann. avg. SO ₂ (µg/m ³)	1.2	0.001	1.2	5 µg/m ³
	3-hour max. SO ₂ (µg/m ³)	10.8	0.105	10.9	100 µg/m ³
	Total Sulfur (kg/ha/yr)	2.85	0.000	2.9	5-7 kg/ha/yr S
	Total Nitrogen (kg/ha/yr)	4.75	0.009	4.8	5-8 kg/ha/yr N
Isle Royale National Park	Ann. avg. SO ₂ (µg/m ³)	2.0	0.000	2.0	5 µg/m ³
	3-hour max. SO ₂ (µg/m ³)	18	0.001	18	100 µg/m ³
	Total Sulfur (kg/ha/yr)	2.15	0.000	2.2	0.01 kg/ha/yr S
	Total Nitrogen (kg/ha/yr)	3.85	0.000	3.9	0.01 kg/ha/yr N
Rainbow Lake Wilderness	Ann. avg. SO ₂ (µg/m ³)	1.6	0.000	1.6	5 µg/m ³
	3-hour max. SO ₂ (µg/m ³)	14.4	0.003	14.4	100 µg/m ³
	Total Sulfur (kg/ha/yr)	2.98	0.000	3.0	5-7 kg/ha/yr S
	Total Nitrogen (kg/ha/yr)	5.88	0.000	5.9	5-8 kg/ha/yr N
Voyageurs National Park	Ann. avg. SO ₂ (µg/m ³)	0.7	0.000	0.7	5 µg/m ³
	3-hour max. SO ₂ (µg/m ³)	6.3	0.020	6.3	100 µg/m ³
	Total Sulfur (kg/ha/yr)	1.84	0.000	1.8	0.01 kg/ha/yr S
	Total Nitrogen (kg/ha/yr)	3.87	0.001	3.9	0.01 kg/ha/yr N
<p>[a] Mean annual SO₂ concentrations (µg/m³): Annual average SO₂ (µg/m³) concentrations calculated from data (1991-1993) in Table 1 (Reference (11)). BWCAW: data from Ely, MN site applied to BWCAW Isle Royale National Park: data from the Finland, MN site applied to Isle Royale National Park. Rainbow Lake Wilderness: data from the Sandstone, MN site applied to Rainbow Lake Wilderness.</p> <p>Voyageurs National Park: data from Annual Data Summary, Voyageurs National Park 2002, National Park Service, Gaseous Air Pollutant Monitoring Network, Report No. NPS D-139.</p> <p>Highest 3-hour SO₂ set equal to annual average SO₂ x 9.0, in accordance with USEPA Guideline (Reference (12)).</p> <p>Annual wet deposition data from NAPD data base (http://nadp.sws.uiuc.edu) BWCAW: data for Hovland Site, Cook County, MN (1997-2003) Isle Royale National Park: data for Fernberg Site, Lake County, MN (1997-2003) Rainbow Lake Wilderness: data for Spooner Site, Washburn County, WI (1997-2003)</p>					

Location ^[b]	Pollutant	Background Data ^[a]	Model Air Concentration or Calculated Project-Related Deposition ^[c]	Total Concentration or Deposition	Green Line Value Or Deposition Analysis Threshold ^{[d] [e]}
<p>Voyageurs National Park: data for Voyageurs National Park, Sullivan Bay, St. Louis County, MN (2000-2003)</p> <p>Annual dry deposition data from CASTnet data base (http://www.epa.gov/castnet) for Voyageurs National Park. (1996-2002)</p> <p>[b] Highest Modeled air concentration in each Class I area. [c] Model estimated ambient air concentrations using the CALPUFF modeling system. [d] Green line concentration from (Reference (11)). Deposition Analysis Threshold (DAT) is based on National Park Service Guidance for the Eastern U.S. [e] S = sulfur; N = nitrogen.</p>					

4.3.3 Aquatic Impacts

The pollutant values required for the aquatic impacts evaluation are the Project-related nitrogen and sulfur deposition. The **maximum** modeling results **across all** Project **scenarios** are provided in Table 4-4. As discussed above, because the **USFS** considers the total deposition, including background in their Green Line analysis, comparison for the BWCAW and Rainbow Lake Wilderness should be made between the column titled “Total Deposition” and the column titled “Green Line Value or Deposition Analysis Threshold”. Similarly, because the National Park Service considers the incremental impact of the Project for deposition (i.e., not including background), deposition comparisons for Isle Royale National Park and Voyageurs National Park should be made between the column titled “Estimated Project-Related Deposition” and the column titled “Green Line Value or Deposition Analysis Threshold”. The green line values or DATs for aquatic effects are not exceeded for any of the National Park Service Class I areas.

Table 4-4 Screening Analysis Results for Potential Aquatic Effects –All AQRV Scenario Maximums

Location ^[d]	Pollutant ^[a]	Background Deposition ^[b] (kg/ha/yr)	Estimated Project-Related Deposition (kg/ha/yr)	Total Deposition (Project + Background) (kg/ha/yr)	Green Line Value or Deposition Analysis Threshold ^[c] (kg/ha/yr)
BWCAW – Ely	Total Sulfur	2.85	0.000	2.85	7.5 - 8.0
	Total S + 20% of Total N	3.80	0.002	3.80	9 – 10
Isle Royale National Park	Total Sulfur	2.15	0.000	2.15	0.01
	Total N	3.85	0.000	3.85	0.01
Rainbow Lake Wilderness	Total Sulfur	2.98	0.000	2.98	3.5 - 4.5
	Total S + 20% of Total N	4.16	0.000	4.16	4.5 – 5.5
Voyageurs National Park	Total Sulfur	1.84	0.000	1.84	0.01
	Total N	3.87	0.001	3.87	0.01

[a] S = Sulfur; N = Nitrogen.

[b] Annual wet deposition data from NAPD data base (<http://nadp.sws.uiuc.edu>)

BWCAW: data for Hovland Site, Cook County, MN (1997-2003)

Isle Royale National Park: data for Fernberg Site, Lake County, MN (1997-2003)

Rainbow Lake Wilderness: data for Spooner Site, Washburn County, WI (1997-2003)

Voyageurs National Park: data for Voyageurs National Park, Sullivan Bay, St. Louis County, MN (2000-2003)

Annual dry deposition data from CASTnet data base (<http://www.epa.gov/castnet>) for Voyageurs National Park. (1996-2002)

[c] Green line concentration from (Reference (5)). Deposition Analysis Thresholds based on National Park Service guidance for the eastern U.S.

[d] Highest modeled deposition used in the assessment.

5.0 Visibility Impacts Analysis

The potential visibility impacts associated with the Project were evaluated using CALPUFF based on currently accepted guidance (i.e., Method 8) from the FLMs (Reference (8)). In addition, results are also presented based on the previous version of the FLM guidance (i.e., Method 2) for comparison purposes (Reference (7)). Potential changes in the visibility were expressed in terms of a light extinction coefficient b_{ext} . The approach has four major steps.

- 1) The atmospheric concentrations of visibility-impairing pollutants at receptors in the BWCAW, Voyageurs National Park, and the Isle Royale National Park were estimated by the CALPUFF modeling system.
- 2) Extinction coefficients were calculated from the model-generated atmospheric concentrations of visibility-impairing pollutants. Extinction coefficient results from both CALPOST Method 8 and Method 2 calculations are presented.
- 3) The emission-derived extinction coefficients were compared to the existing background extinction coefficients derived from the measured background concentrations of visibility-impairing pollutants at the three Class I areas. Results are compared to 20% best pristine day's background and annual average pristine background.
- 4) The potential visibility impacts were expressed as changes in the overall extinction coefficient (Δb_{ext}) and the number of days resulting in a change greater than 5% and 10%.

Three Class I areas were included in the visibility analysis for the Project: the BWCAW (located 34 km from Project facility), Voyageurs National Park (82 km), and Isle Royale National Park (218 km). The Rainbow Lake Wilderness Areas in Wisconsin does not have an AQRV for visibility.

5.1 Visibility Thresholds

Visibility impairment is defined as "... Any humanly perceptible change in visibility (visual range, contrast, coloration) from that which would have existed under natural conditions." (40 CFR 51.301). For this analysis, visibility effects are to be determined by the change in light extinction as calculated in CALPOST. EPA's Prevention of Significant Deterioration (PSD) guidance states; "An 'adverse impact on visibility' means visibility impairment which interferes

with the management, protection, presentation, or enjoyment of a visitor’s visual experience of the Federal Class I area.”

Current FLM guidance provides the following threshold with regard to individual source visibility impacts (Reference (8)):

“The visibility threshold for concern is not exceeded if the 98th percentile change in light extinction is less than 5% for each year modeled, “

Table 5-1 shows the threshold differences between the different methods.

Table 5-1 FLAG Comparison

	FLAG 2000	FLAG 2010
Maximum Day Over 10%	"...FLMs will likely object to the proposed action."	NA ^[a]
Maximum Day Between 5 and 10%	"...a special decision threshold applies."	NA
98th Percentile Day Less Than 5% (H8H)	NA	"Presumptive no adverse impact"
No Days Over 5%	"...generally not trigger a need for a cumulative analysis."	NA

^[a]Not applicable (i.e., the guidance in this column does not use the criteria listed in the first column.

The visibility modeling results consider the Project exclusively.

Flag 2010 (Reference (8)) (Method 8) is the most recent approved guidance from the FLMs. However, previous modeling of the Project used the prior guidance version (Reference (7)) recommending Method 2, so those results are provided Section 5.3 as well for comparison.

5.2 Background Visibility Values

Model runs were also conducted for comparison to average natural (pristine) background and to the 20% best pristine days. Annual average chemical speciation data for the average and 20% best pristine days used for CALPUFF input are shown in Table 5-2.

Table 5-2 Pristine background concentrations

Class I Area	Background	Ammonium Sulfate (µg/m3)	Ammonium Nitrate (µg/m3)	Coarse Particulate Matter (µg/m3)	Organic Carbon (µg/m3)	Soil (µg/m3)	Elemental Carbon (µg/m3)	Rayleigh (Mm-1)
BWCAW	Annual Average (a)	0.23	0.1	3.0	1.4	0.5	0.02	10
	20% Best (b)	0.11	0.02	0.86	0.50	0.13	0.01	11
Voyageurs	Annual Average (a)	0.23	0.1	3.0	1.4	0.5	0.02	10
	20% Best (b)	0.12	0.02	0.86	0.56	0.10	0.01	12
Isle Royale	Annual Average (a)	0.23	0.1	3.0	1.4	0.5	0.02	10
	20% Best (b)	0.10	0.02	0.79	0.34	0.09	0.01	12

- a) Annual Average background from Table 2-1 of EPA's "Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program" (Reference (13)). Used with CALPOST Method 2
- b) 20% Best background from Table V.1-2 in Reference (8). Used with CALPOST Method 8.

5.3 Visibility Modeling Results

CALPUFF/CALPOST modeling results for visibility impacts compared to annual average pristine conditions and 20% best pristine days for each Project scenario are presented in Table 5-3 through 5-6. Results are presented for each Class I area. CALPOST visibility processing used Method 8 for 20% best pristine days and used Method 2 for annual average pristine background. Results are presented in Table 5-3.

Method 8 is the method currently approved in guidance from the FLMs. However, previous modeling of the Project used the prior guidance version (Reference (7)) recommending Method 2, so those results are provided for reference as well.

Method 2 may lead to an over-estimation of visibility impacts during periods of higher relative humidity (above 90 percent). These events were often associated with the peak controlling impacts. The current Method 8 uses the monthly average value thus avoiding the problem that impairs Method 2 results.

Table 5-3 Modeled Visibility Impacts – Scenario 1

Proposed Project Year 1 - 5	Natural Background					
	FLAG 2000 Method 2 (hourly RH, average annual background)			FLAG 2010 Method 8 (monthly RH, 20% best days background)		
	2002	2003	2004	2002	2003	2004
BWCAW						
Maximum Δb_{ext} (%)	11.08	7.88	4.66	9.81	6.8	6.73
8th highest Δb_{ext} (%)	5.08	3.33	3.41	4.86	3.92	3.85
Days with $\Delta b_{ext} \geq 5\%$	8	1	0	5	3	2
Days with $\Delta b_{ext} \geq 10\%$	1	0	0	0	0	0
98th %ile days with $\Delta b_{ext} \geq 5\%$	-	-	-	0	0	0
98th %ile days with $\Delta b_{ext} \geq 10\%$	-	-	-	0	0	0
Voyageurs						
Maximum Δb_{ext} (%)	2.28	4.5	2.76	1.7	3.18	1.9
8th highest Δb_{ext} (%)	1.12	1.28	1.31	0.89	1.11	0.97
Days with $\Delta b_{ext} \geq 5\%$	0	0	0	0	0	0
Days with $\Delta b_{ext} \geq 10\%$	0	0	0	0	0	0
98th %ile days with $\Delta b_{ext} \geq 5\%$	-	-	-	0	0	0
98th %ile days with $\Delta b_{ext} \geq 10\%$	-	-	-	0	0	0
Isle Royale						
Maximum Δb_{ext} (%)	1.12	1.13	1.23	1.03	0.69	0.75
8th highest Δb_{ext} (%)	0.41	0.25	0.38	0.44	0.21	0.23
Days with $\Delta b_{ext} \geq 5\%$	0	0	0	0	0	0
Days with $\Delta b_{ext} \geq 10\%$	0	0	0	0	0	0
98th %ile days with $\Delta b_{ext} \geq 5\%$	-	-	-	0	0	0
98th %ile days with $\Delta b_{ext} \geq 10\%$	-	-	-	0	0	0

Table 5-4 Modeled Visibility Impacts – Scenario 2

Proposed Project Year 6-8	Natural Background					
	FLAG 2000 Method 2 (hourly RH, average annual background)			FLAG 2010 Method 8 (monthly RH, 20% best days background)		
	2002	2003	2004	2002	2003	2004
BWCAW						
Maximum Δb_{ext} (%)	10.88	7.75	4.56	9.63	6.69	6.59
8th highest Δb_{ext} (%)	4.86	3.11	3.27	4.74	3.83	3.8
Days with $\Delta b_{ext} \geq 5\%$	7	1	0	4	2	1
Days with $\Delta b_{ext} \geq 10\%$	1	0	0	0	0	0
98th %ile days with $\Delta b_{ext} \geq 5\%$	-	-	-	0	0	0
98th %ile days with $\Delta b_{ext} \geq 10\%$	-	-	-	0	0	0
Voyageurs						
Maximum Δb_{ext} (%)	2.23	4.41	2.72	1.66	3.13	1.87
8th highest Δb_{ext} (%)	1.1	1.26	1.22	0.85	1.09	0.96
Days with $\Delta b_{ext} \geq 5\%$	0	0	0	0	0	0
Days with $\Delta b_{ext} \geq 10\%$	0	0	0	0	0	0
98th %ile days with $\Delta b_{ext} \geq 5\%$	-	-	-	0	0	0
98th %ile days with $\Delta b_{ext} \geq 10\%$	-	-	-	0	0	0
Isle Royale						
Maximum Δb_{ext} (%)	1.1	1.11	1.2	1.01	0.67	0.74
8th highest Δb_{ext} (%)	0.4	0.25	0.33	0.43	0.19	0.22
Days with $\Delta b_{ext} \geq 5\%$	0	0	0	0	0	0
Days with $\Delta b_{ext} \geq 10\%$	0	0	0	0	0	0
98th %ile days with $\Delta b_{ext} \geq 5\%$	-	-	-	0	0	0
98th %ile days with $\Delta b_{ext} \geq 10\%$	-	-	-	0	0	0

Table 5-5 Modeled Visibility Impacts – Scenario 3

Proposed Project Year 9-10	Natural Background					
	FLAG 2000 Method 2 (hourly RH, average annual background)			FLAG 2010 Method 8 (monthly RH, 20% best days background)		
	2002	2003	2004	2002	2003	2004
BWCAW						
Maximum Δb_{ext} (%)	10.99	7.82	4.61	9.72	6.75	6.66
8th highest Δb_{ext} (%)	4.89	3.14	3.3	4.8	3.87	3.83
Days with $\Delta b_{ext} \geq 5\%$	7	1	0	4	2	2
Days with $\Delta b_{ext} \geq 10\%$	1	0	0	0	0	0
98th %ile days with $\Delta b_{ext} \geq 5\%$	-	-	-	0	0	0
98th %ile days with $\Delta b_{ext} \geq 10\%$	-	-	-	0	0	0
Voyageurs						
Maximum Δb_{ext} (%)	2.26	4.46	2.74	1.68	3.16	1.89
8th highest Δb_{ext} (%)	1.11	1.28	1.23	0.86	1.09	0.97
Days with $\Delta b_{ext} \geq 5\%$	0	0	0	0	0	0
Days with $\Delta b_{ext} \geq 10\%$	0	0	0	0	0	0
98th %ile days with $\Delta b_{ext} \geq 5\%$	-	-	-	0	0	0
98th %ile days with $\Delta b_{ext} \geq 10\%$	-	-	-	0	0	0
Isle Royale						
Maximum Δb_{ext} (%)	1.11	1.12	1.22	1.02	0.68	0.75
8th highest Δb_{ext} (%)	0.41	0.25	0.33	0.43	0.2	0.22
Days with $\Delta b_{ext} \geq 5\%$	0	0	0	0	0	0
Days with $\Delta b_{ext} \geq 10\%$	0	0	0	0	0	0
98th %ile days with $\Delta b_{ext} \geq 5\%$	-	-	-	0	0	0
98th %ile days with $\Delta b_{ext} \geq 10\%$	-	-	-	0	0	0

Table 5-6 Modeled Visibility Impacts – Scenario 4

Proposed Project Year 11-20	Natural Background					
	FLAG 2000 Method 2 (hourly RH, average annual background)			FLAG 2010 Method 8 (monthly RH, 20% best days background)		
	2002	2003	2004	2002	2003	2004
BWCAW						
Maximum Δb_{ext} (%)	9.44	6.8	3.97	8.45	5.95	5.71
8th highest Δb_{ext} (%)	4.43	2.69	2.93	4.21	3.45	3.42
Days with $\Delta b_{ext} \geq 5\%$	3	1	0	2	2	1
Days with $\Delta b_{ext} \geq 10\%$	0	0	0	0	0	0
98th %ile days with $\Delta b_{ext} \geq 5\%$	-	-	-	0	0	0
98th %ile days with $\Delta b_{ext} \geq 10\%$	-	-	-	0	0	0
Voyageurs						
Maximum Δb_{ext} (%)	1.84	3.8	2.39	1.41	2.76	1.62
8th highest Δb_{ext} (%)	0.96	1.11	1.09	0.74	0.97	0.82
Days with $\Delta b_{ext} \geq 5\%$	0	0	0	0	0	0
Days with $\Delta b_{ext} \geq 10\%$	0	0	0	0	0	0
98th %ile days with $\Delta b_{ext} \geq 5\%$	-	-	-	0	0	0
98th %ile days with $\Delta b_{ext} \geq 10\%$	-	-	-	0	0	0
Isle Royale						
Maximum Δb_{ext} (%)	0.93	0.93	0.99	0.88	0.55	0.62
8th highest Δb_{ext} (%)	0.35	0.21	0.29	0.36	0.17	0.19
Days with $\Delta b_{ext} \geq 5\%$	0	0	0	0	0	0
Days with $\Delta b_{ext} \geq 10\%$	0	0	0	0	0	0
98th %ile days with $\Delta b_{ext} \geq 5\%$	-	-	-	0	0	0
98th %ile days with $\Delta b_{ext} \geq 10\%$	-	-	-	0	0	0

When compared to pristine conditions, the Project has no days with a change in extinction greater than 5% at Voyageurs or Isle Royale, for any scenario, using either method.

Using current modeling guidance (Method 8), the 98th percentile day impacts have a change in extinction of less than 5% change at BWCAW for all scenarios. These visibility modeling results meet the current FLM criteria for demonstrating no adverse impacts.

To allow for comparison to previous modeling, the results are also presented using Method 2. BWCAW has zero or one days with greater than a 10% change in extinction and 4 to 9 days greater than 5% using the previous modeling guidance. The results in this report show a significant reduction in the number of days with greater than 5% change in extinction compared

to the modeling results included in the Project Draft Environmental Impact Statement (DEIS) from October of 2009.

6.0 Prevention of Significant Deterioration (PSD) Increment Analysis

Air emission permits for major sources require that an air quality analysis be conducted to demonstrate that national ambient air quality standards will not be exceeded and that the Project will not significantly deteriorate air quality from baseline levels beyond what has been set aside for growth. The allowance for growth, in terms of air quality, is defined as the increment of the national ambient air quality standards that are set aside for increases in ambient air concentrations.

The Project is not a major source, but the same method was used for assessing impacts in Class I Areas that is used for major sources.

In the first step in the Class I PSD increment analysis, the modeled ambient air concentrations are compared to SILs². Modeled air concentrations greater than a SIL do not indicate that

² The SILs were proposed by EPA in July, 1996 (61 FR 61 FR 38292), and are used by the FLMs as a benchmark for determining if further analysis is warranted. The Class I SILs were proposed by EPA but have never been finalized. The SILs were established by EPA as a threshold for decision-making with regard to the need for additional analysis. EPA set the SILs at four percent of the Class I area increment. EPA's working assumption is that as long as no individual source contribution exceeds four percent of a Class I increment, it is unlikely that the accumulation of sources over time will exceed that increment and no additional analysis is needed. The SILs proposed by EPA in July, 1996 (61 FR 61 FR 38292), but never finalized, are *de minimis* levels set at four percent of the allowable Class I increment concentration. According to EPA, "where a proposed source contributes less than four percent to the Class I increment, concentrations are sufficiently low so as not to warrant a costly and detailed analysis of the combined effects of the proposed source and all other increment consuming emissions." (61 FR 38292). Even though the

adverse impacts will be associated with a Project's emissions; they simply trigger additional analysis. If the modeled concentrations exceed the SILs, then the applicant is required to conduct a cumulative increment analysis, which accounts for all increment consuming and expanding sources within 300 km of the Class I areas. As discussed in Section 6.1, the modeled Project air emissions exceeded the 24-hour PM₁₀ SIL in the BWCAW, which triggered a cumulative increment analysis for PM₁₀. The purpose of the cumulative increment analysis is to demonstrate that the addition of the Project along with emission increases and decreases from other facilities that have occurred since the baseline do not exceed the allowed increments.

Two components of the cumulative increment modeling analysis require additional detail beyond that used in the analysis for the AQRVs, and these components are the modeling procedures and the emission inventory. As discussed in Section 3, the modeling domain needed to be expanded to include increment sources within 300 km. Additional post-processing was also required for calculating the net increment consumption. Development of the increment modeling emission inventory is discussed in detail in Section 6.3.

6.1 Project Modeling Results Compared to SILs

Table 6-1 shows the maximum modeled pollutant concentrations of the Project emissions compared to the Class I increments and SILs for the three model years of 2002, 2003, and 2004.

Class I SILs have not been finalized, they were used as guidance for assessing the impacts on the Class I areas.

Table 6-1 Maximum Modeled Pollutant Concentrations from the Project Compared to Class I PSD Increments

Pollutant	Averaging Period	PSD Class I Increment (µg/m ³)	U.S. EPA SIL (µg/m ³)	Modeled Results			
				BWCAW (µg/m ³)	Voyageurs National Park (µg/m ³)	Isle Royale National Park (µg/m ³)	Rainbow Lake Area Wilderness (µg/m ³)
SO ₂	3-Hour	25	1.0	0.106	0.020	0.001	0.003
	24-Hour	5	0.2	0.025	0.005	0.001	0.001
	Annual	2	0.1	0.001	0.000	0.000	0.000
NO ₂	Annual	2.5	0.1	0.037	0.005	0.002	0.002
PM ₁₀	24-Hour	8	0.3	0.331	0.131	0.031	0.033
	Annual	4	0.2	0.020	0.004	0.002	0.002

The maximum modeled concentration from 2002-2004 meteorological data is presented.

While the modeling demonstrates compliance with the promulgated increments by a wide margin, the modeling shows concentrations above the proposed 24-hour SILs for PM₁₀ in the BWCAW. Therefore, additional analysis was conducted to evaluate the cumulative impacts to PM₁₀ increment in the BWCAW.

6.2 Class I Increment Analysis Emission Inventory

A cumulative impacts assessment for PM₁₀ in Voyageurs and the BWCAW was obtained from MPCA. This emission inventory was developed to include increment consuming and expanding sources. Current knowledge is that no other major sources within the region have submitted complete permit applications since this inventory was prepared. The emission inventory includes modifications to existing sources, new facilities that have been permitted or submitted permit applications and increases in actual emissions from existing facilities.

The inventory includes major sources within approximately 300 kilometers of Voyageurs and the BWCAW. Selected minor sources near the Class I Areas are also included, as selected by MPCA. The project impacts are below the SIL in Voyageurs, but at the request of MPCA, the cumulative results for Voyageurs are included.

6.2.1 Minor Source Baseline Dates

The minor source baseline date (MiSBD) is triggered at the time when a major PSD permit application is submitted and deemed complete. A cumulative increment assessment considers increases and decreases in emissions from sources occurring since the MiSBD to the time of the Project. MiSBDs are typically set on a county by county basis. Voyageurs and the BWCAW border several Minnesota counties and border one county in common. Voyageurs borders Koochiching and St. Louis counties. The BWCAW borders St. Louis, Lake and Cook counties. Based on information from the MPCA these four counties have the following MiSBDs for PM₁₀:

Table 6-2 PM₁₀ Minor Source Baseline Dates

County	Minor Source Baseline Date	Facility Triggering MiSBD
Koochiching	1991	Boise Cascade
St. Louis	1979	Potlatch (Cook, MN)
Lake	1999	Cyprus Northshore Mining
Cook	Not applicable	No major modifications

Source: <http://www.pca.state.mn.us/air/modeling.html#psd>

6.2.2 Area and Mobile Sources

The April, 2006 FLM guidance suggests that area and mobile sources be considered in the cumulative increment assessment. The magnitude of PM₁₀ emissions from these sources is quite small in the region around the Class I areas, compared to the major industrial sources. Further, it is likely that these sources have declined since the minor source baseline trigger date. According to the U.S. Census Bureau (censtats.census.gov for 1979 data and www.fedstats.gov for 2004 data), the population in all of the nearby counties except for Cook has decreased since 1979 as shown in Table 6-3. Although there has been a small population increase in Cook County, the overall population in the region has decreased by over 10%.

Table 6-3 U.S. Census Bureau County Population Data

County	1979 Pop.	2004 Pop.
Koochiching	17,500	13,900
St. Louis	221,000	198,000
Lake	12,900	11,200
Cook	4,100	5,300
Total	255,500	228,400

Based on this information, no increase in emissions from area and mobile sources has likely occurred and therefore, they were not included in the increment assessment. Actual emissions from area and mobile sources have probably decreased but were not included as an increment expanding reduction.

6.2.3 New Sources in Inventory

The following recently permitted new sources are included in the emission inventory in addition to the Project:

- Mesabi Nugget
- Keetac Expansion
- Essar Steel

These facilities/projects have been permitted but have not begun operation or have recently commenced operation. The increment consumption for all of these sources was based on permitted emissions, which will be conservative for sources that have commenced operation. The emissions inventory used was prepared by MPCA (February 24, 2012 revision).

6.3 Increment Modeling Results

Modeled air concentrations compared to the Class I PSD increment for the Project are presented in Table 6-1. Overall, the CALPUFF modeling indicates that the emissions associated with the Project will not deteriorate the air quality significantly in the four modeled Class I areas, because all modeled concentrations are well below the PSD Class I Increment.

The cumulative Class I increments are evaluated only for those pollutant/averaging period combinations which exceeded the SIL based on Project emissions. If the cumulative increment modeling shows an exceedance of the increment, and if the Project contribution to that exceedance is less than the SIL, then the Project is not considered to significantly contribute to the exceedance (i.e., it is not an exceedance for the Project).

The increment modeling results indicate that the full increment has not been consumed. Considering both increment consuming emission increases and increment expanding emission decreases, the maximum modeled increment consumption in the BWCAW is $1.76 \mu\text{g}/\text{m}^3$, and $0.22 \mu\text{g}/\text{m}^3$ in Voyageurs for historic projects based on the inventory obtained from MPCA. The analysis modeled all receptors in the BWCAW and Voyageurs, and showed no projected exceedances of increment. Therefore, increment limits will not be exceeded due to the Project.

7.0 Summary and Conclusions – Class I Areas and Impacts to Air Quality Related Values (AQRVs) and Increment

Four Class I areas were assessed for potential impacts from the Project emissions: BWCAW, Isle Royale National Park, Rainbow Lake Wilderness, and Voyageurs National Park. The modeling results show that the Project at Hoyt Lakes, Minnesota will not cause significant deterioration of air quality in these areas.

PolyMet has proposed suitable pollution control equipment for all point sources. In addition, PolyMet has agreed to install emission controls in the Crushing Plant and Concentrator consistent with the best controls currently used in the metallic ore processing industries for fine particulates to address specific regulator concerns. The hydrometallurgical process does not use continuously operating combustion sources. Therefore, NO_x emissions are mostly due to heating. Small amounts of SO₂ are emitted by the process but controlled potential emissions are below the significant level of 40 tpy.

In order to reduce modeled impacts from natural gas fired space heaters, PolyMet has committed to upgrade the insulation in the existing Crusher and Concentrator Buildings and to purchase low-NO_x space heating equipment such that overall NO_x emissions are reduced by at least 50% below that with conventional equipment.

The mine vehicles and locomotives were also included in the emission inventory for the Class I modeling. The equipment utilized for the Project mining operation will meet the applicable standard for the current model year at the time of purchase. The emissions from the mine vehicles for the four scenarios modeled have been calculated based on reasonable assumptions on when Tier 4 vehicles in different size categories will be available and when vehicles in the fleet would be replaced or upgraded.. Maximum modeled fuel consumption was also adjusted for various periods of mine operation to reflect changes in the mine configuration over time.

The Class I modeling also includes the construction equipment used at the Tailings Basin. PolyMet plans to hire a contractor to complete the construction activities at the Tailings Basin. The emissions from the Tailings Basin construction fleet are based on the currently available

equipment configurations, which are at Tier 3 and Tier 4 emissions levels. The level of activity (i.e., number of haul trucks) for each modeled scenario is based on the maximum within the scenario timeframe.

PolyMet and their contractors will also not use any fuel with greater than 15 ppm sulfur in the mine vehicles, locomotives and Tailings Basin construction equipment.

Modeled impacts were compared to PSD Class I increment values and AQRVs; flora and fauna impacts, deposition, and visibility impacts. The CALPUFF Modeling System was used to assess impacts.

PM₁₀ increment modeling was conducted and the results show that increment consumption has not exceeded the allowable value.

No adverse impact on flora and fauna is expected. Deposition values were below the “Green Line Values” set by the USFS and National Park Service. Therefore, no adverse impact on terrestrial and aquatic ecosystems is expected.

When compared to pristine conditions, the Project has no days with a change in extinction greater than 5% at Voyageurs or Isle Royale, for any scenario, using either method.

Using current modeling guidance (Method 8), 98th percentile day has a change in extinction of less than 5% at the BWCAW for all scenarios. These visibility modeling results meet the current FLM criteria for demonstrating no adverse impacts.

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Appendices

Appendix A

Modeled Emission Rates

Volume Sources	UTM: Zone 15 (NAD83)		LCC: 47N 93W (30,60N)		Elevation (m)	Release Height (m)		Sigma Y (m)	Sigma Z (m)				NOx		PM10		PM2.5		SO2		SO4		Heating PMF	PMC (g/s)	PMF (g/s)	SOA (g/s)	EC (g/s)	SO2 (g/s)	SO4 (g/s)	NOX (g/s)	Notes
	Easting (m)	Northing (m)	X (m)	Y (m)		Hourly	Annual						Hourly	Annual																	
CoarseCrush	564824.77	5272640.14	62,664.4	65,207.3	523.1		38.4	10.0	0.9				0.0629	0.0629	0.0097	0.0097	0.0097	0.0097	0.0008	0.0008			0.0097	0.0000	0.0003	0.0070	0.0024	0.0008		0.0629	2, 3, 4, 5
DH	564812.91	5272426.47	62,652.9	65,000.7	530.6		15.1	5.3	0.9				0.0103	0.0103	0.0016	0.0016	0.0016	0.0016	0.0001	0.0001			0.0016	0.0000	0.0000	0.0011	0.0004	0.0001		0.0103	2, 3, 4, 5
FineCrush	564798.39	5272222.94	62,638.8	64,804.0	527.5		44.5	9.8	0.9				0.1033	0.1033	0.0427	0.0427	0.0427	0.0427	0.0012	0.0012			0.0157	0.0000	0.0274	0.0114	0.0039	0.0012		0.1033	2, 3, 4, 5
Conc B V	564637.11	5272166.58	62,482.8	64,749.6	507.3		53.9	20.2	0.9				0.1022	0.1022	0.1006	0.1006	0.1005	0.1005	0.0012	0.0012			0.0311	0.0001	0.0702	0.0225	0.0078	0.0012		0.1022	2, 3, 4, 5
Flot V	564593.36	5272365.42	62,440.6	64,941.8	492.5		30.3	10.7	0.9				0.0190	0.0190	0.0029	0.0029	0.0029	0.0029	0.0002	0.0002			0.0029	0.0000	0.0001	0.0021	0.0007	0.0002		0.0190	2, 3, 4, 5
Conc Dewa V	564577.48	5271652.37	62,425.0	64,252.5	483.6		15.6	8.6	0.9				0.0056	0.0056	0.0009	0.0009	0.0009	0.0009	0.0001	0.0001			0.0009	0.0000	0.0000	0.0006	0.0002	0.0001		0.0056	2, 3, 4, 5
Conc LO V	564569.81	5271562.67	62,417.6	64,165.8	482.6		11.1	8.6	0.9				0.0022	0.0022	0.0003	0.0003	0.0003	0.0003	0.0000	0.0000			0.0003	0.0000	0.0000	0.0002	0.0001	0.0000		0.0022	2, 3, 4, 5
Rebuild V	564975.95	5272116.18	62,810.4	64,700.7	523.4		11.1	7.7	0.9				0.0439	0.0439	0.0067	0.0067	0.0067	0.0067	0.0005	0.0005			0.0067	0.0000	0.0002	0.0048	0.0017	0.0005		0.0439	2, 3, 4, 5
Main WH V	564720.58	5272100.04	62,563.5	64,685.2	522.6		13.8	4.7	0.9				0.0165	0.0165	0.0025	0.0025	0.0025	0.0025	0.0002	0.0002			0.0025	0.0000	0.0001	0.0018	0.0006	0.0002		0.0165	2, 3, 4, 5
Hydromet V	564617.68	5271571.96	62,463.9	64,174.8	482.6		25.4	9.3	0.9				0.0416	0.0416	0.0063	0.0063	0.0063	0.0063	0.0005	0.0005			0.0063	0.0000	0.0002	0.0046	0.0016	0.0005		0.0416	2, 3, 4, 5
Gen Shop V	564918.87	5272034.44	62,755.2	64,621.7	522.7		17.5	14.9	0.9				0.1854	0.1854	0.0282	0.0282	0.0282	0.0282	0.0022	0.0022			0.0282	0.0000	0.0007	0.0204	0.0070	0.0022		0.1854	2, 3, 4, 5
TBWWTPBV	565057.89	5272764.77	62,889.8	65,327.6	498.7		10.1	3.0	0.9				0.0498	0.0498	0.0076	0.0076	0.0076	0.0076	0.0006	0.0006			0.0076	0.0000	0.0002	0.0055	0.0019	0.0006		0.0498	2, 3, 4, 5
Reagent V	564614.26	5271549.75	62,460.5	64,153.3	482.5		19.9	5.6	0.9				0.0128	0.0128	0.0373	0.0373	0.0235	0.0235	0.2028	0.2028	0.0003	0.0003	0.0019	0.0138	0.0213	0.0014	0.0005	0.0028	0.0003	0.0128	2, 3, 4, 5
Spares WH V	564712.69	5272010.04	62,555.8	64,598.2	522.4		8.6	4.7	0.9				0.0134	0.0134	0.0020	0.0020	0.0020	0.0020	0.0002	0.0002			0.0020	0.0000	0.0001	0.0015	0.0005	0.0002		0.0134	2, 3, 4, 5
Heat PI V	564541.19	5271689.93	62,390.0	64,288.8	483.8		19.6	3.6	0.9				0.0257	0.0257	0.0727	0.0727	0.0434	0.0434	0.0003	0.0003			0.0039	0.0293	0.0396	0.0028	0.0010	0.0003		0.0257	2, 3, 4, 5
Area1BV	562275.82	5271257.34	60,200.0	63,871.4	510.7		16.2	9.5	0.9				0.1928	0.1928	0.0104	0.0104	0.0104	0.0104	0.0003	0.0003			0.0104	0.0000	0.0000	0.0074	0.0030	0.0003		0.1928	2, 6, 7
Area2BV	566643.74	5272131.09	64,422.5	64,714.6	510.8		16.2	7.4	0.9				0.1790	0.1790	0.0096	0.0096	0.0096	0.0096	0.0003	0.0003			0.0096	0.0000	0.0000	0.0069	0.0028	0.0003		0.1790	2, 6, 7
MDS 602	[A]	[A]	75,076.0	66,186.0	486.6		4.7	291.6	2.2				0.3926	0.3926	0.0158	0.0158	0.0158	0.0158	0.0007	0.0007				0.0000	0.0057	0.0033	0.0069	0.0007		0.3926	2, 8, 9
MDS 603	[A]	[A]	62,669.0	65,277.0	479.2		4.7	97.6	2.2				0.3926	0.3926	0.0158	0.0158	0.0158	0.0158	0.0007	0.0007				0.0000	0.0057	0.0033	0.0069	0.0007		0.3926	2, 8, 9
MDS 604	[A]	[A]	62,886.0	64,746.0	479.7		4.7	1,127.7	2.2				0.0873	0.0873	0.0035	0.0035	0.0035	0.0035	0.0002	0.0002				0.0000	0.0013	0.0007	0.0015	0.0002		0.0873	2, 8, 9
Year 1-5																															
MDS 601	[A]	[A]	74,865.0	67,272.0	488.8		6.6	3,369.6	3.1				6.5308	6.5308	0.1492	0.1492	0.1492	0.1492	0.0085	0.0085					0.0534	0.0312	0.0647	0.0085		6.5308	2, 8, 9
MDS 605	566377.41	5274058.62	64,165.7	66,577.9	498.0		6.6	207.8	3.1				2.7162	2.7162	0.0335	0.0335	0.0335	0.0335	0.0057	0.0057					0.0120	0.0070	0.0145	0.0057		2.7162	2, 8, 9
Year 6-8																															
MDS 601	[A]	[A]	74,865.0	67,272.0	488.8		6.6	3,369.6	3.1				6.3044	6.3044	0.1260	0.1260	0.1260	0.1260	0.0093	0.0093					0.0450	0.0263	0.0546	0.0093		6.3044	2, 8, 9
MDS 605	566377.41	5274058.62	64,165.7	66,577.9	498.0		6.6	207.8	3.1				1.3190	1.3190	0.0206	0.0206	0.0206	0.0206	0.0028	0.0028					0.0074	0.0043	0.0089	0.0028		1.3190	2, 8, 9
Year 9-10																															
MDS 601	[A]	[A]	74,865.0	67,272.0	488.8		6.6	3,369.6	3.1				6.4392	6.4392	0.1325	0.1325	0.1325	0.1325	0.0098	0.0098					0.0474	0.0277	0.0574	0.0098		6.4392	2, 8, 9
MDS 605	566377.41	5274058.62	64,165.7	66,577.9	498.0		6.6	207.8	3.1				1.3190	1.3190	0.0206	0.0206	0.0206	0.0206	0.0028	0.0028					0.0074	0.0043	0.0089	0.0028		1.3190	2, 8, 9
Year 11-20																															
MDS 601	[A]	[A]	74,865.0	67,272.0	488.8		6.6	3,369.6	3.1				4.4893	4.4893	0.0420	0.0420	0.0420	0.0420	0.0108	0.0108					0.0150	0.0088	0.0182	0.0108		4.4893	2, 8, 9
MDS 605	566377.41	5274058.62	64,165.7	66,577.9	498.0		6.6	207.8	3.1				1.6683	1.6683	0.0238	0.0238	0.0238	0.0238	0.0035	0.0035					0.0085	0.0050	0.0103	0.0035		1.6683	2, 8, 9

Speciation Notes:

- Fraction of PM10 as PMF is set based on PM2.5 rate (PM2.5 rate = PMF rate), PMC is equal to PM10 - PMF.
- Fraction of PM10 as PMF is set based on PM2.5 rate (PM2.5 = PMF + SOA + EC +SO4), PMC is equal to PM10 - PMF -EC -SOA -SO4.
- Emission factor from AP-42 Table 1.4-2 is 7.6 (total PM)/10⁶ scf natural gas
5.5 VOC's
% of Total Particulate assumed to be SOA = 5.5 lb VOCs/mmscf / 7.6 lb PM/mmscf = 72.4%
- Assume all filterable PM emissions from natural gas combustion are EC
AP-42 'Natural Gas Combustion' Table 1.4-2; Total PM Emission factor is 7.6 lb and filterable is 1.9 lb:
EC, percent of PM10: 1.9 / 7.6 = 25.0%
- SO2 emissions from natural gas fired sources are negligible, therefore SO4 emissions are assumed to be zero.
All natural gas particulate is assumed to be PMF
- Assume all filterable PM emissions from propane combustion are EC
AP-42 'Liquified Petroleum Gas Combustion' Table 1.5-1 (07/2008); Total PM Emission factor is 0.7 lb/10³ gallon and filterable is 0.2 lb/10³ gallon:
EC, percent of PM10: 0.2 / 0.7 = 28.6%

Assume condensible PM emissions from propane combustion are SOA
SOA, percent of PM10: 0.5/0.7 = 71.4%
- SO2 emissions from propane fired sources are negligible, therefore SO4 emissions are assumed to be zero.
All propane particulate is assumed to be PMF (no PMC emissions)
- Heavy Duty Diesel speciated emissions from US EPA SPECIATE 3.2, profile number 32202 (added 1/5/89)
EC, percent of (PM10-SOA-SO4) 54.8
Assume SOA equals organic carbon speciation SOA, percent of PM10 20.9

All diesel particulate is assumed to be PMF (no PMC emissions)
- The diesel sources are assumed to have no SO4 concentrations because the exhaust temperatures are higher than the temperatures at which the conversion of SO3 to H2SO4 vapor occurs.

General Notes

- [A] These sources not included in Class II modeling, so UTM coordinates have not been determined. Coordinates in columns D and E are used for Class I modeling.
[B] Ore haul locomotive emissions are divided in half between the Plant Site and the Mine Site.

Appendix B

Class I Modeling Protocol

Class I Area Air Dispersion Modeling Protocol

NorthMet Project

***Prepared for
PolyMet Mining, Inc.***

May 2011



Class I Area Air Dispersion Modeling Protocol

May 2011

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Section 1: Introduction

1.1 Background

PolyMet Mining, Inc. (PolyMet) proposes to reactivate and modify portions of the former LTV Steel Mining Company (LTVSMC) Taconite Processing Plant in Hoyt Lakes, Minnesota for the processing of ore from the NorthMet deposit located approximately eight miles east of the Plant Site. The proposed project is referred to as the NorthMet Project (Project).

This protocol addresses the dispersion modeling procedures that will be followed for the Class I Area air quality analysis to be conducted in support of the Supplemental Draft Environmental Impact Statement (SDEIS) being prepared for the Project. Other analyses required for the SDEIS (e.g., pollution control equipment evaluations, Class II Area analysis) are not addressed in this protocol, but the results of these analyses will be available for the Federal Land Managers (FLMs) to review.

PolyMet is proposing to permit the Project as a synthetic minor source for federal Prevention of Significant Deterioration (PSD) purposes. However, in general, the same procedures that would be used for assessing Class I Area impacts from a PSD major project will be used to provide information to aid in preparation of the SDEIS.

This protocol is being provided as a stand-alone document for review and it will be integrated into the Air Data Package after approval.

1.2 Project Description

A comprehensive description and analysis of all aspects of the Project are provided in the NorthMet EIS Draft Alternative Summary Revised March 4, 2011 and NorthMet Project Description Version 2 submitted April 15, 2011. The Project is well defined at this point, but some design details and specific equipment selections still need to be finalized. Where there is uncertainty in the Project an attempt will be made to make conservative assumptions, such that modeled impacts based on the final Project details will be equivalent or less than those evaluated in the SDEIS .

1.3 Purpose of Protocol

The purpose of this protocol is to establish procedures to be used in evaluating the Project's impact on nearby Class I areas (Figure 1) for the SDEIS. Class I areas are overseen by FLMs from several organizations:

- The National Park Service (NPS): Isle Royale National Park and Voyageurs National Park.
- The U.S. Forest Service (USFS): Rainbow Lake Wilderness Area and the Boundary Waters Canoe Area Wilderness.

Given the proximity of the Project to Class I Areas (Figure 1) an assessment of impacts in the Class I Areas was required for the Draft Environmental Impact Statement (DEIS) prepared for the Project and published in October of 2009. The previous modeling will now be updated to reflect changes to the Project and changes to applicable modeling guidance.

The original modeling protocol prepared for the Project DEIS, as well as the protocols of subsequent projects in the region were used as a guide in preparing this protocol. CALMET specific settings were based on the latest guidance provided by the FLMs: “EPA-FLM Recommended CALMET Input File Values” (August 20, 2009).

The protocol contains separate sections for the main components of the CALPUFF modeling system: Section 2 presents how the CALMET input files will be developed; Section 3 presents the model options for CALPUFF execution; Section 4 describes the post-processing that will be conducted for determining the impacts to the Class I areas and Section 5 describes how the results will be reported.

Section 2: CALMET Settings

The CALMET meteorological model requires input from several meteorological and geophysical data preprocessors prior to model execution. This section describes the data sources, preprocessing methodology and CALMET model settings that will be used for the Project.

The CALMET input files will include SURF.DAT, GEO.DAT, PRECIP.DAT, MM4/MM5 data files and upper air data files, for the years 2002, 2003 and 2004. Compilation of these input files will be done with the currently approved preprocessors from the CALPUFF software suite (CALPUFF v5.8, June 23, 2007 release). Some compilation will occur through the CALPUFF View program by Lakes Environmental.

2.1 Meteorological Data Preprocessing

The meteorological data for CALMET consists of three years (2002, 2003 and 2004) of MM5 prognostic mesoscale meteorological data with surface, upper air and precipitation data from several stations in and around the modeling domain. Figure 1 shows the surface, upper air and precipitation stations that will be included in the modeling.

2.1.1 Surface Data

Surface data will be obtained from the National Climatic Data Center (NCDC). Initial preprocessing will be performed on the surface files with Russell Lee's program, NCDC_CNV (rflee.com). This program converts the files into SAMSON format, which is compatible with the SMERGE preprocessor. Once all files are in a compatible format, SMERGE will be run to combine the individual surface data files into yearly SURF.DAT files. These SURF.DAT files will then be ready for input to CALMET.

2.1.2 Upper Air Data

Upper air data files will be obtained from the NOAA/ERSL RAOBS website (esrl.noaa.gov/raobs/). These files will be processed within the Lakes Environmental CALPUFF View interface using READ62. Quality processing will be done after the READ62 process using the FIX program within the CALPUFF View interface. FIX incorporates station substitution, extrapolation, spatial substitution and temporal substitution to complete the data files. Extrapolation and station substitution will be favored when possible. After preprocessing with READ62 and FIX, the upper air data files (one per station per year) will be ready for input to CALMET.

2.1.3 Precipitation Data

The PRECIP.DAT file required by CALMET contains all of the precipitation observations for the modeling domain. The PRECIP.DAT file will be created within the CALPUFF View program. Precipitation data files will be obtained from the NCDC. The files will then be processed within CALPUFF View by the PMERGE preprocessor, yielding the PRECIP.DAT file.

2.2 Geophysical Data Preprocessing – GEO.DAT

Land use data files and elevation data files are required to develop the GEO.DAT geophysical data file required by CALMET. The MAKEGEO preprocessor will be used to combine a land use data file (LU.DAT) with a terrain elevation file (TERREL.DAT) to create the GEO.DAT file.

2.2.1 Land Use Data

Because CTG land use data files are not available for Canadian portions of the modeling domain, the land use will be set using the North American Land Cover Characteristics database. The CTGCOMP preprocessor will combine the land use files into the LU.DAT file required by the MAKEGEO preprocessor.

2.2.2 Terrain Data

Elevation data files will be created from the appropriate digital elevation model (DEM) files. The DEM files will be obtained from the WebGIS website hosted by Lakes Environmental as well as the GeoBase website hosted by Environment Canada. The DEM files will be of 1:250,000 resolution. The TERREL preprocessor will create the TERREL.DAT file required by the MAKEGEO preprocessor.

2.3 CALMET Control File Input Groups

Each CALMET input group is detailed separately. A preliminary version of the CALMET control file is included as Appendix A.

2.3.1 Input Group 1 – General Run Control Parameters

Run start date and length will vary by which year is being modeled. These will include all available dates from 2002, 2003 and 2004. One month data lengths will be used.

The run type will be set to 1, for computation of wind fields and micrometeorological variables (IRTYPE = 1). The special data fields for CALGRID will be calculated (LCALGRID = T). Initial setup of the

model will be performed with ITEST = 1 with the final runs including the computational phase (ITEST = 2). The check for conformity with regulatory values will be used (MREG = 1).

2.3.2 Input Group 2 – Map Projection and Grid Control Parameters

The Lambert Conformal coordinate system (LCC) will be used for the model as summarized in Table 1. The projection origin will be 47N, 93W, with false easting and northing of 0. The matching parallels of latitude will be 30N and 60N. The datum region used will be the WGS-84 GRS 80 Spheroid, Global coverage.

The rectangular grid defining the domain will be 528 by 360 km with a grid spacing of 4 km. The reference grid coordinate for the southwest corner of the grid will be (-140,-100) km. The vertical grid will consist of 10 layers, with face heights of 0, 20, 40, 80, 160, 320, 640, 1200, 2000, 3000 and 4000 meters.

2.3.3 Input Group 3 – Output Options

All variables in input group 3 except NZPRN will be set to their default values in conformance with EPA-FLM guidance (NZPRN = 0).

2.3.4 Input Group 4 – Meteorological Data Options

The modeling will incorporate meteorological data from surface stations, precipitation stations, upper air stations and MM4/MM5 data sets (NOOBS=0). The number of stations available for use varies slightly by year modeled. For this analysis, there will be approximately 88 surface stations (NSSTA=88), 99 precipitation stations (NPSTA=99) and 4 upper air stations. No cloud data will be used. The default file formats will be used for meteorological inputs.

2.3.5 Input Group 5 – Wind Field Options and Parameters

The wind field options will be set to their default values with the following exceptions:

Model Parameter	Model Input Value
Extrapolation of surface winds will be allowed at all surface stations.	[RMIN2 = -1]
Prognostic wind fields will be used for the initial guess field. These data will come from the MM5 data sets.	[IPROG = 14 (MM5)]
The maximum radius of influence (ROI) settings will be 100 km over land in the surface layer, 200 km over land aloft, 200 km over water and 15 km for terrain features.	RMAX1 = 100 RMAX2 = 200 RMAX3 = 200 TERRAD = 15

Model Parameter	Model Input Value
The relative weighting of the first guess field versus surface observations will be 50 km.	R1 = 50
The relative weighting of the first guess field versus aloft observations will be 100 km.	R2 = 100
The relative weighting of the prognostic wind field data will be 0 km.	RPROG = 0
The surface meteorological station used for surface temperature will be the Hibbing, MN station.	ISURFT = Hibbing, MN
The upper air station used for domain-scale lapse rate will be International Falls, MN.	IUPT = International Falls, MN

2.3.6 Input Group 6 – Mixing Height, Temperature and Precipitation Parameters

The parameters for input group six will be set to the default values with the following exceptions:

Model Parameter	Model Input Value
The over water temperature interpolation scheme requires at least one over water meteorological file, with complete coverage of the modeled time period. Continuous over water data are not available for Lake Superior, as Great Lakes monitoring buoys are removed from the lake for the winter season. The over water interpolation scheme will not be used.	JWAT1 = 55 JWAT2 = 55
Maul-Carson mixing height will be used for land cells only. Offshore and Coastal Dispersion Model (OCD) mixing height will be used over water.	IMIXH = -1
The threshold buoyancy flux required to sustain convective mixing height growth over land will be 0.	THRESHL = 0.0
Over water surface fluxes will use the original deltaT method.	ICOARE = 0

2.3.7 Input Group 7 – Surface Meteorological Station Parameters

Surface weather observations will be obtained from several locations around and in the modeling domain as shown in Figure 1.

2.3.8 Input Group 8 – Upper Air Meteorological Station Parameters

Upper air observations will be obtained from stations at International Falls, MN; Minneapolis, MN; Gaylord, MI; and Green Bay, WI. Upper air station locations are shown in Figure 1.

2.3.9 Input Group 9 – Precipitation Station Parameters

Precipitation observations will be obtained from many locations around and in the modeling domain as shown in Figure 1.

Section 3: CALPUFF Settings

The CALPUFF model grid will be the same as that used for CALMET. A preliminary CALPUFF control file is included in Appendix B.

3.1 Input Group 1 – General Run Control Parameters

The CALPUFF runs will be made with restart files active, writing a restart file throughout the run. This will allow resumption of processing in the event of an error. The restart file includes all puffs that are on the grid at the end of the run. The restarted run will be able to begin with the grid in the exact condition it was in when the previous run left off.

3.2 Input Group 2 – Technical Options

All variables in Input Group 2 will be set to their default values with one exception: the chemical mechanism flag will be set to compute transformation internally (MCHEM = 1).

3.3 Input Group 3 – Species List¹

Species modeled in CALPUFF will be SO₄, SO₂, NO₃, HNO₃, NO_x, PM₁₀, PMF, PMC, EC and OC (as SOA). The species SO₂, SO₄, NO_x, PM₁₀, PMF, PMC, EC and SOA will be modeled as emitted. NO₃ and HNO₃ will be included as non-emitted species, as they result from chemical transformations when SO₂ and NO_x emissions are processed by the model. Dry particle deposition will be modeled for SO₄, NO₃, PM₁₀, PMF, PMC, EC and SOA. Dry gas deposition will be modeled for the species SO₂, HNO₃ and NO_x. OC will be represented in the CALPUFF and CALPOST modeling as SOA. The extinction coefficient of SOA will be set to 4 in CALPOST to reflect that it represents OC.

3.4 Input Group 4 – Map Projection and Grid Control Parameters

The map projection will be the same as for CALMET as discussed in Section 2.3.2 above. Grid corner indices are shown in Table 1.

¹ SO₄ – sulfate; SO₂ – sulfur dioxide; NO_x – nitrogen oxides; PM₁₀ – particulate matter with an aerodynamic diameter of <10 μm; PMF – fine particulate matter (d < 2.5 μm); PMC – coarse particulate matter (2.5 μm < d < 10 μm); EC – elemental carbon; OC – organic carbon; SOA – secondary organic aerosol; NO₃ – nitrate; HNO₃ – nitric acid.

3.5 Input Group 5 – Output Options

Variables for Input Group five will be set to their default values.

3.6 Input Group 6 – Subgrid Scale Complex Terrain Inputs

No complex terrain features will be modeled. The variables of this section will be set to their default values.

3.7 Input Group 7 – Chemical Parameters for Dry Deposition of Gases

The dry deposition parameters for NO_x, SO₂ and HNO₃ will be set in this section as given in Appendix B.

3.8 Input Group 8 – Size Parameters for Dry Deposition of Particles

The size parameters for NO₃, SO₄, PM₁₀, PMF, PMC, EC and OC will be set in this section as given in Appendix B.

3.9 Input Group 9 – Miscellaneous Dry Deposition Parameters

The miscellaneous dry deposition parameters will be set to their default values as given in Appendix B.

3.10 Input Group 10 – Wet Deposition Parameters

Wet deposition parameters for SO₂, SO₄, NO₃, HNO₃, PM₁₀, PMC, PMF, EC and OC will be set in this section as given in Appendix B.

3.11 Input Group 11 – Chemistry Parameters

Most parameters in Input Group 11 will be set to their defaults. An OZONE.DAT file containing data from several representative stations will be included. The OZONE.DAT file used will be based on monitoring stations throughout the modeling domain. The default ozone concentration will be set to 40 ppm, to reflect the average conditions in the domain. This concentration will be used when all observation stations have no data. Initial modeling will set the monthly ammonia concentration to 1 ppb for all months, to give a conservative estimate of background ammonia levels. Refinement of background ammonia levels may be necessary as modeling progresses. A monthly background level of 1 ppb will also be used for H₂O₂ concentrations.

3.12 Input Group 12 – Miscellaneous Dispersion and Computational Parameters

Variables pertaining to the use of a single meteorological station will not be used. Default values will be used for the variables in this group.

3.13 Input Group 13 – Point Source Parameters

Emission rates and stack parameters used in the modeling will be based on the most current emission inventory at the time the modeling is performed. Portions of a draft emission inventory have been submitted to the MPCA for review and the remaining sections will be submitted in the near future. The emission rates and stack parameters used in the modeling will be detailed in the Class I modeling report.

Backup generators and fire pumps will not be included in the modeling because they will only be occasionally operated for a short amount of time for testing, except in emergency situations. During such emergencies, emission generating activities at the plant would be stopped or significantly curtailed.

For speciation of pollutants the analysis will use a combination of information from AP-42, stack test data, process flow simulations and other available data sources. PM handling sources will be speciated into PMC and PMF. Combustion PM₁₀ emissions will be divided into PMC, PMF, OC, SOA, SO₄ and EC. Speciation is expected to utilize the same methodology as the prior PolyMet modeling effort. Final speciation data will be provided with the modeling report. Sulfuric acid mist will be modeled as SO₄. Changes may be made to the speciation calculations as the modeling is completed.

3.14 Input Group 14 – Area Source Parameters

No area sources will be modeled. This input group will not contain any variables for input to the model

3.15 Input Group 15 – Line Source Parameters

No line sources will be modeled. This input group will not contain any variables for input to the model

3.16 Input Group 16 – Volume Source Parameters

Fugitive sources at the facility will not be modeled. Given the nature of the sources (low release height, no upward momentum) emissions would not be expected to reach the Class I Areas. These fugitive sources include: dust generated from traffic on unpaved roads, outdoor conveyor transfer points, other

outdoor handling such as transfer to stockpiles, rail loading operations, truck unloading operations and truck hauling on paved roads.

Several volume sources will be modeled to represent the exhaust emissions from haul trucks, trains, etc. used for mining operations and the transportation of ore to the Plant Site. Non-road haul trucks used for construction of dams at the Tailings Basin will be added to the SDEIS modeling to reflect the current design and proposed operation of the Tailings Basin. Volume sources will be located covering the general operating areas of the diesel equipment.

3.17 Input Group 17 – Non-Gridded (Discrete) Receptor Information

Discrete receptors for each Class I area were obtained from the NPS web site using the NPS Convert Class One Areas DotNet utility. The receptors for Voyageurs National Park, Isle Royale National Park, Rainbow Lake Wilderness and the Boundary Waters Canoe Area Wilderness will encompass the areas shown in Figure 1. The coordinates of these receptors can be found in Appendix B. The receptors included in the modeling consist of the four Class I areas in the region. Figure 1 is a map with the modeling domain, Class I areas, meteorological station locations and source locations.

Section 4: CALPOST analysis

CALPOST analysis will be conducted for fine particulate matter (PMF), coarse particulate matter (PMC), particulate matter with diameters under 10 microns (PM_{10}), sulfur dioxide (SO_2), sulfate (SO_4), nitrate (NO_3), nitric acid (HNO_3), nitrous oxides (NO_x), elemental carbon (EC) and organic carbon (OC). CALPOST will convert the hourly concentration files generated by CALPUFF and monthly average relative humidity data into 24-hour time-averaged extinction coefficients.

Multiple CALPOST runs will be conducted to calculate the Project impacts on each Class I area. Values for visibility, acid deposition, foliar damage and increment consumption will be calculated. Visibility runs will be run independently for each Class I area to maintain clarity of results. The 24-hour time-averaged extinction coefficients generated by CALPOST will be compared to 20% best natural conditions (using Method 8) as part of the visibility analysis. Appendix C contains a sample CALPOST control file.

Section 5: Reporting

The Class I dispersion modeling analysis will be made available for review by the Lead and Cooperating Agencies, along with the MPCA who, as a Participating Agency and as the permitting authority, will be assessing air quality impacts for the Project. The analysis will demonstrate attainment of the Class I Area increments for all appropriate pollutants and averaging times. PM₁₀, SO₂ and NO_x will all be modeled to support the visibility analysis. A comparison to the SILs and Class I increment standard will be made for the increase in emissions associated with the Project and an analysis of cumulative increment consumption will be made for pollutants and averaging times for which the model results are above the SIL.

A summary of the Class I analysis with the appropriate detailed model outputs will be submitted to the FLMs. Electronic copies of the modeling input and output files will be included for technical review by the FLMs. Modeling results may be submitted to the FLMs for comment prior to final submission to the agencies identified in the previous paragraph. Evaluation of visibility impacts, acid deposition, direct foliar damage and increment consumption will be reported. These will be compared with their applicable standards, as detailed below.

5.1 Visibility

Visibility calculations will be performed with CALPOST. A comparison with background conditions will be made to determine the percent change in extinction coefficient over 24-hour averaging periods. Modeled visibility impacts will be compared to the hypothetical natural background conditions (20% best days background extinction coefficients) as developed by the FLMs².

5.2 Deposition

Acid deposition rates associated with the emissions from the Project will be evaluated. Different evaluation criteria exist for the Class I areas managed by the NPS and United States Fish and Wildlife Service (USFWS) versus those managed by the USFS. The Deposition Analysis Threshold (DAT) for Isle Royale National Park and Voyageurs National Park is 0.01 kg/ha/yr for the total N and total S deposition. A DAT is “the additional amount of N or S deposition within a

² Federal Land Managers Air Quality Related Values Workgroup. 2008. *Phase I Report (Revised)*. U.S. Forest Service – Air Quality Program, National Park Service – Air Resources Division, U.S. Fish and Wildlife Service – Air Quality Branch. June 27, 2008 Draft. Appendix V-1.

Class I area, below which estimated impacts from a proposed new or modified source are considered insignificant”³ The threshold of potential impact for Boundary Waters Canoe Area Wilderness and Rainbow Lakes Wilderness will be defined by the “green line” terrestrial and aquatic deposition rates. The “green line” deposition rates are the loading levels below which no adverse impact is expected.⁴ Table 2 contains the “green line” deposition rates. Table 4 lists the background values that will be added to the modeling results for comparison to the “green line” values.

5.3 Direct Foliar Damage

The green line deposition thresholds mentioned above also have values for atmospheric concentration of SO₂ and ozone. The green line concentrations of SO₂ are 100 and 5 µg/m³ for 3-hour and annual averaged concentrations, respectively. The green line ozone concentration during the growing season is 80 µg/m³ for the second highest hourly concentration. The modeling proposed will generate the values needed for SO₂ concentration, but will not produce ozone concentrations. Background values that will be added to the model results for comparison to green line concentrations are listed in Table 4.

5.4 Increment

The modeled concentrations of SO₂, PM₁₀ and NO₂ will be compared to both the Class I PSD increment⁵ and the EPA Significant Impact Level (SIL)⁶ concentrations. These values are detailed in Table 3. In evaluating PM₁₀ concentration, the model-generated PM₁₀ concentration will include the contribution of SO₄ (ammonium sulfate) and NO₃ (ammonium nitrate) to the total PM₁₀ concentration. Only emissions from the Project will be included in the evaluation of the SILs. Table 3 contains the regulatory concentration standards. If modeled concentrations exceed the SILs, a cumulative PSD increment modeling assessment will be performed. Cumulative increment model setup parameters will be consistent with those from the single source modeling above, with grid spacing increased to 12km to maintain manageable runtimes.

³ National Park Service and U.S. Fish and Wildlife Service. 2002. *Guidance on Nitrogen and Sulfur Deposition Analysis Thresholds*. 7 pg. (www2.nature.nps.gov/air/Permits/flag/FlagInfo).

⁴ Adams M. G., et. al. 1991. *Screening Procedure to Evaluate Effects of Air Pollution on Eastern Region Wildernesses Cited as Class I Air Quality Areas*. USDA, Forest Service, Northeastern Forest Experimental Station, General Technical Report NE-151.

⁵ 40 CFR 52.21

⁶ EPA. 1996. Prevention of Significant Deterioration (PSD) and Nonattainment New Sources Review (NSR). *Federal Register*. July 23, 1996, Volume 61, Number 142. Proposed Rules. Pp 38249-38344.

In the time since the DEIS modeling was completed, EPA has promulgated a Class I increment for PM_{2.5}. However, the minor source baseline date has not yet been triggered for this pollutant in the Project area. Therefore, the Project, as a synthetic minor source, does not consume PM_{2.5} increment and an evaluation is not proposed for this pollutant.

Tables

Table 1 Modeling Projection Parameters

Lambert Conformal Conic (LCC) Projection	
Projection Origin	
Latitude	Longitude
47.00N	93.00W
False Easting	False Northing
0	0
Parallels of Latitude	
Parallel Latitude 1	Parallel Latitude 2
30.00N	60.00N
Datum	WGS-G
Grid dimensions	
Number of X grid cells	Number of Y grid cells
132	90
Grid Spacing	4 km
Grid Corner Reference	
X coordinate	Y coordinate
-140	-100

Table 2 Terrestrial and Aquatic Green-Line Deposition Rates

Ecosystem	Pollutant	Green-Line Deposition Rate (kg/ha/yr)
Terrestrial	Total Sulfur (S)	5.0 – 7.0
	Total Nitrogen (N)	5.0 – 8.0
Aquatic	Total S	7.5 – 8.0
	Total S + 20% Total N	9.0 – 10.0

Table 3 Regulatory Concentration Standards Concentrations (µg/m³)

Pollutant	Averaging Period	PSD Increment – Class I Areas ²	EPA SIL – Class I Areas ³
PM 10	Annual	4	0.2
	24-Hour	8 ¹	0.3
SO ₂	Annual	2	0.1
	24-Hour	5 ¹	0.2
	3-Hour	25 ¹	1
NO ₂	Annual	2.5	0.1

[1] Not to be exceeded more than once per year

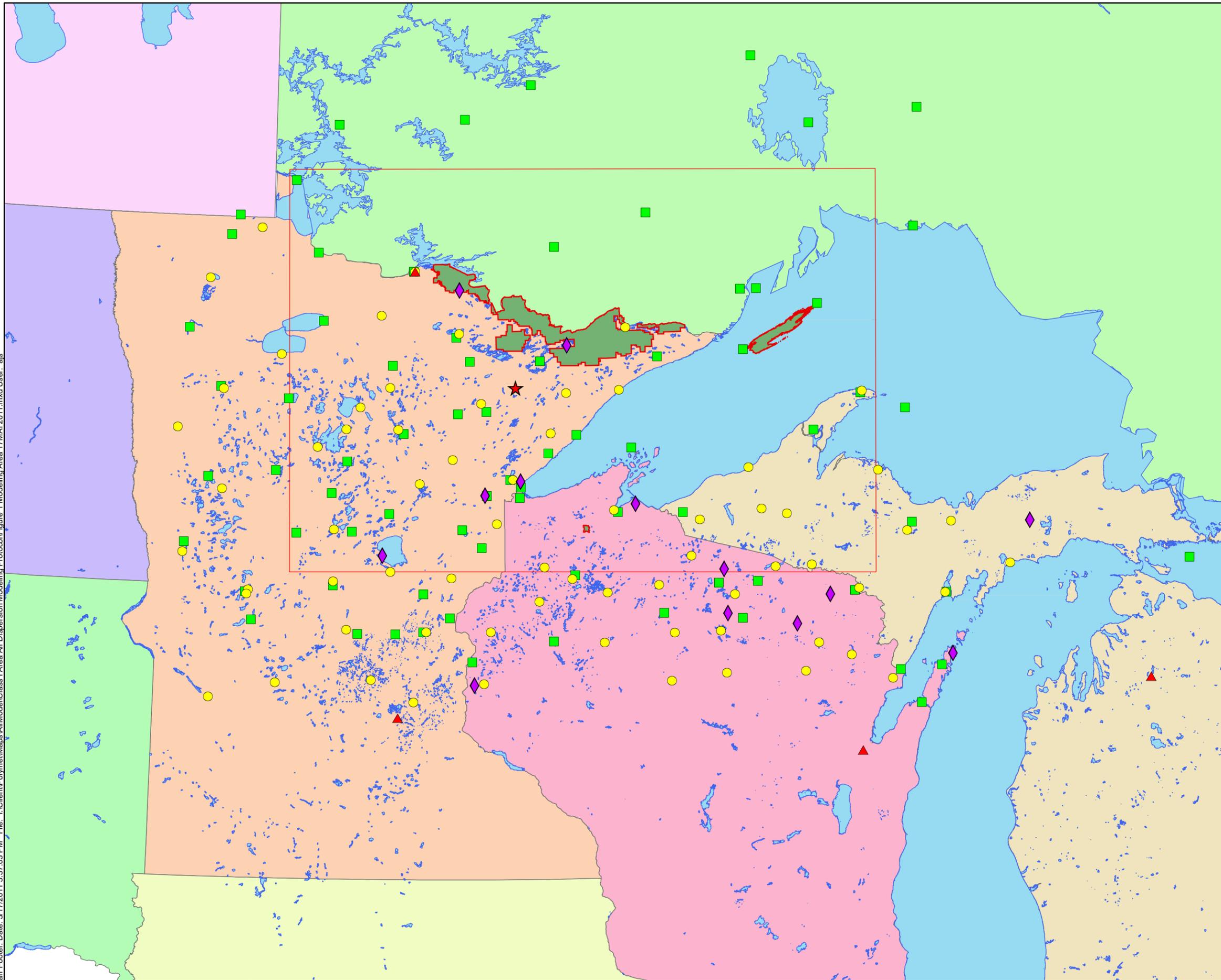
[2] 40 CFR 52.21

[3] EPA. 1996. Prevention of Significant Deterioration (PSD) and Nonattainment New Sources Review (NSR). *Federal Register*. July 23, 1996, Volume 61, Number 142. Proposed Rules. Pp 38249-38344.

Table 4 Background Values

Parameter	Averaging Period	Background Level (kg/hectare/yr)	Data Source
BWCAW Sulfur Deposition	Annual	2.9	Wet deposition data from NAPD data base – Hovland site; Dry from Castnet database for Voyageurs
BWCAW Nitrogen Deposition	Annual	4.8	
BWCAW Sulfur + 20% Nitrogen Dep.	Annual	3.8	Calculated from above data
Rainbow Lakes Sulfur Deposition	Annual	3.0	Wet deposition data from NAPD data base – Spooner site; Dry from Castnet database for Voyageurs
Rainbow Lakes Nitrogen Deposition	Annual	5.9	
Rainbow Lakes Sulfur + 20% Nitrogen Dep.	Annual	4.2	Calculated from above data
BWCAW SO ₂ Concentration	Annual	1.2	1991-1993 data from Ely site
	3-hour	10.8	Calculated from above per EPA guidance
Isle Royale SO ₂ Concentration	Annual	2.0	1991-1993 data from Finland site
	3-hr	18	Calculated from above per EPA guidance
Rainbow Lakes SO ₂ Concentration	Annual	1.6	1991-1993 data from Sandstone site
	3-hr	14.4	Calculated from above per EPA guidance
Voyageurs SO ₂ Concentration	Annual	0.7	1991-1993 data from Sullivan Bay site
	3-hr	6.3	Calculated from above per EPA guidance

Figures



- ★ Project Site
- 4 km Modeling Domain
- Class I Areas
- ▲ Upper Air Stations
- Precipitation Stations
- Surface Stations
- ◆ Ozone Stations



Miles
0 50 100

Kilometers
0 100 200

Figure 1
CLASS I MODELING REGION
NorthMet Project
PolyMet Mining Inc.
Hoyt Lakes, MN

Appendices

See Electronic Media Included for all of the following:

Appendix A CALMET Input Control File

Appendix B CALPUFF Input Control File

Appendix C CALPOST Input Control Files