Essar Steel Minnesota Modifications Project

Draft Supplemental Environmental Impact Statement

April 2011

Minnesota Department of Natural Resources

Signature Page

DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT:

Essar Steel Minnesota Modifications Project

The Minnesota Department of Natural Resources (MNDNR) has prepared the Draft Supplemental Environmental Impact Statement to evaluate the proposed Essar Steel Minnesota Modifications project in accordance with the Minnesota Environmental Policy Act, Minnesota Statues, § 116D.

State Agency and RGU: Minnesota Department of Natural Resources

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Abstract:

The Draft Supplemental Environmental Impact Statement (SEIS) is consistent with the Final Preparation Notice (July 2010). The Draft SEIS is provided to inform the permit process and the public of the project. It provides information for use in permitting as well as data and information necessary to allow agencies and the public to understand and comment on the project. The MNDNR in cooperation with the United States Army Corps of Engineers (USACE) prepared a joint state and federal Environmental Impact Statement (EIS) for the Minnesota Steel Industries, LLC (MSI) taconite mine and steel making project. The original MSI project consisted of a taconite mine, crusher, concentrator, pellet plant, direct reduced iron plant, and steel mill to produce sheet steel from taconite ore, near the town of Nashwauk, Itasca County, Minnesota. The joint EIS was completed in August, 2007 in accordance with the provisions of the National Environmental Policy Act (NEPA; 42 U.S.C. 4321 - 4347) and the Minnesota Environmental Policy Act (MEPA; Minn. Stat. Ch. 116D). The proposed Essar Steel Minnesota Modifications (ESMM) project entails increasing taconite pellet production from 3.8 million metric tons per year of low flux direct reduced iron (DRI) feed grade taconite pellets to 6.5 million metric tons per year of high flux blast furnace grade pellets or 7.0 million metric tons per year of low flux, DRI feed grade taconite pellets, and to reduce the 20-year life of the mine plan to 15 years.

Because MSI's mining and processing operations have already been reviewed through the EIS process, state environmental review requirements for the proposed ESMM project are met by preparing a Supplemental EIS. In addition, because there are no additional wetland impacts, the USACE has made a preliminary determination that a supplement to the federal EIS under NEPA is not required. Therefore the SEIS for the proposed modifications to the originally-reviewed project is a state-only environmental review. The SEIS analyzes impacts associated with the increase in capacity, construction and operation of the modified mine plan, new crushing/concentrating lines, and expansion of the indurating furnace.

Approved for Issuance for Public Comment:

4/22/2011
Date

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Minnesota Department of Natural Resources

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Acronyms

$(NH_4)2(SO_4)$
ammonium sulfate

µg/L
micrograms per liter

ac-ft/yr
acre-feet per year

ACI
activated carbon injection

AERA
Air Emissions Risk Analysis

AERMOD
EPA's preferred air dispersion model for addressing short-range concentration impacts

AG
autogenous

Aker
Aker Metals Inc.

ANC
acid neutralizing capacity

AQRVs
air quality-related values

ASTM
American Society for Testing and Materials

ASTs
Aboveground storage tanks

ATSDR
Agency for Toxic Substances & Disease Registry

B.A.
Bachelor of Art

B.E.
Bachelor of Engineering

BMPs
best management practices

B.S.
Bachelor of Science

BACT
best available control technology

BART
best available retrofit technology

BCE
Bachelor of Chemical Engineering

BLM
Bureau of Land Management

Btu
British thermal units

BWCAW
Boundary Waters Canoe Area Wilderness

CAA
Federal Clean Air Act

CC
climate change

CDC
Center for Disease Control

CENRAP
Central Regional Air Planning Association

CEQ
Council on Environmental Quality

CFCs
Chloroflourocarbons

CFD
Computational fluid dynamics

CFR
Code of Federal Regulations

CH_4
methane

CO
carbon monoxide

CO_2
carbon dioxide

CO_2-e
carbon dioxide equivalents

COPI
chemicals of potential interest

CPT
cone penetration testing

CUP
Conditional Use Permit

CWA
Clean Water Act

DAT
deposition analysis threshold

dB(A)
A-weighted decibels

DO
dissolved oxygen

DOC
dissolved organic carbon

DRI
Direct reduced iron

EAW
environmental assessment worksheet

EC
elemental carbon

EC20
20% effects concentration

Eco-SSLs
Ecological Soil Screening Level guidance values

eGRID
United States EPA Emissions and Generated Resource Integrated Database

EGU
electric utility generator

Eh
oxidation-reduction potential

EPA
United States Environmental Protection Agency

EPT
ephemeroptera, plecoptera, tricoptera

EQB
Environmental Quality Board

ESA
Federal Endangered Species Act

ESMM
Essar Steel Minnesota Modifications

ESQ
Ecological Screening Quotient

Essar
Essar Steel Minnesota LLC

Et
evapotranspiration

F
fluoride

FAA
Federal Aviation Administration

FAR
Federal Aviation Regulations

FEIS
Final Environmental Impact Statement

FERC
Federal Energy Regulatory Commission

FHWA
Federal Highway Administration

Fives NA
Fives North American Combustion

FLAG
Federal Land Managers' Air Quality Related Values Workgroup

FLMs
federal land managers

GHG
greenhouse gas

gpm
gallons per minute

GRP
General Reporting Protocol

GWP
global warming potential

H_2SO_4
sulfuric acid

HAP
hazardous air pollutant

HEAST
Health Effects Assessment Summary Tables

HFCs
hydrofluorocarbons

Hg0
elemental mercury

Hg2+
oxidized mercury

Hgp
particle-bound mercury

HHSLRA
Human Health Screening Level Risk Assessment

HI
haze index

HNO_3
nitric acid

HQ
hazard quotient

HRLs
health risk limits

HRVs
Health Risk Values

IEUBK
Integrated Exposure Uptake Biokinetic

IMPROVE
Interagency Monitoring of Protected Visual Environments

IPCC
Intergovernmental Panel on Climate Change

IRAP
Industrial Risk Assessment Program

IRIS
Integrated Risk Information System

ISTS
individual sewage treatment system

Kow
octanol-water partition coefficient

kWh
kilowatt hour

l.ton
long ton

Lbs
pounds

LEED
Leadership in Energy and Environmental Design

LLC
limited liability corporation

Low NO_x LE Burners
low NO_x natural gas burners

LSDP
large scale demonstration plant

LT
long ton

LTV
LTV Steel Mining Company

m
meter

M.S.
Master of Science

m.ton
metric ton

MAAQS
Minnesota ambient air quality standards

MACT
maximum achievable control technology

MCL
maximum containment levels

MDH
Minnesota Department of Health

MEPA
Minnesota Environmental Policy Act

MGGRA
Midwestern Greenhouse Gas Reduction Accord

MI
Michigan

MLAEM
Multi-Layer Analytical Element Models

MLT
million long tons

MLTPA
million long tons per year

MMREM
MPCA Mercury Risk Estimation Method

MMT
million metric tons

mmtpa
million metric tons per annum

mmtpy
million metric tons per year

MN
Minnesota

MNDNR
Minnesota Department of Natural Resources

MPCA
Minnesota Pollution Control Agency

MROW
Midwest Reliability Organization (West)

MSI
Minnesota Steel Industries

MSW
municipal solid waste
MT
metric ton

MTBE
methyl tert-butyl ether

MWh
megawatt hour

N_2O
nitrous oxide

NAAQS
national ambient air quality standards

NADP
National Atmospheric Deposition Program

NASA
National Aeronautics and Space Administration

National
National Steel Pellet Company

NEPA
National Environmental Policy Act

NESHAP
National Emissions Standards for Hazardous Air Pollutants

NH_4NO_3
ammonium nitrate

NHPA
National Historic Preservation Act

NO
nitrous oxide

NO_2
nitrogen dioxide

NO_x
nitrogen oxides

NPDES
National Pollutant Discharge Elimination System

NPDES/SDS
National Pollutant Discharge Elimination System / State Disposal System

NPS
National Park Service

NSPS
New Source Performance Standards

NSR
New Source Review

NY
New York

O_3
ozone

OEHHA
Office of Environmental Health Hazard Assessment

OES
Minnesota Office of Energy Security

OHWL
ordinary high water level

ORP
oxidation-reduction potential

PA
per annum

PAHs
polycyclic aromatic hydrocarbons

Pb
lead

PBT
persistent, bioaccumulative and toxic

PCB
polychlorinated biphenyls

PDSEIS
Preliminary Draft Supplemental Environmental Impact Statement

PFCs
perfluorocarbons

Ph.D.
Doctor of Philosophy

PM
particulate matter

PM_{10}
particulate matter less than or equal to 10 micrometers in aerodynamic diameter

$PM_{2.5}$
particulate matter less than or equal to 2.5 microns in aerodynamic diameter

PMC
coarse particulate matter

PMF
fine particulate matter

ppm
parts per million

PSD
Prevention of Significant Deterioration

PTE
Potential to Emit

PUDs
planned unit developments

QA/QC
quality assurance / quality control

RCRA
Resource Conservation and Recovery Act

RfD
reference dose

RGU
responsible governmental unit

RHR
Regional Haze Rule

RPG
reasonable progress goal

RPO
regional planning organization

s.ton
short ton

SAG
semi-autogenous

SAM
Standardized Air Modeling

SCR
selective catalytic reduction

SDS
State Disposal System

SEIS
Supplemental Environmental Impact Statement

SF_6
sulfur hexafluoride

SHHSLRA
Supplemental Human Health Screening Level Risk Assessment

SIL
Significant Impact Level

SiO_2
silicon dioxide

SIP
state implementation plan

SLERA
Screening Level Ecological Risk Assessment

sMCL
secondary MCLs

SO_2
sulfur dioxide

SO_3
sulfur trioxide

SO_4
sulfate

SONAR
MN EQB Statement of Need and Reasonableness

SVR
standard visual range

SWPPP
stormwater pollution prevention plan

T&D
transmission and distribution

TCDD
2,3,7,8-tetrachlorodibenzo-p-dioxin

TCR
The Climate Registry

TDS
total dissolved solids

TIP
tribal implementation plan

TMDL
Total maximum daily load

Tonne
metric ton

TP
total phosphorus

TPY
tons per year

TRVs
toxicity reference values

TSDF
treatment, storage and disposal facility

UCL
upper confidence limit

UMD
University of Minnesota Duluth

UNFCCC
United Nations Framework Convention on Climate Change

USACE
United States Army Corps of Engineers

USEPA
United States Environmental Protection Agency

USFS
United States Forest Service

USFWS
United States Fish and Wildlife Service

USGCRP
United States Global Change Research Program

VMT
vehicle miles traveled

VNP
Voyageurs National Park

VOC
volatile organic compound

VT
Vermont

WCA
Wetland Conservation Act

WRRS
water recovery and reuse system

WWTP
wastewater treatment plant

Definitions

AERMOD Air Dispersion Model
EPA's preferred air dispersion model for addressing short-range concentration impacts. It is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain.

Aggradation
The process by which a stream's gradient steepens due to increased deposition of sediment.

Air Quality Related Values (AQRVs)
Features or properties of Class I areas that could be adversely affected by air pollution.

Ambient Air Quality Standards
An ambient air quality standard sets legal limits on the level of an air pollutant in the outdoor (ambient) air necessary to protect public health. The U.S. Environmental Protection Agency (USEPA) is authorized to set ambient air quality standards.

BACT (Best Available Control Technology)
An emission limitation (including a visible emission standard) based on the maximum degree of reduction for each pollutant subject to regulation under the Clean Air Act which would be emitted from any proposed major stationary source or major modification.

Baseflow
The component of streamflow not directly attributed to storm water runoff. Baseflow defines low flow conditions for maintaining viable habitat for stream organisms. While baseflow does not transport large amounts of sediment it can be important in maintaining a low-flow channel needed by stream organisms when water levels drop in the summer and fall.

BMPs – Best Management Practices
The schedule of activities, prohibition of practices, maintenance procedures, and other management practices to avoid or minimize pollution or habitat destruction to the environment. BMPs can also include treatment requirements, operating procedures and practices to control runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Breach
An opening in the dam/dike embankment to allow drainage.

CALPUFF Model
A non-steady-state puff air dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation, and removal. CALPUFF can be applied for long-range transport and for complex terrain.

cfs (cubic feet per second)
The rate of flow representing a volume of 1 cubic foot passing a given point in 1 second.

Chemicals of Potential Interest (COPI)
COPI from mining sources are primarily metals and other constituents of the ore. COPI from processing sources include metals from the ore, emissions from fuel combustion, emissions related to processing agents (additives) and process products and by-products.

Class I Area
Areas set aside under the Clean Air Act for air quality protection. The Clean Air Act identifies 156 mandatory Class I areas made up of national parks, wilderness areas, national memorial parks, and international parks. Additional Class I areas have been designated by federal, state, and tribal governments.

Class II Area
All areas that are not Class I areas.

Criteria Pollutant
EPA has set national air quality standards for six common pollutants referred to as "criteria" pollutants. These pollutants are particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and lead.

- "Primary" ambient air quality standards are designed to establish limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly.
- "Secondary" ambient air quality standards set limits to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

Concentrate
Crushed ore is conveyed to a concentrator where the magnetic iron oxide minerals (concentrate) are separated from the nonmagnetic waste.

Crude ore
Ore which has not been processed or refined in any way.

Decibels (dB(A))
The logarithmic increase in sound energy relative to a reference energy level.

Dewatering
Removing water from one water body or area by pumping excess water to another area in preparation for mining, ore processing, and/or flow augmentation.

Direct Reduced Iron (DRI) Plant
A natural gas-fired facility that converts iron oxide (Fe_2O_3) pellets to direct reduced iron (Fe) by stripping oxygen away from iron oxide with reducing gas (a carbon monoxide/hydrogen mix).

Dry cobbing
A dry magnetic separation process during the concentrating process to extract the iron ore.

EC20
Highest tested concentration causing impacts in less than 20% of organisms.

Ecological Classification System (ECS)
Developed by the MNDNR and U.S. Forest Service, ecological land classifications are used to identify, describe, and map progressively smaller areas of land with increasingly uniform ecological features. The system uses associations of biotic and environmental factors, including climate, geology, topography, soils, hydrology, and vegetation.

Electric Arc Furnace (EAF)
A system that heats charged material by means of an electric arc. Arc furnaces range in size from small units of approximately one ton capacity used in foundries for producing cast iron products, up to about 400 ton units used for secondary steelmaking. Temperatures inside an electric arc furnace can rise to approximately 3,300 degrees Fahrenheit.

Environmental Assessment Worksheet (EAW)
An Environmental Assessment Worksheet provides information about a project that may have the potential for significant environmental effects. The EAW is prepared by the Responsible Governmental Unit or its agents to determine whether an Environmental Impact Statement should be prepared.

EPT taxa
The aquatic insect species: ephemeroptera (mayfly family), plecoptera (stonefly family), and tricoptera (caddisfly family).

Evapotranspiration
The sum of evaporation and plant transpiration. Evaporation accounts for the movement of water to the air from sources such as the soil, canopy interception, and water bodies. Transpiration accounts for the movement of water within a plant and the subsequent loss of water as vapor through stomata in its leaves.

Final Scoping Decision Document (FSDD)
A Scoping Decision Document is a companion to the Scoping EAW prepared for the project. The purpose of a Scoping Decision Document is to identify those project alternatives and environmental impact issues that will be addressed in the EIS. A Scoping Decision Document also presents a tentative schedule of the environmental review process.

Flow augmentation
The addition of water to a stream, especially to meet instream flow needs.

Footwall
The mass of rock underlying a mineral deposit in a mine.

Fugitive Sources
Sources of emissions which could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening.

General Development (GD) lakes
GD lakes are large, deep lakes or lakes of varying sizes and depths with high levels and mixes of existing development. These lakes are extensively used for recreation and except for the very large lakes are heavily developed around the shore. Second and third tiers of development are common (source: Itasca County Zoning Ordinance).

Geomorphology
The study of the evolution and configuration of landforms.

gr/dscf
Grains per dry standard cubic feet.

Gross ton (long ton)
State mineral leases with Essar are expressed in these units and are what is historically used on the Mesabi Iron Range; 1 gross ton equals 2240 pounds; 1 long ton equals 1.016 metric tons.

Hazardous air pollutant (HAP)
One of 187 hazardous compounds listed in section 112(b) of the Clean Air Act.

Horizon (soil horizon)
A layer of soil that can be distinguished from the surrounding soil by such features as chemical composition, color, and texture.

Hydrology
The science dealing with the origin, distribution and circulation of waters of the earth such as rainfall, streamflow, infiltration, evaporation, and groundwater storage.

Industrial Risk Assessment Program (IRAP)
A computer based program that was developed to assess the impacts from facility emissions and related exposures.

Inert
Having little or no tendency to react chemically with other substances.

Integrated Exposure Uptake Biokinetic (IEUBK) model
Developed by EPA, it evaluates potential risks based on predicted blood lead levels associated with exposure to lead. It calculates an incremental increase in blood lead concentration due to exposure to lead.

Iron Oxide (Taconite) Pellets
Produced from taconite iron ore by a separation and concentration process (fine grinding and magnetic or flotation treatment) of iron ore from taconite to produce pellets.

Karst topography
A landscape created by groundwater dissolving sedimentary rock such as limestone. This creates land forms such as shafts, tunnels, caves, and sinkholes, resulting in a fragile landscape susceptible to erosion and pollution.

L10
The level exceeded 10 percent of the time, which is typically the most intrusive noise levels.

L50
The level exceeded 50 percent of the time, which typically represents the median noise level.

Ladle Metallurgy Furnace (LMF or Ladle furnace)
An intermediate steel processing unit that further refines the chemistry and temperature of molten steel while it is still in the ladle. The ladle metallurgy step comes after the steel is melted and refined in the electric arc or basic oxygen furnace, but before the steel is sent to the continuous caster.

Lean Ore
Rock with less than 15 percent magnetic iron content may be economically viable in certain conditions.

Littoral zone
The portion of a lake that is less than 15 feet in depth (MNDNR/MPCA); extends from the shoreline of a lake and continues to depth where sufficient light for plant growth reaches the sediments and lake bottom (U of M Extension).

Ln
Percent noise Levels is the measurement of background noise.

Macroinvertebrate
An animal without a backbone living in one stage of its life cycle, usually the nymph or larval stage that can be seen with the naked eye.

MACT
(Maximum Achievable Control Technology)
Technology-based hazardous air pollutant emission standards established under Title III of the 1990 Clean Air Act Amendments.

Metric ton (tonne)
Commonly used in Asia and Europe for expressing weight of iron bearing materials; 1,000 kilograms; abbreviated as MT; 1 metric ton equals 0.984 long or gross tons.

Mycorrhizal Fungi
A group of soil organisms living in and around plant roots with which most plants establish a symbiotic relationship. Mycorrhizae extract mineral elements and water from soil for their host plant, and live off the plant's sugars. Trees and plants with thriving "mycorrhizal roots" systems are better able to survive and thrive in a variety of environments.

Natural Environment (NE) Lakes
NE lakes are small, often shallow lakes with limited capacities for assimilating the impacts of development and recreational use. They often have adjacent lands with substantial constraints for development such as high water tables, exposed bedrock and soils unsuitable for septic systems. These lakes usually do not have much existing development or recreational use (source: Itasca County Zoning Ordinance).

NO_2
Nitrogen dioxide

NO_x
Nitrogen oxides – including all of the oxides of nitrogen.

NPDES Permit
The National Pollutant Discharge Elimination System permit is associated with the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Clean Water Act.

NPDES/SDS Permit
An NPDES/SDS Permit is a document that establishes the terms and conditions that must be met when a facility discharges wastewater to surface or ground waters of the state. The permit is jointly issued under two programs. The National Pollutant Discharge Elimination System (NPDES) is a federal program established under the Clean Water Act, aimed at protecting the nation's waterways from point and nonpoint sources. In Minnesota, it is administered by the Minnesota Pollution Control Agency (MPCA) under a delegation from the U.S. Environmental Protection Agency. The State Disposal System (SDS) is a state program established under Minn. Stat. § 115. In Minnesota, when both permits are required they are combined into one NPDES/SDS Permit administered by the state. The permits are issued to permittees discharging to a surface water of the state.

Ore
Rock with greater than 15 percent magnetic iron content.

Orifice
An opening in a wall or dam through which flow occurs. Orifices may be used to measure or control rates of flow.

Outfall
The discharge point of a waste stream into a body of water; alternatively it may be the outlet of a river, drain or a sewer where it discharges into a lake or other body of water.

Overburden
Unconsolidated material above bedrock, such as soil and other material.

Oxhide Ore
Rock with less than 15 percent magnetic iron content but a high percentage of total iron.

PM
Particulate matter.

PM_{10}
Particulate matter less than or equal to 10 microns in aerodynamic diameter.

$PM_{2.5}$
Particulate matter less than or equal to 2.5 microns in aerodynamic diameter.

ppm
Parts per million.

Proposed Project
The proposed project is the proposed ESMM project, which entails modifications from the original MSI project (the MSI FEIS and permits). The proposed ESMM project is most succinctly described as an increased taconite pellet production from 4.1 million metric tons per year of low flux direct reduced iron (DRI) feed grade taconite pellets to 6.5 million metric tons per year of high flux blast furnace grade pellets or 7.0 million metric tons per year of low flux, DRI feed grade taconite pellets.

Proposed Project Boundary
The Proposed Project Boundary is defined as the area which Essar will own, lease or have access to in relation to the Proposed Project.

Proposed Project Impact Area
The Proposed Project Impact Area is the area within the Proposed Project Boundary where physical ground disturbances are proposed to occur. These types of disturbances would include areas associated with the mining pits, stockpile areas, plant layout/construction areas, tailings basin and conveyance systems.

ProUCL
Software developed by the EPA to conduct statistics for site monitoring and site characterization.

PSD provisions
Prevention of Significant Deterioration of Air Quality regulations/program as cited at 40 C.F.R. 52.21 and incorporated by reference at Minn. Rules, part 7007.3000.

Short ton (net ton)
Common usage term for 'ton'; 1 short ton equals 2000 pounds.

Sinter feed
Materials remaining from the ore process that can be sold and used by others to extract additional, desirable materials from the waste products.

Slab caster
The semifinished shapes (slabs) that the molten steel from the steelmaking operation or ladle metallurgy step is cast directly into.

Slag
By-product formed during metallurgical and combustion processes from impurities in the metals or ores being treated. The major constituents of slag are calcium oxide, silicon oxide and iron. Slag is considered non-hazardous and is commonly used as construction material.

SO_2
Sulfur dioxide

Straight Grate Indurating Furnace
A furnace system that consists of a traveling grate that carries the taconite pellets through different furnace temperature zones. In the straight grate indurating furnace a layer of fired pellets, called the hearth layer, is placed on the traveling grate prior to the addition of unfired pellets. The straight grate indurating furnace begins at the point where the grate feed conveyor discharges the green balls onto the furnace traveling grate and ends where the hardened pellets drop off of the traveling grate.

Synoptic inventory
An inventory or survey of natural resource features relative to a particular point in space.

Taconite iron ore
A variety of chert containing magnetite and hematite; mined as a low-grade iron ore.

Tailings
Coarse and/or finely ground, nonmagnetic waste rock from the concentrating process, which are pumped by pipeline as a slurry to the tailings basin.

Taxa
A grouping of organisms given a formal taxonomic name such as species, genus, family, etc.

Toe of dike
The lowest part of the dike embankment, where it meets the ground surface.

Tunnel Furnace
The Tunnel Furnace maintains and equalizes the temperature of the slabs arriving from the caster and delivers them to the rolling mill.

$\mu g/m^3$
Micrograms per cubic meter of air.

Vegetative reference area
A vegetative "reference area" means a vegetated land unit which is designated for comparatively measuring reclamation vegetation success (based on Minnesota State Rule 6130.0100).

VOC
Volatile organic compound.

Waste Rock
Rock with less than 15 percent magnetic iron content and all other rock materials outside of the Lower Cherty unit of the Iron Formation.

Watershed
A geographic area from which water is drained by a river and its tributaries to a common outlet. A ridge or drainage divide separates a watershed from adjacent watersheds.

Weir
A weir is a small overflow type dam commonly used to raise the level of a small river or stream. Weirs have traditionally been used to create mill ponds. Water flows over the top of a weir, although some weirs have sluice gates which release water at a level below the top of the weir. The crest of an overflow spillway on a large dam is often called a weir.

Executive Summary

The Minnesota Department of Natural Resources (MNDNR) has prepared this Supplemental Environmental Impact Statement (SEIS) to evaluate the proposed Essar Steel Minnesota Modifications (ESMM) project in accordance with SEIS preparation requirements of the Minnesota Environmental Policy Act (MEPA), Minnesota Statute §116D.

In June of 2007, a Final Environmental Impact Statement (FEIS) was issued jointly by the MNDNR and USACE for MSI reactivation of the former Butler Taconite mine and tailings basin area. The MSI FEIS was determined adequate in August 2007 and is incorporated in its entirety by reference in this SEIS. The MSI FEIS is available at:

http://www.dnr.state.mn.us/input/environmentalreview/minnsteel/index.html

In accordance with Minnesota Rules 4410.2300 through 4410.2800 and 4410.3000, this Supplemental Environmental Impact Statement (SEIS) is being prepared as a supplement to the MSI FEIS. Because there are no additional wetland impacts, the USACE has made a preliminary determination that a supplement to the federal EIS under NEPA is not required. Therefore the SEIS for the proposed modifications to the originally-reviewed project is a state-only environmental review.

The SEIS is intended to provide information to the public and units of government on the environmental impacts of the proposed project before approvals or necessary permits are issued and to identify measures which could be implemented to avoid, reduce, or mitigate adverse environmental effects. The SEIS is not a means to approve or disapprove a project.

The MNDNR serves as the Responsible Governmental Unit (RGU) for preparation of this SEIS in accordance with Minnesota Rules from the Minnesota Environmental Policy Act (MEPA). The MNDNR will be responsible for determining SEIS adequacy pursuant to MEPA and will prepare the state Adequacy Decision and Finding of Fact. The roles of consulting agencies are described in Chapter 6.0; there are no cooperating agencies for this SEIS.

PROJECT OVERVIEW

Essar Steel Minnesota LLC (Essar) purchased Minnesota Steel Industries (MSI) in October 2007 and is now proposing modifications to the original MSI project.

The proposed Essar Steel Minnesota Modifications (ESMM) project would increase the taconite pellet production and associated mining, crushing, ore concentrating and tailings generation rates compared to the MSI project. All of the other aspects of the original MSI project including direct reduced iron (DRI) production and steelmaking remain unchanged. No physical changes to DRI or steel making processes are proposed.

The proposed ESMM project would continue to be located near Nashwauk, Minnesota on the Mesabi Iron Range and integrate the steps necessary to make low-cost, high-quality steel at the former Butler Taconite site.

The proposed ESMM project modifications are summarized below.

- Increase taconite pellet production from 3.8 million metric tons per year (mmtpy) of low flux taconite pellets to 6.5 mmtpy of high flux or 7.0 mmtpy of low flux taconite pellets. The low flux pellets will be made for use as a feed material to the DRI process and the high flux pellets will be made for use as a feed material in blast furnaces located off-site. Either pellet type may also be sold on the open market depending upon internal demands and market conditions.
- Reduce the initial mine plan time period from 20 to 15 years and mine generally the same geologic ore body identified in the existing Permit to Mine at a faster rate and greater quantity.

- Increases in total tailings, overburden, and waste rock due to an increase in available ore.

Equipment and/or process changes to achieve increased pellet capacity are summarized below.

- **Mining**
  - o Increase from 200- to 240-ton haul trucks
  - o Pits 5 and 6 are combined and mined to a greater depth
- **Crushing**
  - o Additional secondary crusher
- **Ore Storage**
  - o Larger fine and coarse ore storage areas
- **Concentrating**
  - o Additional concentrating line
- **Pelletizing**
  - o Additional ceramic filters and balling discs
  - o Additional additive storage bins and mixers
  - o 744 m^2 (4 meter by 186 m) pelletizing furnace with:
    - Low NO_x LE Burners for control of NO_x emissions
    - Activated carbon injection for control of mercury emissions
    - Multi-stage air pollution equipment for control of PM, PM_{10}, $PM_{2.5}$, and SO_2/SO_3 emissions
  - o Use of water contained in Pits 1 and 2, as needed, to provide process make-up water

The tailings basin height and footprint would increase to accommodate additional tailings disposal; these changes would not extend beyond areas previously considered for disturbance and would not result in additional wetland impacts or other land cover changes beyond those estimated for the original MSI project.

Mitigation measures identified for the original MSI project would be maintained and in many cases improved upon as part of the proposed ESMM project. Some of the key mitigative measures from the original MSI project that would continue are:

- Integrated mine through steel making process for conservation of energy;
- Natural gas for process heating;
- Zero surface liquid discharge via a reuse and recycle system;
- Use of water from Pits 1 and 2 for stream augmentation.

Essar Steel expects to employ about 1,200 to 2,000 people during construction for production, support, and administration. At full operation, Essar expects to provide 500 full time jobs.

The proposed ESMM project would obtain its magnetic taconite ore from a horizon within the Lower Cherty of the Biwabik Iron Formation. The inferred ore reserves at the project site are currently estimated at about 1.4 billion long tons. The amount of ore to be mined within the 15-year production period is 322 million long tons. The taconite ore of the Biwabik Iron Formation would be mined by open-pit methods within the area authorized under the existing MSI Permit to Mine.

PURPOSE & NEED FOR PROJECT

On October 11, 2007, MSI received a final air permit and authorization to construct and operate the reactivation of the former Butler Taconite mine and tailings basin area near Nashwauk, Minnesota and build a new processing facility to make sheet steel coils from the ore that is mined. In June 2007, Essar Global Limited purchased Algoma Steel in Sault Ste. Marie, Ontario and formed Essar Steel Algoma. In October 2007, Essar Steel Holdings LLC purchased MSI and formed Essar. Since the purchase of these two entities, Essar has reviewed the projects in terms of their strategic fit with Essar's North American business strategy. Based on this strategy a need for additional taconite pellet production capacity was identified as well as the need to produce high flux pellets for use in the blast furnaces at Essar Steel Algoma.

The purpose and need of the proposed ESMM project is to increase production and introduce environmental and processing efficiencies into the original MSI project to be consistent with and supportive of other Essar operations. With respect to the pellet and steel making aspects of the original MSI project, Essar also completed a comprehensive technical and economic review to identify productivity, energy efficiency and environmental performance enhancements. This led to the proposed modification to increase taconite pellet making capacity. By increasing pellet capacity to the level proposed, Essar can eventually source all of its North American iron ore pellet requirements for steel making from internal sources, thereby eliminating the need to purchase pellets on the open market. Essar has identified several ways to conserve the consumption of resources such as water, natural gas and power.

ABOUT THE PROPOSER

Founded in 1969 by the Ruia family of India, Essar is a global corporation with assets in the construction, steel, shipping and logistics, oil and gas, telecommunication and power industry sectors. Essar employs 70,000 people across the globe and is the parent company of Essar Steel Minnesota LLC.

SCOPING

In accordance with Minnesota Rules 4410.3000 Subpart 5A, the information presented in the SEIS is focused on the proposed ESMM project. Only modifications identified in the SEIS Preparation Notice and associated environmental impacts are the subject of this SEIS as all other project activities were reviewed in the MSI FEIS.

In accordance with Minn. Rules part 4410.3000, subp. B(3), alternatives shall be evaluated and may exclude those that would not meet the underlying need for or purpose of the project; likely not have any significant environmental benefit compared to the project as proposed; or have another alternative, of any type, that will be analyzed and likely have similar environmental benefits, or similar environmental benefits but substantially less adverse economic, employment, or sociological impacts.

The SEIS began with the preparation notice publication date of March 22, 2010.

Issues Identified in the Preparation Notice for Evaluation in the SEIS

- Impacts to Surface Water Quantity;
- Impacts to Surface Water Quality;
- Impacts on Solid Waste Generation;
- Impacts on Air Quality;
- Contribution to Global Greenhouse Gas (GHG) Emissions;
- Impacts Associated with Mercury;
- Cumulative Air Quality Effects – Class I PSD Pollutants;

- Cumulative Air Quality Effects – Class I Acid Deposition and Ecosystem Acidification;
- Cumulative Air Quality Effects – Class I Visibility Impairment;
- Cumulative Effects Mercury;
- Cumulative Effects – Climate Change;
- Socioeconomic Effects.

Incorporation of Mitigation Measures Identified Through Public Comment

Public comments were accepted in accordance with publication of the Preparation Notice. Review of the public comments found no mitigation measures identified by the public.

Special Studies or Research Identified in the Preparation Notice to Support the Evaluation of Potential Impacts

The SEIS has used the following special studies or research to evaluate impacts:

- Revised Mine Plan/Permit to Mine Application;
- Updated Water and Chemical Balance;
- Interim Water Quality, Hydrology, and Wild Rice Monitoring Report;
- Solid Waste Generation Estimates and Disposal Options;
- Air Emission Inventory and Greenhouse Gas Emissions;
- Air Pollution Control Alternatives Analysis;
- Class I Air Quality Analysis;
- Class II Air Quality Analysis;
- Mercury Mass Balance and Control Technology Assessment;
- Human Health Screening Level Risk Assessment;
- Screening Level Ecological Risk Environmental Loading Data Submittal;
- Cumulative Effects on Class I Air Quality – PSD Pollutants;
- Cumulative Effects on Class I Air Quality – Acid Deposition and Ecosystem Acidification;
- Cumulative Effects on Class I Air Quality – Visibility Impairment;
- Cumulative Impacts from Estimated Mercury Air Emissions and Local Deposition and the Potential for Bioaccumulation in Fish;
- Cumulative Human Health Screening Level Risk Assessment;
- Cumulative Effects on Climate Change;
- Update of Economics Model.

The SEIS Preparation Notice indicated a best available control technologies (BACT) assessment would be completed. The Air Pollution Control Alternatives Analysis listed above was completed to address part of the BACT requirements; the remaining steps will be completed for permitting. The selection of BACT is not a requirement of state-only environmental review and is therefore not included in this SEIS.

PROPOSED ACTION

The proposed action is the proposed ESMM project, which entails modifications from the original MSI project (the MSI FEIS and permits). The proposed ESMM project is most succinctly described as the following:

- An increased taconite pellet production from 3.8 mmtpy of low flux direct reduced iron (DRI) feed grade taconite pellets to 6.5 mmtpy of high flux blast furnace grade pellets or 7.0 mmtpy of low flux, DRI feed grade taconite pellets.

No modifications have been proposed to the DRI or steel mill processes previously approved through the MSI FEIS and issued permits.

Mining and Tailings Modifications

The existing Permit to Mine was signed August 22, 2007 and is available from the MNDNR, Division of Lands and Minerals, Hibbing office. An application for amendment to the existing Permit to Mine was submitted to the MNDNR for consideration on September 24, 2010 (Barr Engineering 2010a). The overall mine pit, stockpile, and tailings basin locations and proposed amendments are shown on SEIS Figure 3-1 as well as within the amended Permit to Mine application. The mine pits (mine area) include areas previously referred to as Pit 5, Pit 6, and Draper Annex Pit. Information in this SEIS on mining, waste rock, tailings, crusher, and pellet plant operations is based on the details provided to MNDNR for consideration of an amended Permit to Mine. Essar has determined that 322 million long tons of ore are available, in contrast to the 234 million long tons identified in the MSI Permit to Mine amendment application.

Based on the increased production rates proposed by Essar, tailings production rates would be approximately 8.82 mltpy (8.976 mmtpy) generated during the first two years of production, increasing to 16.27 mltpy (16.53 mmtpy) in year 3 for the remaining 13 years. This would result in approximately 229.2 mlt (232.8 mmt) of tailings storage needed in the tailings basin or approximately 105,163 acre-feet. The proposed ESMM production rate increase and estimated operating rate of 88 percent, a tailings porosity of 42 percent, and an estimated dry density of 112 pounds per cubic foot, results in a tailings storage need of approximately 105,163 acre-feet. With the original MSI project, the required storage volume was 68,642 acre-feet, so as a result of the increased production rate, there would be an increased storage need of approximately 36,521 acre-feet.

The proposed ESMM project tailings basin footprint will cover approximately 1,600-1,690 acres, an increase from the MSI tailings basin which was estimated to cover 1,580 acres. The basin would not extend beyond areas previously considered for disturbance and would not result in additional wetland impacts or other land cover changes beyond those estimated for the original MSI project. The original MSI project Permit to Mine states that the basin was designed to accommodate 152 million metric tons of tailings storage; however, the basin design has been updated to hold the 233 million metric tons of tailings that will be generated over the new 15-year mine plan presented in the Permit to Mine Amendment. The proposed ESMM project will result in a change in the height of the tailings basin due to increased generation of tailings over the extent of the 15-year mine plan. The current Permit to Mine states that the tailing dams would be about 100 feet high and could continue to be raised to provide additional storage. For the proposed ESMM project and new 15-year mine plan, the tailings dams at the end of production year 15 are estimated to be between 110 and 160 feet high, depending on the deposited tailing slopes.

The 15-year production schedule entails several mining phases based on an economic mine model and reserves within the current Pit 5 and proposed Pit 6 Permit to Mine limits. The mine plan targets an annual pellet production of 4.1 mmtpy for the first 2 years, increasing to 6.5/7.0 mmtpy until the reserves are depleted within Pits 5 and 6. It is anticipated that there are enough reserves for the proposed 15-year production period. The mine phases have been defined as follows:

- Pre-Production Phase (year 0): Includes stripping and stockpile development that must take place to access production ore, but before plant commissioning. Expected duration of this period is 18 months. Overburden stripping will be prevalent, but some waste rock stripping may be required to expose the upper benches of the ore. While not targeted in the Pre-Production Phase, any quantifiable pre-production ore that is found within the waste rock materials will be stockpiled at the primary crusher site.

- Phase I (years 1 - 5): These first five production years have been planned annually starting from plant commissioning. In these years, approximately 92 million long tons of ore would be mined in the northern areas of the mine pit (near outcrop at low stripping ratios), in-pit stockpile locations will be developed on the ore body footwall, and Pit 5 water transfer (dewatering) is planned to be converted to maintenance dewatering of the active mining sump. A blend of both glacial till and waste rock stripping is expected as the mine is opened up to Permit to Mine limits.

- Phase II (years 6 – 10): In Phase II, which is described as production years 6-10 after plant commissioning, mining will continue down dip and the lower ore benches will be developed in the mine pit, including the ore that is currently under water in Pit 5. Glacial till stripping will gradually be phased out as the final pit limits are reached in the upper benches to the south. Waste rock stripping will be most prevalent, with glacial till becoming exhausted within the mining boundary. Approximately 113 million long tons of ore would be mined during Phase II.
- Phase III (years 11 – 15): In Phase III, which is described as production years 11-15 after plant commissioning, mining will continue down dip in the mine pit to the lowest benches and final limits as shown in the permit boundary. Very little stripping, either waste rock or glacial till, is expected in this phase, as most above formation waste would have been removed prior to exposing these ores. Approximately 118 million long tons of ore would be mined during Phase III.

It should be noted that mine operations are scheduled to begin before the mineral processing facilities are operational. It is expected that the Pre-Production phase will be 18 months in duration; therefore permit years may begin ahead of production years by six months or so. In addition, mine development and ore processing schedules are estimates only, and both will vary based on a variety of factors.

A review of the mine operation will occur around production year 10 or 11 to evaluate the feasibility of operating the mine beyond 15 years. If more production is intended, then environmental review and permits would need to be supplemented, and the Permit to Mine and production permits would need to be reviewed and updated to reflect a revised plan.

Ore Processing Modifications

In October 2008, Essar initiated geotechnical soil investigations of the project site at the location of the process equipment and buildings. The results showed a significant amount of bedrock below the concentrator and pellet plant facilities. To minimize the rock blasting quantity and make use of the natural topography, Essar has proposed to slightly shift the building orientations. Essar has proposed to modify the currently permitted single pelletizing facility to manufacture both high and low flux pellets. Essar is not proposing any physical change to the capacity of the DRI units or steel manufacturing facilities as described in the MSI FEIS and Air Permit #06100067. However, because air emissions are sometimes based on process capacity, Table Ex-1 below is provided to illustrate differences in capacities between the original MSI project and the proposed ESMM project. The air emissions inventory was prepared for both types of pellets to be produced. The maximum value from either inventory for a given pollutant was used in air dispersion modeling assessments.

Table Ex-1. Pellet Production Capacity Comparison of the Original MSI and Proposed ESMM Projects

Unit Operation	Type of Pellet	Original MSI Project Capacity (million m.t. per year)	Proposed ESMM Project Capacity (million m.t. per year)
Taconite Pelletizing Furnace	Low Flux (DRI feed grade)	3.8[1]	7.0[3, 5]
Taconite Pelletizing Furnace	High Flux (Blast furnace feed grade)	0	6.5[4, 5]
Two DRI Modules	Not applicable	2.8[2]	2.8
Steel Making	Not applicable	2.5[6]	2.5[6]

1 = pelletizing air emission calculations included a 10% safety factor to account for the level of detailed engineering that existed at the time of permitting. Actual capacity used for air emission calculations was 4.1 million metric tons (m.t.) per year

2 = for the original MSI FEIS and Air Permit #06100067, the capacity of the DRI modules was described as 2.8 million m.t. per year. However, the MSI air emissions inventory inadvertently used a value of 3.5 million m.t. per year plus a 10 percent safety factor which equates to 3.85 million m.t. per year. The Essar emission inventory corrects this throughput and uses the capacity of 2.8 million m.t. plus a 10 percent safety factor or 3.08 million m.t. per year in the

air emission calculations. The 10 percent safety factor is maintained for the DRI calculations because Essar has not yet completed detailed design engineering of this process.

3 = Essar will make Low Flux, otherwise known as DRI grade feed, pellets for on-site steel making or for sale on the open market. The quantity of this type of pellet to be produced on an annual basis will depend on internal manufacturing needs and on market conditions.

4 = Essar will make High Flux, otherwise known as Blast Furnace grade feed, pellets for Essar Steel Algoma or for sale on the open market. The quantity of this type of pellet to be produced on an annual basis will depend on internal manufacturing needs and on market conditions.

5 = An air emission inventory was prepared for both types of pellets to be produced. The maximum value from either inventory for a given pollutant was used in air dispersion modeling assessments.

6 = Steel making capacity includes a 10 percent safety factor because Essar has not yet started detailed engineering of this process.

WATER MANAGEMENT

Various proposed project processes have led to modifications in the water and chemical balances used to predict the quantity and quality of water associated with the proposed ESMM project. The water quantity needs for the proposed ESMM project are satisfied according to the existing Water Appropriation Permit 2006-0433. This permit allows appropriations from Pits 1 and 2 not to exceed 7,000 gpm or 3,679 million gallons per year. The maximum appropriation under normal climatic conditions that would be required from Pits 1 and 2 from precipitation and existing storage under Phase 1 of the DRI plant and steel mill would be approximately 3,588 gpm (without stream augmentation). After Phase 2 of the DRI plant and steel mill begins operating in year 10, this appropriation requirement would be approximately 4,161 gpm prior to stream augmentation. Therefore, no additional water appropriations are needed over those currently permitted.

As part of the existing Water Appropriation Permit 2006-0433, a Stream Augmentation Plan must be submitted for Oxhide and Snowball Creek at least one year prior to the completion of the water transfer from Pit 5 and the Draper Annex Pit, respectively. This Stream Augmentation Plan must comply with the recommended augmentation strategy described in the MSI FEIS. Based on this water balance analysis, adequate water sources will still be available to meet the requirements necessary for stream augmentation as described in the FEIS from Pits 1 and 2 and the Hill Annex Pit, if required.

As in the original MSI project, the proposed ESMM project would have no surface water discharge. Pit 5 and Draper Annex Pit would have on-going maintenance dewatering and will be subject to NPDES/SDS permit requirements once mining activities begin. Process wastewater would be reused onsite or treated by the water recovery and reuse system (WRRS). No process wastewater is discharged to the tailings basin. The water and chemical balance includes an analysis of deeper groundwater seepage associated with the tailings basin (Barr Engineering 2010b). The re-evaluation used more detailed data, and the results led to a revision from the previously calculated seepage value of 758 gpm for the original MSI project to a much lower deep seepage value of 199 gpm for the proposed ESMM project. Modeling results of deep seepage flow to Swan Lake indicate a 0.3 mg/L increase in sulfate concentration as compared to an increase of 3.3 mg/L under the original MSI project.

SOLID AND HAZARDOUS WASTE GENERATION

The waste generation identified in the original MSI FEIS has been compared to the proposed ESMM project. The proposed ESMM project is different from the original MSI project in generation rates of some items in the waste stream. The differences in waste generation would be related to changes in production rates for the crusher/concentrator and taconite pellet plant operations. Neither the DRI process nor the steel mill waste generation rates would change, as those facilities would not change from the original MSI to the proposed ESMM project.

The proposed methods of disposal would not differ from the original MSI project. Fugitive dust emissions, emission control dust, and slag are part of the solid waste stream evaluated for air pollutant effects. Other wastes would be addressed according to state statutory requirements such as those applicable to storage tanks and hazardous waste generation.

Like MSI, Essar proposes to incorporate the concept of reduce, reuse and recycle into its project.

ENERGY MANAGEMENT

Essar plans to integrate energy management into the operational design of the proposed ESMM project. Proposed energy management considerations were used in the development of the greenhouse gas (GHG) emission inventory and carbon footprint following MPCA and DNR guidance which rely heavily on The Climate Registry (TCR) General Reporting Protocol (GRP).

The majority of energy consumed would be as electricity and fuel used in process equipment. The remainder of the energy consumed would be building heat, lighting, mobile equipment fuel, and similar uses. Essar has selected natural gas as a process fuel, as an approach to reducing stationary combustion and greenhouse gas emissions. Natural gas usage results in lower emissions of SO2, CO, PM, VOCs, GHGs, metals (including mercury) and other hazardous air pollutants (excluding NOx) based on stack tests, CEMS and AP-42 test data compared to the use of coal and other fossil fuels.

Operations and energy planning items evaluated were identified, comparative analysis of GHG emissions of operations was performed, and GHG emissions with respect to climate change was summarized. Total direct and indirect emissions change from over 3.8 million metric tons carbon dioxide equivalents per year to 4.5 million metric tons carbon dioxide equivalents per year for the proposed ESMM project.

STATIONARY SOURCE AIR EMISSIONS

The proposed ESMM project is a major source of air emissions. The majority of special studies listed above under Scoping were prepared to assess the impacts associated with air emissions and the potential control technologies. Modeling the potential impacts to ambient air quality was performed to address national and state ambient air quality standards. Impacts on visibility in the Boundary Waters Canoe Area Wilderness and Voyageurs National Park, referred to as Class I areas, were also modeled.

During review of air-related analyses for the proposed ESMM project, erroneous statements were found to have been made within the MSI FEIS text related to hot charging pellets to the DRI process. The MPCA has determined that the analyses for air modeling and permitting for the MSI project correctly utilized pellets at a temperature close to or at the ambient temperature as feed pellets to the DRI.

The potential cumulative impacts from the proposed ESMM project and other foreseeable past and present projects in the Class I areas were also assessed. The cumulative impact assessments addressed particulate emissions, acid deposition, ecosystem acidification, and visibility. The assessments indicated that no adverse impacts related to particulate emissions, acid deposition, or ecosystem acidification would be expected. However, air dispersion modeling completed for the project shows it has the potential for adverse impacts on visibility in the Class I areas. Several potential mitigation measures for adverse impacts were identified. The technology alternatives committed to by Essar are described below under Project Alternatives. Additional testing is currently underway by Essar to quantify the additional reductions in NO_x emissions that are intended from the redesigned combustion chamber and low NO_x natural gas burners. Based on these test results it will be determined if additional mitigation is necessary. If additional mitigation of these adverse impacts is necessary, these must be identified and included in the air emission permit for the ESMM project before it can be issued.

Screening level risks of air emissions exposure were performed for humans and ecosystem components (soil, sediment, and surface water). In addition, risks from mercury emissions were evaluated. The estimated increases in human health risks associated with the proposed ESMM project are below facility risk guidelines established by the Minnesota Department of Health. The proposed ESMM project is expected to contribute relatively small amounts of additional risk to that associated with background levels of pollutants in air and mercury in fish.

CLOSURE

There would be no change in the reclamation methodology from the MSI FEIS. Reclamation of the tailings basin areas (including the basin, dikes and dams) would be carried out incrementally as areas are no longer scheduled to be disturbed. The establishment of vegetation would be initiated during the next normal growing season. Slopes would be graded as necessary, seeded and mulched. All vegetation would meet the requirements of Minnesota Rules 6130.3600. Vegetative reference areas for the tailings basin were identified in the MSI FEIS Sections 4.6.2.1, 4.6.2.2 and 6.15.2 in adjacent areas and remain valid for the stockpile and pit areas.

SITE PREPARATION AND SCHEDULE

The overall project timeline is dependent on numerous factors including acquiring project financing, completion of the SEIS process, acquiring all necessary permits (federal, state and local), and construction of the proposed ESMM project. The following timeline is presented to provide the reader with a general understanding of the anticipated project schedule.

Table Ex-2. Proposed ESMM Project Timeline

Commence and continue construction of concentrating and pelletizing facilities under existing (original MSI project) environmental permits and obtain project financing	2008 to present
For the proposed ESMM project, complete the Supplemental EIS process, obtain required permits and obtain additional ESMM modifications project financing	2010 to 2011
Commence construction of ESMM project facilities required for additional concentrating and pelletizing capacity	2011
Startup concentrating and pelletizing operations	2012
Commence construction of DRI and steel making facilities	2013
Startup DRI and steel making facilities	2015

CONNECTED ACTIONS

No connected actions as defined under Minn. Rules part 4410.0200, subp. 9, are proposed for the ESMM project. A natural gas supply line, power transmission lines, roadway improvements, a rail access line, and water and sewer lines connecting to the City of Nashwauk infrastructure improvements were required for the construction and operation of the original MSI project. No changes to any of these are necessary for the ESMM project. These improvements are being implemented by separate entities. Itasca County is implementing the infrastructure for roads and railroads. Electrical power providers and/or local public utility providers are responsible for construction of the infrastructure to supply electricity and natural gas to the facility. Separate permits and environmental review are required for these infrastructure projects.

The issue of electrical power supply for the MSI Project was considered in the MSI FEIS; see FEIS Section 6.13.2.6 and Response 16.d, Responses to Comments on FEIS. No connected actions as defined under Minn. Rules part 4410.0200, subp. 9, for electrical generation capacity are proposed for the ESMM project subject to the SEIS. Essar reports that energy conservation measures identified during detailed engineering have greatly reduced the electricity demand per ton of pellet. As a result, the incremental increase in electricity required for the increased pellet capacity is 35 MW, which represents only a 10%

increase in electricity demand compared to the original MSI project. This increase in power demand can be supported by currently operating power generating units consistent with the findings of the original MSI FEIS.

NO ACTION ALTERNATIVE

The No Action Alternative is the original MSI project as described in the MSI FEIS, and the additional detail provided in all subsequent permits for the original MSI project. Essar has commenced construction of permitted activities from the original MSI project that are not subject to environmental review in this SEIS. In this SEIS, the use of the MSI FEIS means the Final EIS, and existing permits means the subsequent permits written and authorized for the MSI project and transferred to Essar Steel Minnesota LLC.

PROJECT ALTERNATIVES

The MNDNR considered the following alternatives for environmental review as part of the MSI FEIS, and again for the proposed ESMM project in selecting alternatives to be evaluated in this SEIS. With the exception of air pollution control alternatives, none of these alternatives were determined to warrant review in the SEIS.

- Air Pollution Control Technologies;
- Alternative Mine Site and Plant Site;
- Alternative Site(s) for the Additional Secondary Crusher and Concentrating Line;
- Ore Processing Technology Alternatives;
- Plant locations and onsite sanitary wastewater treatment systems (selective findings of MSI FEIS Section 3.3.3);
- Stockpiling Alternatives;
- Crusher and Pellet Plant Location Alternatives;
- Scale or Magnitude.

For the proposed ESMM project a re-assessment of the air pollution control alternatives was performed, including an assessment of mercury controls.

Air Pollution Control Technology Alternatives
In accordance with the SEIS Preparation Notice, air pollution control alternatives were evaluated for the proposed ESMM project for the mitigation of air emissions. The two technology alternatives identified are

- Emission control technology for mercury;
- Best Available Control Technology (BACT) for criteria pollutants.

In October 2009 the MPCA adopted a statewide mercury total maximum daily load (TMDL) which includes guidance for new and expanding sources of mercury emissions. One of the requirements of the TMDL is that new or expanding sources of mercury emissions install best available controls.

The alternatives evaluation examined the technical feasibility of each available mercury control technology and the list was reduced to those that could be considered applicable to the proposed ESMM project taconite furnace. The technologies identified as technically feasible were then evaluated for ability to control pollutants other than mercury and compatibility with the furnace design.

The majority of the published information reviewed in the alternatives analysis showed that research on mercury control technologies is based on coal-fired utility boilers. Data are not available on pilot or full scale mercury control technology installations associated with taconite facilities in Minnesota, Michigan or other areas of the world. The MNDNR has begun to conduct research on five mercury control technologies being used by other industries for applicability to taconite facilities, as part of long-term mercury reduction goals in the state. Activated carbon injection was recently approved for the Keetac facility as the first for a taconite plant.

Activated carbon injection technology has not been demonstrated on a taconite furnace by Essar. Activated carbon would be expected to provide a reduction in mercury emissions of 50 to 80%. According to the MNDNR investigations currently occurring, data from taconite plants employing the kind of straight grate pollution control system included in the proposed ESMM project and potentially involving different concentrations of reactive components indicate mercury removal efficiency may be as low as 10 percent.

Activated carbon injection is the mercury control technology being proposed by Essar to control mercury emissions from the indurating furnace. Consistent with MPCA guidance, Essar used a BACT-like approach to evaluate alternative technologies compatible with the indurating furnace.

A second technology alternatives analysis was undertaken to re-evaluate the best available control technology (BACT) for criteria pollutants whose emissions are estimated to increase in amounts greater than the significant increase thresholds. Projected potential pollutant emission rates and dispersion modeling results include the effect of control technologies and methods committed to in the MSI FEIS and included in the original MSI project air quality permit.

An Air Pollution Control Alternatives Analysis report was prepared to address part of the BACT requirements. The report reviews technologies for particulate matter (PM, PM10, and PM2.5), fluoride, lead, sulfur dioxide, carbon monoxide, volatile organic compounds, nitrogen oxides (NOx), and greenhouse gas (GHG) emissions. The details on the proposed NOx emission reduction technology are summarized below. Other control measures include the use of a dry scrubber for control of SO2, and a baghouse for control of PM, PM10, and PM2.5 emissions from the taconite indurating furnace. Table Ex-3 provides a summary of mitigation measures proposed for air emissions.

NO_x would be an air pollutant emitted from the indurating furnace. Emissions controls were analyzed for compatibility with the 744 m^2 furnace being proposed. This a larger indurating furnace at the pellet plant compared to the 464 m^2 furnace in the original MSI project. Aker Metals Inc. (Aker), the technology supplier for the indurating furnace, and Fives (pronounced feeves) North American Combustion (Fives NA), the natural gas burner designers, were engaged by Essar to study a gas burner technology intended to be in compliance with federal and state NO_x emission standards at maximum and reduced (turn down) pellet-making capacities. This "Low NOx Study" evaluated an application of ultra low NO_x natural gas burners (low NO_x LE burners) in a custom-designed combustion chamber for an iron ore pellet plant indurating furnace. The Low NO_x option was compared to a standard traveling grate furnace that uses inspirating natural gas burners. Inspirating natural gas burners are the type typically in use at most straight grate indurating furnaces currently in operation and were the basis of uncontrolled NO_x emission rates in the MSI FEIS and air permit application.

Initial discussions with Aker indicated that constraints of >70% NO_x reduction with a fuel penalty of no greater than 30% were required to make the application of Low NO_x LE Burners on this project viable. Concluding the engineering analysis, Aker and Fives NA were able to report that both these constraints could be readily achieved for the proposed 744 m^2 indurating furnace operating for low flux (7.0 mmtpy) and high flux (6.5 mmtpy) pellets at a full or turndown production rate. The study results point to an opportunity to reduce NO_x emissions from the indurating furnace at the source and thereby potentially eliminate the need for add-on NO_x emission controls on the exhaust stacks.

To further evaluate the viability of this burner technology, a quarter (¼) scale trial of the Fives Low NO_x LE gas burner system would be completed prior to startup of the indurating furnace.

Essar has prepared the alternative analysis report cited above and is preparing the complete BACT analysis required for the Air Permit amendment application.

The Air Pollution Control (APC) Alternatives Analysis report addressed the first 3 steps and part of the 4th step in the 5 Step BACT Process:

- Step 1 – Identify All Control Technologies
- Step 2 – Eliminate Technically Infeasible Options
- Step 3 – Rank Remaining Control Technologies by Control Effectiveness
- Step 4 – Evaluate Most Effective Control Technologies and Document Results

In Step 3 each technology was ranked based on its control efficiency or expected controlled emission rate. This provided the information for an understanding of the alternatives available and the degree of mitigation that each would provide. Step 4 of the BACT process evaluates the top ranking technologies with respect to other environmental impacts and in some cases cost effectiveness if the top ranking control technology is not selected. However, no economic analyses were conducted because Essar was still obtaining from vendors the final technical and cost information. The economic analyses which is part of Step 4 of the BACT process is only required if a project proposer wishes to rule out a control technology in a final permit based on cost effectiveness (e.g. $/ton removed).

The BACT report being prepared for air permitting addresses the remainder of Step 4 and Step 5 (select BACT) that are not covered in the APC Report. Step 5 involves a final pollution control technology selection and details regarding permit limits, compliance demonstration methods, and recordkeeping and reporting which are needed for the air permit application. The SEIS Preparation Notice identified that BACT alternatives analysis would be performed. However, the selection of BACT, a requirement of permitting, is not a requirement of a state-only SEIS. The BACT selection is therefore not included in this SEIS.

MITIGATION MEASURES

Minnesota Rules, part 4410.2300, item G includes the requirement that an SEIS must consider alternatives that incorporate reasonable mitigation measures identified through the comment periods for SEIS scoping or for the Draft SEIS.

The SEIS presents mitigation measures for each of the potential project impacts identified. Some of these mitigation measures have been incorporated into the proposed ESMM project, including:

- Using larger trucks and optimizing the mine plan to reduce haul truck vehicle miles traveled, thereby reducing particulate and HAP/COPI emissions;
- Implementing emissions control technologies that are currently required by the current MSI air quality permit. Examples include material handling bag houses, implementation of a dust control plan;
- The use of wet or dry air pollution control of indurating furnace emissions;
- Using an indurating furnace design that produces lower NO_x emissions per unit of pellet production;
- Reducing mercury emissions from the indurating furnace using activated carbon injection;
- Monitoring emissions as required by the MPCA;
- Limiting GHG emissions primarily through the use of natural gas and various energy efficiency measures.

The summary of impacts identified through the SEIS process and mitigation measures proposed are presented in the table below.

Table Ex-3. Summary of Mitigation Measures Proposed and Identified for the ESMM Project

Potential Environmental Effect	Mitigation Incorporated into Proposed ESMM Project	Additional Mitigative Measures Identified
	Water Resources and Wild Rice (see Chapter 4.1)	
• Potential for decreased stream flow due to pit dewatering • Statistically insignificant increases in sulfate concentrations in Swan Lake from tailings basin seepage • No impacts are anticipated to wild rice due to changes in water levels or sulfate concentrations	• Adaptive Management • Special Conditions of existing MSI NPDES/SDS permit, including continued monitoring of ground water, surface waters, and tailings basin influent • Stream Augmentation Plan per existing Water Appropriations Permit • Hydrologic Monitoring per existing Water Appropriations Permit • Maintain zero liquid surface water discharge and water reuse & recycling strategy	None
	Air Quality (see Chapter 4.2)	
• Fugitive dust emissions • Major stationary sources of air emissions • Air quality impacts to Class I areas • Air quality impacts to Class II areas • Mercury bioaccumulation in fish • Exceedance of state and federal NO_x and SO_2 air emissions standards	• Implement fugitive dust control plan • Installation of best available control technologies • Installation of New Combustion Chamber Design and LE Burners • Installation of activated carbon injection for control of mercury emissions • Use of larger trucks to reduce fugitive dust emissions and diesel exhaust emissions	• Accepting a lower NO_x limit than currently modeled, contingent upon results of ¼ scale pilot test of Low NO_x LE Burners for new indurating furnace • Reducing NO_x emissions from other sources or purchasing tradable NO_x or SO_2 emissions allowances from sources impacting surrounding Class I areas • Install additional NO_x emission reduction technology after testing to determine feasibility
	Human Health Risk (see Chapter 4.3)	
• Small incremental increase in potential human health risks (but below Minnesota Department of Health guidelines)	• Installation of New Combustion Chamber Design and Low NO_x LE Burners • Installation of activated carbon injection system to reduce mercury emissions from the indurating furnace • Use of larger trucks to reduce fugitive dust emissions and diesel exhaust emissions	None

Potential Environmental Effect	Mitigation Incorporated into Proposed ESMM Project	Additional Mitigative Measures Identified
	Ecological Risk (see Chapter 4.4)	
• Low increase in concentrations of chemicals in surface soils and sediments • Moderate risk for manganese and low risk due to iron would be possible for Snowball Lake and other lakes along the south boundary of the mine • Low risk due to magnesium would be possible for Swan Lake compared to background levels	• Installation of best available control technologies • Implement fugitive dust control plan • Maintain zero liquid surface water discharge and water reuse & recycling strategy • Mitigation measures to reduce air emissions applicable to the chemicals potentially posing moderate levels of risks	None
	Socioeconomics (see Chapter 4.5)	
• Same housing effects as in original MSI FEIS • Additional jobs created for construction and operation at a smaller number than the original MSI project • A change in demand for public services	• Acquisition of 6 onsite properties	None
	Cumulative Air Quality Class I Particulates and Visibility (see Chapter 5.1)	
• Emissions of haze-producing air pollutants • Cumulative impacts to visibility at surrounding Class I areas	• Same measures identified for Air Quality	• Accepting a lower NO_x limit than currently modeled, contingent upon results of ¼ scale pilot test of Low NO_x LE Burners for new indurating furnace • Reducing NO_x emissions from other sources or purchasing tradable NO_x or SO_2 emissions allowances from sources impacting surrounding Class I areas
	Cumulative Air Quality Class I Acid Deposition (see Chapter 5.2)	
• Ecosystem acidification	• Installation of best available emission controls for NO_x and SO_2. • Installation of New Combustion Chamber Design and Low NO_x LE Burners	None
	Cumulative Mercury Deposition (see Chapter 5.3)	
• Mercury emissions • Mercury bioaccumulation in fish • Health impacts due to fish consumption	• Installation of an activated carbon injection system to reduce mercury emissions and corresponding permit limits • Clean fuels (natural gas is low in mercury)	None

Potential Environmental Effect	Mitigation Incorporated into Proposed ESMM Project	Additional Mitigative Measures Identified
Cumulative Climate Change (see Chapter 5.4)		
• Environmental effects on climate change • Increases in GHG emissions	• Best available control technology and corresponding permit limits • Use of larger trucks to reduce vehicle miles traveled thereby reducing fuel usage and associated GHG emissions • Dry cobbing of crude ore • Use autogenous grinding • Elimination of steel balls from SAG grinding • Use of hydraulic AG mill trommel • Use of ball mill instead of cyclone in primary screening circuit • Maximize use of gravity flow to transport through crushing/grinding/concentration circuits • Filtration using ceramic filters	• Carbon offset credits could be considered at some point in the future for the proposed ESMM project

1.0 Introduction and Purpose

1.1 PROJECT OVERVIEW

Essar Steel Minnesota LLC (Essar) purchased Minnesota Steel Industries (MSI) in October 2007 and is now proposing modifications to the original MSI project.

The proposed Essar Steel Minnesota Modifications (ESMM) project would increase the taconite pellet production and associated mining, crushing, ore concentrating and tailings generation rates compared to the MSI project. All of the other aspects of the original MSI project including direct reduced iron (DRI) production and steel-making remain unchanged. No physical changes to DRI or steel making processes are proposed.

The proposed ESMM project would continue to be located near Nashwauk, Minnesota on the Mesabi Iron Range (Figure 1-1) and integrate the steps necessary to make low-cost, high-quality steel at the former Butler Taconite site.

The proposed ESMM project modifications are summarized below.

- Increase taconite pellet production from 3.8 million metric tons per year (mmtpy) of low flux taconite pellets to 6.5 mmtpy of high flux or 7.0 mmtpy of low flux taconite pellets or any combination depending on internal needs and market demands. The low flux pellets will be made for use as a feed material to the DRI process and the high flux pellets will be made for use as a feed material in blast furnaces located off-site. Either pellet type may also be sold on the open market depending upon internal demands and market conditions. Section 3.2 provides a more detailed explanation of the pellet production capacity differences between the original MSI project and proposed ESMM project.
- Reduce the initial mine plan time period from 20 to 15 years and mine generally the same geologic ore body identified in the existing Permit to Mine at a faster rate and greater quantity.
- Increases in total tailings, overburden, and waste rock due to an increase in available ore.

Equipment and/or process changes to achieve increased pellet capacity are summarized below and described with more detail in Chapter 3.0.

- Mining
    - Increase from 200- to 240-ton haul trucks
    - Pits 5 and 6 are combined and mined to a greater depth
- Crushing
    - Additional secondary crusher
- Ore Storage
    - Larger fine and coarse ore storage areas
- Concentrating
    - Additional concentrating line
- Pelletizing
    - Additional ceramic filters and balling discs
    - Additional additive storage bins and mixers
    - 744 m^2 (4 meter by 186 m) pelletizing furnace with:
        - Low NO_x LE Burners for control of NO_x emissions

- Activated carbon injection for control of mercury emissions
- Multi-stage air pollution equipment for control of PM, PM_{10}, $PM_{2.5}$, and SO_2/SO_3 emissions

- Use water contained in Pits 1 and 2, as needed, to provide process make-up water

The tailings basin height and footprint would increase to accommodate additional tailings disposal; these changes would not extend beyond areas previously considered for disturbance and would not result in additional wetland impacts or other land cover changes beyond those estimated for the original MSI project.

Mitigation measures identified for the original MSI project would be maintained and in many cases improved upon as part of the proposed ESMM project. Some of the key mitigative measures from the original MSI project that would continue are:

- Integrated mine through steel making process for conservation of energy;
- Natural gas for process heating;
- Zero surface liquid discharge via a reuse and recycle system;
- Use of water from Pits 1 and 2 for stream augmentation.

1.2 PURPOSE AND NEED

On October 11, 2007, MSI received a final air permit and authorization to construct and operate the reactivation of the former Butler Taconite mine and tailings basin area near Nashwauk, Minnesota and build a new processing facility to make sheet steel coils from the ore that is mined. In June 2007, Essar Global Limited purchased Algoma Steel in Sault Ste. Marie, Ontario and formed Essar Steel Algoma. In October 2007, Essar Steel Holdings LLC purchased MSI and formed Essar. Since the purchase of these two entities, Essar has reviewed the projects in terms of their strategic fit with Essar's North American business strategy. Based on this strategy a need for additional taconite pellet production capacity was identified as well as the need to produce high flux pellets for use in the blast furnaces at Essar Steel Algoma.

The purpose and need of the proposed ESMM project is to increase production and introduce environmental and processing efficiencies into the original MSI project to be consistent with and supportive of other Essar operations. With respect to the pellet and steel making aspects of the original MSI project, Essar also completed a comprehensive technical and economic review to identify productivity, energy efficiency and environmental performance enhancements. This led to the proposed modification to increase taconite pellet making capacity. By increasing pellet capacity to the level proposed, Essar can eventually source all of its North American iron ore pellet requirements for steel making from internal sources, thereby eliminating the need to purchase pellets on the open market. Essar has identified several ways to conserve the consumption of resources such as water, natural gas and power. These conservation measures are reflected in specific consumption numbers presented in the comparison of alternatives in Chapters 4.0 and 5.0 of the SEIS.

1.3 ABOUT THE PROPOSER

Founded in 1969 by the Ruia family of India, Essar is a global corporation with assets in the construction, steel, shipping and logistics, oil and gas, telecommunication and power industry sectors. Essar employs 70,000 people across the globe and is the parent company of Essar Steel Minnesota, LLC.

1.4 SEIS OVERVIEW

In June of 2007, a Final Environmental Impact Statement (FEIS) was issued jointly by the MNDNR and USACE for MSI reactivation of the former Butler Taconite mine and tailings basin area. The MSI FEIS was determined adequate in August 2007 and is incorporated in its entirety by reference in this SEIS. The MSI FEIS is available at:

http://www.dnr.state.mn.us/input/environmentalreview/minnsteel/index.html

In accordance with Minnesota Rules 4410.2300 through 4410.2800 and 4410.3000, this Supplemental Environmental Impact Statement (SEIS) is being prepared as a supplement to the MSI FEIS. Because there are no additional wetland impacts, the USACE has made a preliminary determination that a supplement to the federal EIS under NEPA is not required. Therefore the SEIS for the proposed modifications to the originally-reviewed project is a state-only environmental review.

The SEIS began with the preparation notice publication date of March 22, 2010. A supplement to an EIS is to include all of the parts commonly found in the EIS, including:

- List of Preparers;
- Project Description;
- Government Approvals;
- Alternatives that are reasonable for addressing potentially significant impacts of the proposed project, alternatives excluded, and the no action alternative;
- Environmental, economic, employment, and sociological impacts for the proposed project and each major alternative, including any major differences of opinion concerning significant impacts;
- Mitigation measures reasonable for eliminating or reducing adverse effects;
- Appendix as applicable for material prepared in connection with supplementing the EIS, including concurrently developed permit information;
- References;
- Explanation of incomplete or unavailable information as needed.

The SEIS Preparation Notice indicated a best available control technologies (BACT) assessment would be completed. The Air Pollution Control Alternatives Analysis listed above was completed to address part of the BACT requirements; the remaining steps will be completed for permitting. The selection of BACT is not a requirement of state-only environmental review and is therefore not included in this SEIS.

In accordance with Minnesota Rules 4410.3000 Subpart 5A, the information presented in the SEIS is focused on the proposed ESMM project. Only modifications identified in the SEIS Preparation Notice (July 2010) and associated environmental impacts are the subject of this SEIS, as all other project activities were reviewed in the MSI FEIS.

This SEIS process also incorporates the following actions in accordance with Minnesota Rules:

- Publishing the availability notice;
- Distributing the draft supplement to the EIS;
- Holding an informational meeting not less than fifteen days after publication of the availability notice;

- Preparing a Final SEIS to include responses to substantive comments; and
- Distributing and noticing the Final SEIS. A determination of adequacy of the Final SEIS shall be made at least 10 days following notice of release.

The SEIS is intended to provide information to the public and units of government on the environmental impacts of the proposed project before approvals or necessary permits are issued and to identify measures which could be implemented to avoid, reduce, or mitigate adverse environmental effects. The SEIS is not a means to approve or disapprove a project.

1.5 AGENCY ROLES AND RELATIONSHIPS

The MNDNR serves as the Responsible Governmental Unit (RGU) for preparation of this SEIS in accordance with Minnesota Rules from the Minnesota Environmental Policy Act (MEPA). The MNDNR will be responsible for determining SEIS adequacy pursuant to MEPA and will prepare the state Adequacy Decision and Finding of Fact. The roles of consulting agencies are described in Chapter 6.0; there are no cooperating agencies for this SEIS.

2.0 Governmental Permits and Approvals

2.1 SUMMARY OF REQUIRED PERMITS AND APPROVALS

All known potential government permits and approvals for the proposed Essar Steel Minnesota Modifications (ESMM) project are listed below in Table 2-1. Since the original Minnesota Steel Industries (MSI) project mining and processing operations have already been reviewed through the EIS process, all of the permits in Table 2-1 were obtained, as necessary, for the original MSI project. Only a subset of the permits applicable to the original project is applicable to the SEIS for the proposed ESMM project. Although the SEIS provides information for use by decision-makers in permit modifications, issuance or denial, it is not required to gather or present all necessary permit-related information. No permits may be issued until the SEIS receives a State Determination of Adequacy.

Table 2-1 Summary of Permits and Approvals for the Original MSI Project and Proposed ESMM Project

AGENCY/PERMIT	Original MSI Project (Current Permit # and Date of Issuance, where applicable)	Proposed ESMM Project (Permits to Be Obtained for Proposed Modifications)
Federal Aviation Administration (FAA)		
14 CFR Part 77 Notice to the Federal Aviation Administration [Construction]	The FAA must be notified if any structures more than 200 feet high would be constructed or altered at the proposed site. No structures more than 200 feet were proposed for construction.	Notification required. Proposed modifications entail an air pollution control system stack height of 100 meters (328 feet).
U.S. Army Corps of Engineers (USACE)		
Section 404 Permit of the Clean Water Act [Wetlands]	Permit No. MVP-2005-546-JKA Issued August 30, 2007	Not required. Proposed modifications do not result in new direct or indirect wetland impacts.
Section 7 Endangered Species Act Consultation with USFWS [Endangered Species]	Completed as required.	Not required. Proposed modifications do not impact any new Threatened or Endangered Species.
Section 106 of the National Historic Preservation Act Determination for Cultural Resources [Historic Properties]	Determination issued on October 22, 2007	Not required. Proposed modifications do not trigger need for federal involvement under NEPA, therefore Section 106 determination is not required.

AGENCY/PERMIT	Original MSI Project (Current Permit # and Date of Issuance, where applicable)	Proposed ESMM Project (Permits to Be Obtained for Proposed Modifications)
Minnesota Department of Natural Resources (MNDNR)		
Permit to Mine [Operations]	Permit Issued August 22, 2007	Substantial Change Amendment required.
Water Appropriation Permit [Surface Water]	Permit Nos. 2008-0065, 2008-0066, 2008-0067 and 2006-0433 Issued on August 22, 2007	Permit amendment required. Proposed modifications do not appear to create the need for additional water supply, but this will need to be confirmed with additional modeling during the permitting process.
Tailings Basin Public Waters Permit - Dam Safety [Construction]	Expect application to be submitted by April 15, 2011.	Expect application to be submitted by April 15, 2011.
Public Waters Permit [Surface Water]	Not required. Would be required if construction is proposed in Public Waters. The existing mining pits which would be affected by proposed mining activities are not considered "public waters" and therefore, proposed intake and discharge structures in the pits would not be subject to a public waters permit.	Not required. Proposed modifications do not change existing status. Permit would be required if construction is proposed in Public Waters.
Wetlands Conservation Act (WCA) Permit [Wetlands]	Permit No. MVP-2005-546-JKA Issued August 30, 2007	Not required. Proposed modifications do not result in new direct or indirect wetland impacts.
Burning Permit [Construction]	Permit No.1030562331 Issued on November 18, 2008	Not required. Proposed modifications do not create need for new tree or brush clearing activities.
Takings Permit (for Endangered or Threatened Species) [Endangered Species]	Special Permit No. 14484 Issued August 23, 2007	Not required. Proposed modifications do not impact any new Threatened or Endangered Species.

AGENCY/PERMIT	Original MSI Project (Current Permit # and Date of Issuance, where applicable)	Proposed ESMM Project (Permits to Be Obtained for Proposed Modifications)
Minnesota Pollution Control Agency (MPCA)		
Part 70 Operating Permit/New Source Review (NSR) Authorization [Air Quality]	Permit No. 06100067-001 Issued on October 11, 2007	Based on the potential-to-emit (PTE) and changes to BACT for some pollutants, the proposed ESMM project is subject to NSR/PSD and the Part 70 operating permit program.
NPDES/SDS Permit for Industrial Wastewater Discharge and Stormwater Discharge for Industrial Activity (including Tailings Basin Operation) [Surface Water]	Permit No. MN0068241 Issued on August 21, 2007	Not required. Proposed modifications do not create need for wastewater discharge. Zero surface liquid discharge is maintained.
NPDES/SDS Construction Stormwater General Permit [Surface Water]	Permit No. C00023715 Issued on August 21, 2007	Not required. Existing construction stormwater permit is in force and carried forward for future project construction phases.
Section 401 Water Quality Certification [Wetlands]	Permit No. MVP-2005-546-JKA Issued on August 21, 2007	Not required. Proposed modifications do not result in new direct or indirect wetland impacts.
Storage Tank Permits (fuel tanks, etc.) [Hazardous Materials/Waste]	Yet to be applied for - aboveground storage tank needs for project yet to be determined.	Yet to be applied for - aboveground storage tank needs for project yet to be determined.
Hazardous Waste Generator and Storage [Hazardous Materials/Waste]	Yet to be applied for because it has not been determined if hazardous waste will be generated.	Proposed modification does not change the permit status. Yet to be applied for because it has not been determined if hazardous waste will be generated.
Minnesota Department of Health (MDH)		
Radioactive Material Registration (low-level radioactive materials in measuring instruments) [Hazardous Materials/Waste]	Yet to be applied for – the need for process measurement instrumentation containing low-level radioactive material not yet determined.	Proposed modification does not change the permit status. Yet to be applied for - the need for process measurement instrumentation containing low-level radioactive material not yet determined.

AGENCY/PERMIT	Original MSI Project (Current Permit # and Date of Issuance, where applicable)	Proposed ESMM Project (Permits to Be Obtained for Proposed Modifications)
Itasca County		
Zoning Variance or Conditional Use Permit [Construction]	Not required.	Not required.
Shoreland Alteration Permit [Construction]	Not required. No shoreland alteration is proposed.	Not required. No shoreland alteration is proposed.
Building Permit [Construction]	Not required. Building permit issued by City of Nashwauk (see below).	Not required. Building permit to be issued by City of Nashwauk (see below).
City of Nashwauk		
Zoning (Land Use) Permit [Construction]	Rezoning and permitting completed in July 2007	Not required.
Building Permit [Construction]	Permit No. 14-2008 Issued on September 12, 2008	A building permit for building modifications is required prior to construction.
Sewer and Water Permits [Construction]	To be applied for prior to startup.	To be applied for prior to startup.

2.2 REGULATORY FRAMEWORK

The sections provide a general description of each permit listed in Table 2-1. The descriptions are not specific to the proposed ESMM project. They provide detail on the applicable laws, rules, or statutes that provide authority to the permitting agencies, as well as the general intended purpose of the legislation. The permits are grouped based upon the specific area of applicability (operations, wetlands, surface water, drinking water, air quality, historic properties, waste/hazardous materials, endangered species, and construction).

2.2.1 Operations

MNDNR: Permit to Mine

Minn. Stat. § 93.481

Minn. R. 6130

https://www.revisor.leg.state.mn.us/statutes/?id=93.481

A Permit to Mine is required in order to carry out a mining operation for metallic minerals within the state. The Permit to Mine includes construction, operations, closure and post closure. The applicant must submit Mining and Reclamation Plans covering the life of the mine, as proposed at the time of application.

2.2.2 Wetlands

USACE: Section 404 Permit

CWA Section 404

http://www.epa.gov/lawsregs/law/cwa.html

The Clean Water Act (CWA) is the cornerstone of surface water quality protection in the United States. The CWA does not deal directly with groundwater or with water quantity issues. The statute employs a variety of regulatory and nonregulatory tools to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

Section 404 of the CWA (Permits for Dredged or Fill Material) regulates the discharge of dredged or fill material in the jurisdictional wetlands and waters of the United States. The USACE has been delegated the responsibility for authorizing these actions. Permit applications are reviewed for wetland impact avoidance, minimization, and compensation. See also MPCA: Section 401 Water Quality Certification.

MNDNR: Wetlands Conservation Act (WCA) Permit

Minn. Stat. § 103G

Minn. R. 8420

Minnesota WCA

https://www.revisor.mn.gov/rules/?id=8420&view=chapter

https://www.revisor.mn.gov/rules/?id=8420&view=chapter#rule.8420.0930

To retain the benefits of wetlands and reach the legislation's goal of no-net-loss of wetlands, the Wetland Conservation Act (WCA) requires anyone proposing to drain, fill, or excavate a wetland first try to avoid disturbing the wetland; second, try to minimize any impact on the wetland; and, finally, replace any lost wetland acres, functions, and values. Compliance with the WCA, evaluation of impacts to wetlands and wetland mitigation plans are reviewed by the DNR as part of the Permit to Mine for mineral development projects under Minnesota Statutes, section 93.481.

MPCA: Section 401 Water Quality Certification

CWA Section 401

http://proteus.pca.state.mn.us/water/401.html

Section 401 of the Clean Water Act requires that an applicant for a federal license or permit provide a certification that any discharges from the facility would comply with the Clean Water Act, including compliance with state water quality standards. Projects that fit certain criteria related to the likely impact on water resources are reviewed by the MPCA to ensure compliance with state water quality standards. In particular, the MPCA intends to ensure that no prudent and feasible alternatives to impacting wetlands are available, the project's impact on wetlands is minimized, and adequate compensatory mitigation would be implemented to protect the designated uses of the wetland and the water quality standards of the affected watershed. Projects in these areas that would be in compliance with the standards would receive an MPCA 401 Certificate, the conditions of which would be incorporated into the USACE Section 404 Permit and must be adhered to by the Permittee.

2.2.3 Surface Water

MNDNR: Water Appropriation Permit

Minn. Stat. § 103G.271

http://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/permits.html

A water use permit is required for all water users in Minnesota withdrawing more than 10,000 gallons of water per day, or 1 million gallons per year, from surface or groundwater.

MNDNR: Public Waters Permit

Minn. Stat. § 103G.245

https://www.revisor.mn.gov/rules/?id=8420&view=chapter

https://www.revisor.mn.gov/rules/?id=8420&view=chapter#rule.8420.0930

The DNR Water Permits Unit oversees the administration of the Public Waters Work Permit Program. This program regulates water development activities below the ordinary high water level (OHWL) in public waters and public waters wetlands. These areas are identified on maps available for viewing at numerous locations. Examples of development activities addressed by this program include filling, excavation, shore protection, bridges and culverts, structures, docks, marinas, water level controls, dredging, and dams. Field staff serve as the primary contacts for this program, and most activities can be authorized at either MNDNR Waters area or regional offices. The program staff in St. Paul provide policy guidance, program coordination with other water and wetland resource protection programs, permit decision appeal processing, and permit data management services.

MPCA: NPDES/SDS Permit for Industrial Wastewater Discharge and Stormwater Discharge for Industrial Activity (including tailings basin operation)

CWA Section 402

Minn. R. 7001, 7050, 7052, 7060, 7090

Minn. Stat. § 115

http://www.epa.gov/owow/wetlands/laws/section402.html

http://www.pca.state.mn.us/water/stormwater/

https://www.revisor.leg.state.mn.us/rules/?id=7090&view=chapter

CWA Section 402 establishes the National Pollutant Discharge Elimination System (NPDES) permit program to regulate point source discharges of pollutants into waters of the United States. An NPDES permit sets specific discharge limits for point sources discharging pollutants into waters of the United States and establishes monitoring and reporting requirements, as well as special conditions. The State Disposal System (SDS) permit program is established under Minnesota Statute 115 and follows requirements set forth in the Clean Water Act. An SDS permit regulates non-surface water discharges.

The State of Minnesota regulates the management and discharge of wastewater and stormwater through the NPDES/SDS permitting program. The MPCA administers both the NPDES and SDS permits, which often contain stormwater requirements, and generally issues combined NPDES/SDS permits. Minnesota Rules Chapter 7090 establishes the Minnesota Stormwater Permit Program. Other relevant rules are Chapters 7050 and 7052 for applicable water quality standards upon which permit limitations and other requirements are based, and Chapter 7060 for protection of groundwater.

MPCA: NPDES/SDS Construction Stormwater General Permit

CWA Section 402

40 CFR 122, 123 & 124

Minn. Stat. § 115-116

Minn. R. 7001, 7090

http://www.epa.gov/owow/wetlands/laws/section402.html

http://www.pca.state.mn.us/water/stormwater/

https://www.revisor.leg.state.mn.us/rules/?id=7090&view=chapter

(See above permit for general information on the NPDES, SDS and Minnesota Stormwater Permit Programs).

Construction projects in Minnesota require a construction stormwater permit if they: 1) disturb one acre or more of soil, or 2) disturb less than one acre of soil if that activity is part of a "larger common plan of development or sale" that is greater than one acre, or 3) disturb less than one acre of soil, but the MPCA determines that the activity poses a risk to water resources. The permit is intended to prevent stormwater pollution during and after construction by providing erosion control that reduces the amount of sedimentation and other pollutants transported by runoff from construction sites. As part of the application, the owner and operator must create a stormwater pollution prevention plan (SWPPP) that explains how they will control stormwater.

2.2.4 Drinking Water

See Section 2.2.8 Construction: City of Nashwauk: Sewer and Water Permits.

2.2.5 Air Quality

MPCA: Part 70 Operating Permit/New Source Review Authorization

C.F.R. Title 40, part 70 & 52.21

Minn. R. 7007.3000

http://www.pca.state.mn.us/air/permits/aboutairpermits.html

In Minnesota, air quality permits are required to operate certain existing air emission facilities and to begin construction on either new facilities or modifications to existing facilities. Air quality permits contain a wide range of state and federal requirements to minimize the impact of the air emissions from these facilities on the environment. Others have a wider scope and involve addressing the impact of newly constructed facilities, or modifications to existing facilities, on ambient air quality.

Minnesota's air permitting program includes the Title V (or Part 70) operating permit program and the Part 52.21 New Source Review (NSR) program. Title V refers to the section of the Clean Air Act, and Part 70 refers to the part of Title 40 of the Code of Federal Regulations, which contains the requirements for the operating permit program. NSR is a program of the federal Clean Air Act that covers the construction of new major-emitting industrial facilities, and construction at existing facilities that will significantly increase pollution emissions. The permit is issued only if the new plant or major modification includes pollution control measures that reflect the best available control technology (BACT). NSR consists of the Prevention of Significant Deterioration (PSD) program and Non-Attainment Area Review. Only the PSD portions of the NSR regulations apply in Minnesota.

2.2.6 Historic Properties

USACE: Section 106 Determination for Historic Properties

National Historic Preservation Act of 1966 (NHPA) Section 106

http://www.achp.gov/106summary.html

Section 106 of the National Historic Preservation Act (NHPA) requires federal agencies to take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on such undertakings. The procedures in Section 106 define how federal agencies meet these statutory responsibilities. The Section 106 process seeks to accommodate historic preservation with the needs of federal undertakings through consultation among the agency officials and other parties with an interest in the effects of the undertaking on historic properties. This consultation is to commence at the early stages of project planning. The goal of consultation is to identify historic properties potentially affected by the undertaking, assess its effects and seek ways to avoid, minimize or mitigate any adverse effects on historic properties. Representatives of the federal government agency (e.g., the USACE) are specifically tasked to consult with representatives of Native American Tribal Nations according to Section 106.

2.2.7 Waste/Hazardous Materials

MPCA: Hazardous Waste Generator and Storage

Minn. R. ch. 7045

https://www.revisor.leg.state.mn.us/rules/?id=7045

All generators of hazardous waste must obtain a hazardous waste generator license for each individual generation site. The procedures for application and issuance are described in Minnesota Rules 7045.0225 to 7045.0250. A generator must prominently display the hazardous waste generator license in a public area at the licensed site.

MDH: Radioactive Material Registration (low-level radioactive materials in measuring instruments)

Minn. R. 4731.3215

https://www.revisor.leg.state.mn.us/rules/?id=4731.3215

Commercial and industrial firms and other entities are issued a general license to acquire, receive, possess, use, or transfer, according to this part, radioactive material contained in devices designed and manufactured for purposes such as detecting, measuring, and gauging, provided the devices meet certain criteria of prior licensing. Licensed devices must be registered with the MDH.

MPCA: Storage Tank Permits (fuel tanks, etc.)

Minn. R. ch. 7151

http://www.pca.state.mn.us/cleanup/ast.html

Aboveground storage tanks (ASTs) that store liquid substances that may pollute the waters of the state are regulated by Minnesota Rule, Chapter 7151, if site capacity is less than one million gallons. Larger facilities, those with a capacity of one million gallons or more, are regulated by permits negotiated with MPCA. The goal of regulating ASTs is to prevent spills and leaks by requiring storage tank owners to incorporate various safeguard options. These options include safeguards such as: secondary containment to minimize the impact of a release, corrosion protection and overfill prevention to prevent releases, and tank monitoring for leak detection. The level of protection needed depends on the type of product stored, the size of the tank, and the date that the tank was installed.

2.2.8 Endangered Species

USACE: Section 7 Endangered Species Act Consultation with USFWS

Endangered Species Act of 1973 Section 7

http://www.fws.gov/endangered/ESA/sec7.html

Under provisions of section 7(a)(2) of the Federal Endangered Species Act (ESA) of 1973, a federal agency that carries out, permits, licenses, funds, or otherwise authorizes activities that may affect a listed species must consult with the United States Fish and Wildlife Service (USFWS) to ensure that its actions are not likely to jeopardize the continued existence of any listed species.

MNDNR: Takings Permit (for Endangered or Threatened Species)

Minn. Stat. § 84.0895

Minn. R. 6212.1800

http://www.dnr.state.mn.us/eco/nhnrp/endangered_permits.html

For species to be taken from the wild in Minnesota, the applicant must document the justification for the taking, location, species, number of individuals to be taken or possessed, that there are no feasible alternatives to the taking, and provide assurance that the taking would not negatively affect the species' status in Minnesota.

When taking is proposed in connection with a development project, the request can be in the form of a letter that outlines the nature of the project, location and species and number of individuals that would be taken. Before a permit can be issued, the project proposer is asked to explore project alternatives, including other locations or designs, which would avoid or minimize the taking.

2.2.9 Construction

FAA: Notice to the Federal Aviation Administration

14 CFR Part 77

FAA Form 7460-1

https://oeaaa.faa.gov/oeaaa/external/content/FAR_Part77.pdf

The FAA must be notified if any structures more than 200 feet high would be constructed or altered at the proposed site. The FAA would then determine if the structures would or would not be an obstruction to air navigation. As required by Federal Aviation Regulations (FAR) 77.13 subpart A, the FAA Form 7460-1 must be completed and submitted to the appropriate regional FAA office for review and final determination status.

MNDNR: Burning Permit

Minn. Stat. § 88.16, 88.17

http://www.dnr.state.mn.us/forestry/fire/questions.html

A permit to start a fire to burn vegetative materials and other materials allowed by Minnesota Statutes or official state rules and regulations may be issued by the MNDNR commissioner or the commissioner's agent. This permission shall be in the form of: (1) a written permit issued by a forest officer, fire warden, or other person authorized by the commissioner; or (2) an electronic permit issued by the commissioner, an agent authorized by the commissioner, or an Internet site authorized by the commissioner. Burning permits shall set the time and conditions by which the fire may be started and burned. The permit shall also specifically list the materials that may be burned. Coordination with a local government unit (e.g., the City of Nashwauk) may also be required.

MNDNR: Dam Safety Permit

Minn. Stat. § 103G.515

http://www.dnr.state.mn.us/waters/surfacewater_section/damsafety/index.html

The Dam Safety Program exists to ensure that dams in Minnesota are safe, are operated responsibly, and are removed when they become obsolete. The Dam Safety Program has the following responsibilities: inspect and analyze publicly and privately owned dams to ensure their structural integrity and safety; provide engineering review of proposed dam projects; issue dam safety permits; and administer state bonding funds for the repair, reconstruction, or removal of dams owned by the state and local governments and determine the scope of work for these projects.

Itasca County: Zoning Variance, Conditional Use Permit (CUP)

Itasca County Zoning Ordinance Articles 2, 19 & 21

http://www.co.itasca.mn.us/Zoning/Zoning%20Ordinance.pdf

Itasca County zoning permits are required for new construction, replacement, or additions onto a structure, new installation or alteration of Individual Sewage Treatment Systems (ISTSs), grading/filling or excavation in a Shoreland District, alteration of wetlands and public waters. Other zoning-related permits include variances, conditional uses, planned unit developments (PUDs) and rezoning. Once issued, these permits are valid for a period of one year to start construction.

Variances are necessary when the setback or lot size requirements cannot be complied with. Conditional Use Permits are necessary for certain land uses or development that would not be appropriate generally or without restriction in a particular zoning district, but may be allowed with conditions. Rezoning or a map amendment would be needed if changing of a zoning district is proposed. These applications require a public hearing process and review by the Itasca County Planning Commission/Board of Adjustment.

Itasca County: Shoreland Alteration Permit

Itasca County Zoning Ordinance Article 5

http://www.co.itasca.mn.us/Home/Departments/Environmental%20Services/Documents/Zoning%20Ordinance.pdf

(See Itasca County: Zoning Variance, Conditional Use Permit (CUP) for general information on zoning permits)

A shoreland alteration permit is required from Itasca County for any grading/filling or excavation within the Shoreland Overlay District established under the County Zoning Ordinance. The Shoreland Overlay District is defined as the area surrounding a designated waterbody, extending out 1,000 feet from the ordinary high water level (OHWL) of lakes/wetlands and 300 feet from streams.

Itasca County: Building Permit

Itasca County Zoning Ordinance Articles 3, 4 & 12

http://www.co.itasca.mn.us/Zoning/Zoning%20Ordinance.pdf

(See Itasca County: Zoning Variance, Conditional Use Permit (CUP) for general information on zoning permits)

Buildings and/or building modifications would have to be constructed to comply with applicable building codes. In an effort to ensure buildings are constructed to minimum standards for safety and durability, Itasca County has adopted the Minnesota State Building Code. County building code enforcement staff review building plans and permit applications, issue building permits, and conduct a wide range of field inspections to ensure compliance with state and local building and zoning codes.

City of Nashwauk: Zoning (Land Use) Permits

Nashwauk, MN Code of Ordinances Title XV

http://www.amlegal.com/nxt/gateway.dll/Minnesota/nashwauk_mn/nashwaukminnesotacodeofordinances?f=templates$fn=default.htm$3.0$vid=amlegal:nashwauk_mn

Zoning (land use) permits are issued by the City of Nashwauk based on its Code of Ordinances.

City of Nashwauk: Building Permit

Nashwauk, MN Code of Ordinances Title XV

http://www.amlegal.com/nxt/gateway.dll/Minnesota/nashwauk_mn/nashwaukminnesotacodeofordinances?f=templates$fn=default.htm$3.0$vid=amlegal:nashwauk_mn

Building permits are issued by the City of Nashwauk based on its Code of Ordinances.

City of Nashwauk: Sewer and Water Permits

Nashwauk, MN Code of Ordinances Title V

http://www.amlegal.com/nxt/gateway.dll/Minnesota/nashwauk_mn/nashwaukminnesotacodeofordinances?f=templates$fn=default.htm$3.0$vid=amlegal:nashwauk_mn

Sewer and water permits are issued by the City of Nashwauk based on its Code of Ordinances.

3.0 Proposed Action and Alternatives

In accordance with Minnesota Rules 4410.2300, items D to J, 4410.2400, and 4410.2500, for environmental review, the SEIS Preparation Notice identified alternatives that are reasonable for addressing potentially significant impacts of the proposed project, alternatives excluded, and the no action alternative. The Preparation Notice listed the following alternatives:

- Proposed Alternative (the proposed ESMM project) and associated Technology Alternatives
- No Action Alternative (the original MSI EIS project)

Chapter 3.0 is organized as follows in order to address the above alternatives and also describe alternatives excluded from evaluation in the SEIS.

- 3.1 No Action Alternative (original MSI project as permitted)
- 3.2 Proposed Action (proposed ESMM project)
    - 3.2.1 Mining
    - 3.2.2 Overburden and Waste Rock Management
    - 3.2.3 Crusher and Pellet Plant Operations
    - 3.2.4 Tailings Management
    - 3.2.5 Solid and Hazardous Waste Generation
    - 3.2.6 Energy Management
    - 3.2.7 Water Management
- 3.3 Air Pollution Control Technology
    - 3.3.1 Emission Control Technology for Mercury
    - 3.3.2 BACT for Criteria Pollutants
- 3.4 Alternatives Considered
- 3.5 Incorporation of Mitigation Measures Identified Through Public Comment

The following table provides a reference for the reader to the use of the term "ton" in this document. Several forms of this term are used as it relates to different aspects of the project. The production capacity of the indurating furnace and other pieces of process equipment are generally given in metric tons, because Essar is an international company and the design of the equipment is done in metric tons. Mining capacities are typically stated in long tons, which is equal to 2,240 pounds. Short tons are used in air permitting regulations. A short ton is equal to 2000 pounds.

Unit of Weight	Abbreviation	Long Ton (mining)	Short Ton (air permit)	Metric Ton (equipment)
Pounds	lbs	2240	2000	2204.62
Long Ton	l.ton or lt	1	1.12	1.016
Short Ton	s.ton	0.8929	1	0.9072
Metric Ton	m.ton or mt or Tonne	0.9842	1.1023	1

The MSI FEIS is regularly referenced in this SEIS for details on the original MSI project. Reference shall be to section numbers in the MSI FEIS.

Documentation to Prepare Chapter 3.0:

Barr Engineering. 2010a. Permit to Mine Amendment Application. (Report ID: MP1)

Barr Engineering. 2010b. Water and Chemical Balance for a Proposed Pellet Production Rate of 6.5 MMTPA. (Report ID: W1)

Barr Engineering. 2010c. Tailings Basin Design Report.

Barr Engineering. 2010d. Mercury Control Technology Evaluation. September 2010

Barr Engineering. 2007. Permit to Mine, issued August 22, 2007 to Minnesota Steel Industries, LLC.

Minnesota Department of Natural Resources and U.S. Army Corps of Engineers, 2007. Minnesota Steel Final Environmental Impact Statement.

3.1 NO ACTION ALTERNATIVE

The No Action Alternative is the original MSI project as described in the MSI FEIS, and the additional detail provided in all subsequent permits for the original MSI project. Essar has commenced construction of permitted activities from the original MSI project that are not subject to environmental review in this SEIS. In this SEIS, the use of the MSI FEIS means the Final EIS, and existing permits means the subsequent permits written and authorized for the MSI project and transferred to Essar Steel Minnesota LLC.

3.2 PROPOSED ACTION

The proposed action is the proposed ESMM project, which entails modifications from the original MSI project (the MSI FEIS and permits). These modifications are subject to environmental review. The proposed ESMM project is most succinctly described as the following:

An increased taconite pellet production from 3.8 million metric tons per year of low flux direct reduced iron (DRI) feed grade taconite pellets to 6.5 million metric tons per year of high flux blast furnace grade pellets or 7.0 million metric tons per year of low flux, DRI feed grade taconite pellets or any combination.

Essar has proposed to modify the currently permitted single pelletizing facility to manufacture both high and low flux pellets. Essar is not proposing any physical change to the capacity of the DRI units or steel manufacturing facilities as described in the MSI FEIS and Air Permit #06100067. However, because air emissions are sometimes based on process capacity, Table 3-1 below is provided to illustrate differences in capacities between the original MSI project and the proposed ESMM project. The air emissions inventory was prepared for both types of pellets to be produced. The maximum value from either inventory for a given pollutant was used in air dispersion modeling assessments.

Table 3-1. Capacity Differences between the Original MSI Project and Proposed ESMM Project

Unit Operation	Type of Pellet	Original MSI Project Capacity (million m.t. per year)	Proposed ESMM Project Capacity (million m.t. per year)
Taconite Pelletizing Furnace	Low Flux (DRI feed grade)	3.8[1]	7.0[3, 5]
Taconite Pelletizing Furnace	High Flux (blast furnace grade)	0	6.5[4, 5]
Two DRI Modules	Not applicable	2.8[2]	2.8
Steel Making	Not applicable	2.5[6]	2.5[6]

[1] Pelletizing air emission calculations included a 10% safety factor to account for the level of detailed engineering that existed at the time of permitting. Actual capacity used for air emission calculations was 4.1 million metric tons (m.t.) per year

[2] For the original MSI FEIS and Air Permit #06100067, the capacity of the DRI modules was described as 2.8 million m.t. per year. However, the MSI air emissions inventory inadvertently used a value of 3.5 million m.t. per year plus a 10 percent safety factor which equates to 3.85 million m.t. per year. The Essar emission inventory corrects this throughput and uses the capacity of 2.8 million m.t. plus a 10 percent safety factor or 3.08 million m.t. per year in the air emission calculations. The 10 percent safety factor is maintained for the DRI calculations because Essar has not yet completed detailed design engineering of this process.

[3] Essar will make Low Flux, otherwise known as DRI feed grade pellets for on-site steel making or for sale on the open market. The quantity of this type of pellet to be produced on an annual basis will depend on internal manufacturing needs and on market conditions.

[4] Essar will make High Flux, otherwise known as DRI or Blast Furnace grade feed, pellets for Essar Steel Algoma or for sale on the open market. The quantity of this type of pellet to be produced on an annual basis will depend on internal manufacturing needs and on market conditions.

[5] An air emission inventory was prepared for both types of pellets to be produced. The maximum value from either inventory for a given pollutant was used in air dispersion modeling assessments.

[6] Steel making capacity includes a 10 percent safety factor because Essar has not yet started detailed engineering of this process.

The proposed action modifies the indurating furnace where taconite (oxide) pellets are produced. The DRI process is separate from the indurating furnace. The oxide pellets would be transported to an off-site blast furnace or on-site DRI process. In the DRI process the oxide pellets are converted to DRI pellets. There would be no modifications to the DRI process or the steel mill that were approved through the MSI FEIS and issued permits.

The existing Permit to Mine was signed August 22, 2007 and is available from the MNDNR, Division of Land and Minerals, Hibbing office. An application for amendment to the existing Permit to Mine was submitted to the MNDNR for consideration on September 24, 2010 (Barr Engineering 2010a). The overall mine pit, stockpile, and tailings basin locations and proposed amendments are shown on SEIS Figure 3-1 as well as within the amended Permit to Mine application. The mine pits (mine area) include areas previously referred to as Pit 5, Pit 6, and Draper Annex Pit. Information presented below on mining, waste rock, tailings, crusher, and pellet plant operations is based on the details provided to MNDNR for consideration of an amended Permit to Mine. Essar has determined that 322 million long tons of ore are available, in contrast to the 234 million long tons identified in the MSI Permit to Mine amendment application.

With regard to analysis of the indurating furnace, the MSI FEIS and Air Permit #06100067 described the throughput of the taconite pellet plant as 3.8 million m.t. per year. The MSI air emissions inventory used the 3.8 million m.t. per year capacity plus a 10 percent "safety factor" for air emission calculations on the indurating furnace, which equates to 4.1 million m.t. per year. For original project development, MSI added a 10 percent "safety factor" for capacity to take into consideration the level of design detail that existed at that time (see Footnote 2 in Table 3-1). With the additional indurating furnace design for the proposed ESMM project, the calculations are more certain so the 10 percent safety factor has been dropped from the air emission calculations for the indurating furnace. The amended air permit application includes revisions to the air emission limits for DRI sources that correspond to the corrected values in the Essar air emissions inventory.

With regard to analysis of the DRI process, Essar is not proposing any change to the capacity of the DRI units as described in the MSI FEIS and Air Permit #06100067. However, the original MSI air emissions inventory contained a capacity error that has been corrected by Essar. In the original MSI FEIS and Air Permit #06100067, the capacity of the DRI units was described as 2.8 million m.t. per year. However, the MSI air emissions inventory inadvertently used a value of 3.5 million m.t. per year plus a 10 percent safety factor which equates to 3.85 million m.t. per year. The Essar emission inventory corrects this throughput and uses the capacity of 2.8 million m.t. plus a 10 percent safety factor or 3.08 million m.t. per year. The 10 percent safety factor is maintained for the DRI calculations (and the steel mill calculations) to allow for final decisions on detailed design engineering of these processes.

Essar proposes to produce taconite pellets for use in both a blast furnace as well as in the DRI process. High flux oxide pellets intended for use in a blast furnace for steel production would be shipped to Essar Steel Algoma in St. Ste. Marie Ontario, Canada or sold on the open market. Essar Steel Algoma currently receives most of the pellets from a taconite facility located in the Upper Peninsula of Michigan. Low flux oxide pellets would be produced for use in the DRI process and remain onsite. Once the low flux oxide pellets are converted to reduced iron pellets in the DRI process they would either be used onsite for production of steel or shipped and sold in the market. The number and type of pellets produced and either used onsite or shipped offsite would vary from year to year depending upon market demands. Initially before the DRI and steel plants are constructed taconite pellets would be shipped offsite. Once the DRI and steel mill are built a portion would be used as feed material to the DRI process and a portion might be shipped offsite. Once the DRI and steel mill are constructed Essar would produce slab and coil steel. These products would be shipped to various locations throughout the world depending upon market demands.

The 15-year production schedule entails several mining phases based on an economic mine model and reserves within the current Pit 5 and proposed Pit 6 Permit to Mine limits. The mine plan targets an annual pellet production of 3.8 mmtpy for the first 2 years, increasing to 6.5/7.0 mmtpy until the reserves are depleted within Pits 5 and 6. It is anticipated that there are enough reserves for the proposed 15-year production period. The mine phases have been defined as follows:

Pre-Production Phase (year 0): Includes stripping and stockpile development that must take place to access production ore, but before plant commissioning. Expected duration of this period is 18 months. Overburden stripping will be prevalent, but some waste rock stripping may be required to expose the upper benches of the ore. While not targeted in the Pre-Production Phase, any quantifiable pre-production ore that is found within the waste rock materials will be stockpiled at the primary crusher site.

Phase I (years 1 - 5): These first five production years have been planned annually starting from plant commissioning. In these years, approximately 92 million long tons of ore would be mined in the northern areas of the mine pit (near outcrop at low stripping ratios), in-pit stockpile locations will be developed on the ore body footwall, and Pit 5 water transfer (dewatering) is planned to be converted to maintenance dewatering of the active mining sump. A blend of both glacial till and waste rock stripping is expected as the mine is opened up to Permit to Mine limits.

Phase II (years 6 – 10): In Phase II, which is described as production years 6-10 after plant commissioning, mining will continue down dip and the lower ore benches will be developed in the mine pit, including the ore that is currently under water in Pit 5. Glacial till stripping will gradually be phased out as the final pit limits are reached in the upper benches to the south. Waste rock stripping will be most prevalent, with glacial till becoming exhausted within the mining boundary. Approximately 113 million long tons of ore would be mined during Phase II.

Phase III (years 11 – 15): In Phase III, which is described as production years 11-15 after plant commissioning, mining will continue down dip in the mine pit to the lowest benches and final limits as shown in the permit boundary. Very little stripping, either waste rock or glacial till, is expected in this phase, as most above formation waste would have been removed prior to exposing these ores. Approximately 118 million long tons of ore would be mined during Phase III.

It should be noted that mine operations are scheduled to begin before the mineral processing facilities are operational. It is expected that the Pre-Production phase will be 18 months in duration; therefore permit years may begin ahead of production years by six months or so. In addition, mine development and ore processing schedules are estimates only, and both will vary based on a variety of factors.

A review of the mine operation will occur around production year 10 or 11 to evaluate the feasibility of operating the mine beyond 15 years. If more production is intended, then environmental review and permits would need to be supplemented, and the Permit to Mine and production permits would need to be reviewed and updated to reflect a revised plan.

The remainder of this chapter describes the activities proposed for achieving the increased pellet production through mining and furnace operations, including integrated energy efficiency and pollutant reduction features.

3.2.1 Mining

Since the 2007 acquisition of MSI, Essar has developed a detailed mine plan for the first 15 years that is subject to environmental review in this SEIS. Mine planning activities have included:

- Evaluation of 240-short ton trucks for hauling of ore, waste rock and overburden;
- Certification of iron ore reserves to Canadian and US standards;
- Quantitative analysis and "pot-grate" testing of iron ore samples for use in mine planning and process design; and
- Optimization of haul road placement and length to minimize haul distances.

The proposed ESMM project would obtain its magnetic taconite ore from a horizon within the Lower Cherty of the Biwabik Iron Formation. The inferred ore reserves at the project site are currently estimated at about 1.4 billion long tons. The amount of ore to be mined within the 15-year production period is 322 million long tons. The taconite ore of the Biwabik Iron Formation would be mined by open-pit methods within the area authorized under the existing MSI Permit to Mine. Initially, mining would begin in the north central portion of the pit and eventually would be expanded in all directions including within the existing Pit 5 and Draper Annex Pit.

After overburden is removed, waste rock and taconite ore would be drilled, blasted, and loaded into 240-short ton mine trucks by diesel-hydraulic shovels (Table 3-2). The raw ore would be trucked to the primary crusher. Waste rock would either be used to construct dikes and haul roads or placed in waste rock stockpiles. As mining continues, reclamation of the overburden slopes and stockpiles would be completed according to MNDNR mine land reclamation requirements in the existing MSI Permit to Mine. The proposed ESMM project would utilize haul roads to transport overburden and waste rock to the stockpile areas and taconite ore from the mine to the crusher.

Table 3-2. Mining and Tailings Operations Equipment

Equipment	Original MSI Project (FEIS Section 4.10.2.1)	Proposed ESMM Project (Year 5 quantities)
Haul Trucks	9 - 200-short ton trucks	8 - 240-short ton trucks
Shovels	3	4
Loaders	1	3
Grader	Not provided	2
Dozers	Not provided	4
Blasthole drill	Not provided	3
Sand & Water truck	Not provided	2

The original MSI FEIS provided noise analysis based upon actual performance data from 240-ton haul trucks in use at the ArcelorMittal Minorca mine site compared to manufacturer data for the 240-ton Caterpillar CAT 793C (similar to the proposed ESMM haul trucks). The former data showed louder noise levels, and this was applied as a 'worst case' scenario to the original MSI project. The proposed ESMM project mine and road system configuration would be different from the original MSI project. However, the configuration modifications do not affect the 'worst case' scenario source-receptor pairings as modeled for the original MSI project (MSI FEIS Figure 4.101).

The haul road system was modified to achieve higher energy and cost efficiencies. Some would follow routes previously used by Butler taconite, some would follow routes previously permitted in the MSI project, and some would be new (i.e. not previously permitted). Some of the haul roads previously permitted in the MSI project would not be used as some haul road routing has changed with the ESMM mine plan. Existing mine pit and inter-pit haul roads would be used as much as possible. As the mine pits are expanded and eventually depleted of mineral reserves, in-pit stockpiling would be used to the maximum extent possible to minimize the transport of material. This would occur in Pits 5 and 6 (the proposed combination pit) after depletion of ore and satisfying mineral lease requirements. The use of 240-short ton trucks, transport-optimized haul routes and in-pit stockpiling would result in a slight reduction in total vehicle miles traveled (VMT) compared to the original MSI project. The VMT per unit of material mined would be reduced compared to the original MSI project, along with air pollutant emissions (refer to Chapter 4.2 comparing air pollutant emissions for VMTs).

For publically held companies, a 20- to 25-year mine production period is typically used for mine financing and mine planning; however, the time period may be set by the project proposer. Although a 20-year mine plan time period was used by MSI, Essar proposes to reduce this mine plan time period to 15 years. The reduction in mine plan time period would allow Essar to maintain essentially the same mine area boundary (refer to Figure 3-1) and thus avoid any new direct or indirect wetland impacts. If additional mining beyond the proposed 15-year mine production period is desired, it would be subject to Minnesota Rules, part 4410.2000, subpart 4 and Minnesota Rules, part 4410.3000, subpart 3. Mining operations beyond this 15-year time period would likely require additional environmental review and permitting depending upon the extent of the additional mining and regulations at that time.

3.2.2 Overburden and Waste Rock Management

Preserving mineral rights access in the proposed ESMM project is a primary consideration in overburden and waste rock management. No change to mineral ownership has occurred from the existing MSI Permit to Mine. There has been a change in surface ownership, which is addressed in the ESMM Permit to Mine amendment application. Ownership within the ESMM mine pit and stockpile areas is by several parties. This applies to both waste rock and ore. Mineral ownership impacts where stockpiles can be placed in two primary ways. First, mineral owners typically will not allow stockpiles to be located on top of known mineral reserves as removal of the stockpiles would significantly increase the cost of mining these reserves in the future. Secondly, the materials that are now considered waste rock or low grade ore may have more value in the future and become economically viable to recover the minerals from or to be used for some other purpose (i.e. aggregate). Therefore, mineral owners typically require waste rock and low grade ore that they own the rights for to be kept in separate stockpiles from material owned by other fee holders.

Overburden and waste rock would be stored in above-ground stockpiles and open pits, as permitted for the original MSI project. The stockpiles would be located in close proximity to the mine haul roads for Pit 5 and Pit 6, and to the crusher site. A stockpile location alternatives analysis was conducted and reported in the original MSI FEIS, and three locations were determined to be the preferred locations. These areas are designated as Stockpile Area A, Stockpile Area B, and Stockpile Area C (described in Section 3.3.3.2 and 4.6.1 of the MSI FEIS). These general stockpile footprints are proposed to be utilized for overburden and waste rock for the proposed ESMM project, although the boundaries are modified. The original and proposed boundaries are compared on Figure 3-1. No additional wetland impacts are caused by the modifications.

In addition to above-ground stockpiling, in-pit stockpiling was considered for waste rock, and reported in Section 3.3.3.2 of the original MSI FEIS and subsequent Permit to Mine. In-pit stockpiling was re-evaluated for the proposed ESMM project. In-pit stockpiling would be used to the maximum extent feasible for the combined Pit 5/6 in areas where the mine has reached the footwall of the ore body, and there are no viable mineral values at lower elevations. In the original MSI FEIS and Permit to Mine, the extent to which in-pit stockpiling could be used could not be determined because of the complex issues associated with mineral rights and the lack of adequate available in-pit volume in the first few years of mine operation. Therefore, in order to estimate the maximum potential impacts associated with the stockpiles, the stockpiles were sized assuming that no in-pit stockpiling would occur. The re-evaluation of in-pit stockpiling provided an estimate of the extent of waste rock storage. Estimated quantities of overburden and waste rock generation were not included in the MSI FEIS, but were provided in Table 7-2 of the June 6, 2007 Permit to Mine Application. For the original MSI project, it was estimated that with a 0.35 stripping ratio, on an annual basis there would be approximately 80.9 million long tons (82.2 million metric tons, mmt) of waste (overburden and waste rock) generated for the life of the project. Therefore, stockpile capacities were designed to hold approximately 80.9 million long tons of material (Table 3-3).

In estimating waste rock generation for the proposed ESMM project, the average stripping ratio of 0.47 was used. The changed stripping ratio was based upon combining Pits 5 and 6 into one pit. The proposed pellet production rate of 4.1 mmt or 4.03 million long tons (mlt) per year (py) for two years and 6.5 mmtpy (6.4 mlt) high flux pellets for the remaining 13 years would generate approximately 154 mmt (151.6 mlt) of waste rock and overburden over 15 years (7.0 mmtpy (6.9 mlt) low flux pellets estimates vary). This would result in approximately 70.7 mlt (71.8 mmt) of excess material for stockpiling over what was provided in the original MSI project. It should be noted that there is no difference in waste rock generation due to the pellet type. Essar has modified the above-ground stockpile capacity for some of this excess material, but also plans to utilize the capacity available for in-pit stockpiling. More detailed mine planning by Essar has refined the stockpiling plan to utilize the general footprint of stockpile areas A, B, and C for the first five production years, giving time for the in-pit stockpiling areas of the mine area to be prepared. From that time forward in-pit stockpiling would be used to the maximum extent feasible to minimize haul distances. Operational flexibility to use above-ground stockpile areas would be necessary for stockpile segregation as determined by mineral ownership. Summing the capacity in above-ground Stockpile Areas A, B, and C and in-pit stockpile volume, the overburden and waste rock storage would be adequate for the proposed ESMM project. Stockpile reclamation would be completed in accordance with the Minnesota Rules, part 6130.2400, 6130.2500, 6130.2700, and 6130.3600, as described in MSI FEIS Section 6.15.3.

Table 3-3. Waste Rock and Overburden Generation and Storage Sites

	Original MSI for Life of Project (data from Permit to Mine)	Proposed ESMM for Life of Project
Stripping Ratio	0.35	0.47
Waste Rock & Overburden Generated (mlt)	80.9	151.6
Waste Storage Sites (mlt)	80.9 (Stockpile Areas A, B, C)	119.9 (above-ground), 31.7 (in-pit)

3.2.3 Crusher and Pellet Plant Operations

3.2.3.1 Crusher and Pellet Plant Building Orientation

In October 2008, Essar initiated geotechnical soil investigations of the project site at the location of the process equipment and buildings. The results showed a significant amount of bedrock below the concentrator and pellet plant facilities. To minimize the rock blasting quantity and make use of the natural topography, Essar has proposed to slightly shift the building orientations. Changes to building orientations result in changes to stack positions.

3.2.3.2 Crusher and Pellet Plant Process Materials and Equipment

A long list of items utilized in the crusher and pellet plant operations were inventoried and compared between the original MSI and proposed ESMM projects. Energy use analysis and emission estimates are reported on an annual or short term basis (24-hr, 1-hr, etc) in Chapter 4.2, and take into account items listed in Table 3-4. The increased numbers of some process items have been evaluated and accounted for in terms of energy efficiency and pollutants. Changes in stack locations are accounted for in the modeling "true-ups" completed for the existing air permit.

Table 3-4. Crusher and Pellet Plant Process Materials and Equipment

Item No.	Process Item	Original MSI	Proposed ESMM
CRUSHING			
1	Primary Crusher	1	1
2	Scalping Grizzly	1	1
3	Secondary Screens	3	4
4	Secondary Crushers	3	4
5	Dry Cobbers	3	4
6	Coarse Ore Storage	For 2 mill feed conveyor	For 3 mill feed conveyor
7	Fine Ore Storage	For 2 mill feed conveyor	For 3 mill feed conveyor
CONCENTRATING			
1	Autogenous Mills	2	3
2	Rougher Magnetic Separator	18	27
3	Cyclone Units	2	3
4	Ball Mills	2	3
5	Primary Screens	24	36
6	Finisher Magnetic Separator	10	15
7	Fines Screens	30	45
8	Concentrate Hydro-separators	2	3
9	Tailings Hydro-separators	2	3
10	Concentrate Thickener	2	2
11	Concentrate Pumps	6	6 with higher capacity
12	Concentrate Line To Pellet Plant	8" diameter pipe	10″ diameter pipe
13	Tailings Thickener	2	2
14	Tailings Pumps	7 Working + 7 Standby	7 Working + 7 Standby with higher capacity
15	Two Tailings Pipe Lines To Tailings Basin	20" diameter pipe	24″ diameter pipe
PELLET PLANT			
1	Slurry Tanks	1	2
2	Ceramic Filters	4	7
3	Filter Cake Stockpile	25,000 tons for emergency use	25,000 tons for emergency use
4	Mixers	1	1
5	Balling Disc	7	14
6	Single Deck Roller	7	14

Item No.	Process Item	Original MSI	Proposed ESMM
	Screens		
7	Double Deck Roller Screens	1	1
8	Induration Furnace	1 464 m2	1 744 m2
9	Air Pollution Control For Induration Area	1 Single-stage system	1 Multi-stage system
10	Hearth Layer Separation Bin	1	1
11	Product Pellets Conveyor	1	1
12	Pellet Bunker House	1	1
13	Wagon Loading System	1	1

3.2.3.3 Indurating Furnace and Nitrogen Oxide Reduction Technology

The proposed project modifies the indurating furnace and the integrated technology design for reducing potential nitrogen oxides (NO_x) air pollution emissions. After acquisition of MSI, Essar initiated an assessment to determine how best to fully incorporate the original MSI project into its existing and planned pellet and steel making assets. Prior to purchasing MSI, Essar had completed all detailed designs for a number of pellet plants to be built in India and other locations. The design basis for these pellet plants includes a standardized indurating furnace dimension of 744 m^2. Thus the proposed ESMM project would have a larger indurating furnace at the pellet plant compared to the 464 m^2 furnace in the original MSI project.

3.2.4 Tailings Management

The original MSI project and proposed ESMM project would use the same tailings basin and slurry pumping. As in the original MSI project, the proposed ESMM project would have no surface water discharge. Pit 5 and Draper Annex Pit will have on-going maintenance dewatering and will be subject to NPDES/SDS permit requirements once mining activities begin. No process wastewater is discharged to the tailings basin. The only water entering the tailings basin is from precipitation and the water used to convey tailings to the basin from the concentrator.

As described in the MSI FEIS Section 3.1.2, tailings would be pumped in slurry form via pipeline to the tailings basin. The tailings basin is located on top of an existing tailings basin that was used by Butler Taconite. The tailings basin would be designed and constructed to meet the requirements of Minnesota Rules, part 6130.3000. The preliminary estimates for tailings for the original MSI project were an average production of 4.87 mltpy (4.95 mmtpy) for the first five years, with an increase to approximately 8.13 mltpy (8.26 mmtpy) for the remaining 15 years. This estimate would result in approximately 150 mlt (152 mlt) of tailings storage required (Table 3-5).

3.2.4.1 Revised Tailings Production Rate

Based on the increased production rates proposed by Essar, tailings production rates would be approximately 8.82 mltpy (8.976 mmtpy) generated during the first two years of production, increasing to 16.27 mltpy (16.53 mmtpy) in year 3 for the remaining 13 years. This would result in approximately 229.2 mlt (232.8 mmt) of tailings storage needed in the tailings basin or approximately 105,163 acre-feet. The proposed ESMM production rate increase and estimated operating rate of 88 percent, a tailings porosity of 42 percent, and an estimated dry density of 112 pounds per cubic foot, results in a tailings storage need of approximately 105,163 acre-feet. With the original MSI project, the required storage volume was 68,642 acre-feet, so as a result of the increased production rate, there would be an increased storage need of approximately 36,521 acre-feet.

3.2.4.2 Tailings Dam and Height

The proposed ESMM project tailings basin footprint will cover approximately 1,600-1,690 acres, an increase from the MSI tailings basin which was estimated to cover 1,580 acres. The basin would not extend beyond areas previously considered for disturbance and would not result in additional wetland impacts or other land cover changes beyond those estimated for the original MSI project. The original MSI project Permit to Mine states that the basin was designed to accommodate 152 million metric tons of tailings storage; however, the basin design has been updated to hold the 233 million metric tons of tailings that will be generated over the new 15-year mine plan presented in the Permit to Mine Amendment. The proposed ESMM project will result in a change in the height of the tailings basin due to increased generation of tailings over the extent of the 15-year mine plan. The current Permit to Mine states that the tailing dams would be about 100 feet high and could continue to be raised to provide additional storage. For the proposed ESMM project and new 15-year mine plan, the tailings dams at the end of production year 15 are estimated to be between 110 and 160 feet high, depending on the deposited tailing slopes.

In *Technical Report Volume VII: Preliminary Tailings Basin Design* submitted with the MSI Permit to Mine Application (Barr Engineering 2010a), the stage-volume capacities for the tailings basin areas were estimated from elevation 1425 up to elevation 1600 to determine the preliminary dam elevation range of the tailings basin required to store the estimated tailings produced for the 20-year life. The estimated dam elevations for a 20-year design life ranged from elevation 1510 on the north side of the basin to about elevation 1475 on the south side of the tailings basin.

Dam elevations estimates for the proposed ESMM project range between 1545 to 1590 feet at year 15. This results in a height of the tailings basin that would be about 110 to 160 feet above the current elevations. The area where the tailings basin is located is not flat so there is a range in the change in height of the dams above the current elevation.

In *Technical Report Volume VII: Preliminary Tailings Basin Design* (Barr Engineering 2010a), the preliminary basin was estimated at 1,349 acres and the reclaim pond was estimated at 231 acres for a total basin area of 1,580 acres. Detailed engineering design currently underway has resulted in a revised basin area (including reclaim pond) of approximately 1,600 acres. Potential future dam buttresses and infrastructure may cause an increase in footprint up to, but not exceeding 1,690 acres. The ESMM Permit to Mine will provide the final approved acreage, and all future increases would require an amendment to the Permit to Mine. The footprint differs from the preliminary design but results in no additional direct wetland impacts or land cover changes analyzed in the MSI FEIS.

As a result of the increased tailings production, modifications to tailings basin construction staging were evaluated. The revised production rates would result in approximately 4,051 acre-feet of tailings in the first two years and 7,466 acre-feet for the following 13 years. Essar proposes to vary the configuration of the basin dams or revise operations on placement timing due to the increased rate of deposition after year 2. Development of the tailings basin would be based on upstream deposition, as described in the MSI FEIS Section 4.6.2.1, so the total footprint of the basin would not change over time. As required for the Dam Safety Permit, an instrumentation monitoring plan has been developed to monitor seepage and dam stability throughout the life of the basin.

Construction methods of the tailings basin would be the same as previously described in the MSI FEIS Section 4.6.2.1. Initially, the starter dams would be constructed around the existing perimeter of the basin. As mining begins and tailings are discharged into the basin, the dams would be constructed using the upstream construction method with a perimeter pipeline constructed around the basin. The dam construction would be staged over time. Some areas in the tailings basin would need to be raised and some would need flow rerouted with construction of weirs throughout the life of the operation. Detailed information on the proposed construction, typical cross sections, stability analysis and phasing has been submitted with the ESMM Permit to Mine amendment application. Table 3-5 summarizes tailings basin data available for the SEIS. The quantities shown may be subject to change in accordance with the review and approval of the permit amendment application.

Table 3-5. Tailings Generation and Tailings Basin Dimensions

	Original MSI (data from Permit to Mine)	Proposed ESMM
Tailings per Year (million long tons)	4.87 (for 5 years) 8.13 (for 15 years)	8.82 (for 2 years) 16.27 (for 13 years)
Tailings for Project (million long tons)	150	229.1
Tailings Volume in acre-feet per annum (and total)	2,300 (for 5 years) 3,800 (for 15 years) (68,642 total)	4,051 (for 2 years) 7,466 (for 13 years) (105,163 total)
Tailings Basin Designed Storage Capacity (million long tons)	150	229.1
Tailings Basin Design Volume (in acre-feet for evaluating height)	68,642	105,163
Tailings Basin Area (acres)	1,349 for the basin, 1,580 acres with the reclaim pond	1,600 acres (total area, including reclaim basin); up to 1,690 acres for potential future needs
Tailings Dam Elevation (feet)	1475-1510 (40-75 feet above baseline elevation) year 20	1545-1590 (110-160 feet above baseline elevation) year 15

3.2.4.3 Tailings Basin Reclamation

There would be no change in the reclamation methodology from the MSI FEIS. Reclamation of the tailings basin areas (including the basin, dikes and dams) would be carried out incrementally as areas are no longer scheduled to be disturbed. The establishment of vegetation would be initiated during the next normal growing season. Slopes would be graded as necessary, seeded and mulched. All vegetation would meet the requirements of Minnesota Rules 6130.3600. Vegetative reference areas for the tailings basin were identified in the MSI FEIS Sections 4.6.2.1, 4.6.2.2 and 6.15.2 in adjacent areas and remain valid for the stockpile and pit areas. The tailings basin vegetative reference area is being modified to a previously identified site with the MNDNR.

3.2.4.4 Lateral Seepage Collection System

The seepage collection system was designed to satisfy permit requirements, which specified that the design of the seepage collection systems for the tailings basin be in compliance with NPDES/SDS Permit MN0068241. This permit requires that all visible seepage water be collected and returned to the tailings basin, creating a zero surface water discharge facility. The seepage collection system constructed around the tailings basin must be capable of collecting seepage and precipitation up to the design event and conveying it to the crest of the dam where it will flow back into the basin. The final plans and specifications for the seepage collection system would be submitted to the MPCA 60 days prior to construction as required by the NPDES/SDS Permit MN0068241.

The seepage collection system will be constructed along the toe of the exterior dams and will return collected seepage back into the tailings basin (approximately 2,000 gpm). This system includes a network of ditches and pipes along the toe of the embankment; it will not collect deep seepage lost to groundwater through the bottom of the tailings basin.

3.2.5 Solid and Hazardous Waste Generation

The waste generation identified in the original MSI FEIS has been compared to the proposed ESMM project. The proposed ESMM project is different from the original MSI project in generation rates of some items in the waste stream (refer to Appendix A). The differences in waste generation would be related to changes in production rates for the crusher/concentrator and taconite pellet plant operations. Neither the DRI process nor the steel mill waste generation rates would change, as those facilities would not change from the original MSI to the proposed ESMM project.

The proposed methods of disposal would not differ from the original MSI project. Fugitive dust missions, emission control dust, and slag are part of the solid waste stream being evaluated for air pollutant effects in Chapter 4.2. Other wastes would be addressed according to state statutory requirements such as those applicable to storage tanks and hazardous waste generation (see Table 2-1).

Like MSI, Essar proposes to incorporate the concept of reduce, reuse and recycle into its project.

3.2.6 Energy Management

Essar plans to integrate energy management into the operational design of the proposed ESMM project. Proposed ESMM project energy management considerations were used in the development of the greenhouse gas (GHG) emission inventory and carbon footprint following MPCA and DNR guidance which rely heavily on The Climate Registry (TCR) General Reporting Protocol (GRP).

The majority of energy consumed would be as electricity and fuel used in process equipment. The remainder of the energy consumed would be building heat, lighting, mobile equipment fuel, and similar uses. Essar has selected natural gas as a process fuel, as an approach to reducing stationary combustion and greenhouse gas emissions. Natural gas usage results in lower emissions of SO_2, CO, PM, VOCs, GHGs, metals (including mercury) and other hazardous air pollutants (excluding NO_x) based on stack tests, CEMS and AP-42 test data compared to the use of coal and other fossil fuels.

Operations and items evaluated in energy planning are listed below. Details on comparative analysis of GHG emissions of operations are provided in Appendix B. The reporting of GHG emissions is discussed in Chapter 4.2; assessment with respect to climate change is discussed in Chapter 5.4.

3.2.6.1 Operations Analyzed for Energy Efficiency

- Haul truck size
- Dry cobbing of crude ore
- Autogenous grinding and elimination of steel balls from SAG grinding
- Use of hydraulic AG mill trommel
- Use of screen to replace the cyclone in the primary screening circuit
- Maximizing gravity flow to transport through crushing/grinding/concentration circuits
- Filtration using ceramic filters
- Use of Hytemp system to charge hot DRI pellets to steel mill.
- Furnace fuel source
- Electric power provider
- Fuel Shipping

3.2.6.2 Other items under evaluation for energy efficiencies

- Mixing using vertical mixes instead of horizontal mixes.
- Running greenball production using a balling disc instead of a balling drum.

3.2.7 Water Management

Chapter 4.1 describes how various proposed project processes have led to modifications in the water and chemical balances used to predict the quantity and quality of water associated with the proposed ESMM project. The water quantity needs for the proposed ESMM project are satisfied according to the existing Water Appropriation Permit 2006-0433. This permit allows appropriations from Pits 1 and 2 (see location on Figure 3-1) not to exceed 7,000 gpm or 3,679 million gallons per year. The maximum appropriation under normal climatic conditions that would be required from Pits 1 and 2 from precipitation and existing storage under Phase 1 of the DRI plant and steel mill would be approximately 3,588 gpm (without stream augmentation). After Phase 2 begins in year 10, this appropriation requirement would be approximately 4,161 gpm prior to stream augmentation. Therefore, no additional water appropriations are needed over those currently permitted.

As part of the existing Water Appropriation Permit 2006-0433, a Stream Augmentation Plan must be submitted for Oxhide and Snowball Creek at least one year prior to the completion of the water transfer from Pit 5 and the Draper Annex Pit, respectively. This Stream Augmentation Plan must comply with the recommended augmentation strategy described in the MSI FEIS. Based on this water balance analysis, adequate water sources will still be available to meet the requirements necessary for stream augmentation as described in the FEIS from Pits 1 and 2 and the Hill Annex Pit, if required.

As in the original MSI project, the proposed ESMM project would have no surface water discharge. Pit 5 and Draper Annex Pit would have on-going maintenance dewatering and will be subject to NPDES/SDS permit requirements once mining activities begin. Process wastewater would be reused onsite or treated by the water recovery and reuse system (WRRS). No process wastewater is discharged to the tailings basin. The water and chemical balance includes an analysis of deeper groundwater seepage associated with the tailings basin (Barr Engineering 2010b). The re-evaluation used more detailed data, and the results led to a revision from the previously calculated seepage value of 758 gpm for the original MSI project to a much lower deep seepage value of 199 gpm for the proposed ESMM project. Modeling results of deep seepage flow to Swan Lake indicate a 0.3 mg/L increase in sulfate concentration as compared to an increase of 3.3 mg/L under the original MSI project. Although the volume of make-up water needed for the concentrator has nearly doubled from the original MSI project water balance, the resultant change in concentrations is minimal, even with the increased rate of production.

3.3 AIR POLLUTION CONTROL TECHNOLOGY ALTERNATIVES

In accordance with the SEIS Preparation Notice, two technology alternatives were evaluated for the proposed ESMM project. The technologies for control of mercury emissions were examined and reported in detail in *Mercury Control Technology Evaluation, September 2010*, by Barr Engineering. The findings are summarized in Section 3.3.1. A second technology alternatives analysis was undertaken to re-evaluate the best available control technology (BACT) for criteria pollutants whose emissions are estimated to increase in amounts greater than the significant increase thresholds. The BACT technology assessment findings are summarized in Section 3.3.2.

Projected potential pollutant emission rates and dispersion modeling results reported in Chapter 4.2 include the effect of control technologies and methods committed to in the MSI FEIS and included in the original MSI project air quality permit. Two principal differences from the original MSI project air quality permit are: 1) adding activated carbon injection to the furnace exhaust system to reduce mercury emissions, and 2) the new indurating furnace design which incorporates inherent low-emitting NOx technologies. These are discussed below.

3.3.1 Emission Control Technology for Mercury

The proposed ESMM project indurating furnace would require mercury emissions control technology. In October 2009 the Minnesota Pollution Control Agency (MPCA) adopted a statewide mercury total maximum daily load (TMDL) which includes guidance for new and expanding sources of mercury emissions. One of the requirements of the TMDL is that new or expanding sources of mercury emissions install best available controls. A technical report, Mercury Control Technology Evaluation, was prepared to evaluate alternatives, and the proposed selection of activated carbon injection on the indurating furnace is described here (Barr Engineering 2010d).

The mercury control technologies are classified into categories of availability:

- commercially available and potentially viable,
- emerging technologies, and
- research and development stages.

The alternatives evaluation examined the technical feasibility of each available mercury control technology and the list was reduced to those that could be considered applicable to the proposed ESMM project furnace. The technologies identified as technically feasible were then evaluated for ability to control pollutants other than mercury and compatibility with the furnace design.

The majority of the published information reviewed in the study showed that research on mercury control technologies is based on coal-fired utility boilers. Data are not available on pilot or full scale mercury control technology installations associated with taconite facilities in Minnesota, Michigan or other areas of the world. The MNDNR has begun to conduct research on five mercury control technologies being used by other industries for applicability to taconite facilities, as part of long-term mercury reduction goals in the state. Activated carbon injection was recently approved for the Keetac facility as the first for a taconite plant.

Activated carbon injection is the mercury control technology being proposed by Essar to control mercury emissions from the indurating furnace. Consistent with MPCA guidance Essar used a BACT-like approach to evaluate alternative technologies compatible with the indurating furnace (Table 3-6).

Table 3-6. Alternative Emission Control Technologies for Mercury

Technology	Name
Fuel-Related Activities	Clean Fuels
Traditional Air Pollution Control Devices (APCD)	Dry System
	Wet System
Carbon Capture	Activated Carbon Injection (ACI)
	Carbon Beds
Metal Catalyst	Selective Catalytic Reduction (SCR)
Multipollutant Controls	Lo-TO_x
	Regenerative Activated Coke

Activated carbon injection technology has not been demonstrated on a taconite furnace by Essar. Activated carbon would be expected to provide a reduction in mercury emissions of 50 to 80%. According to the MNDNR investigations currently occurring, data from taconite plants employing the kind of straight grate pollution control system included in the proposed ESMM project and potentially involving different concentrations of reactive components indicate mercury removal efficiency may be as low as 10 percent.

3.3.2 BACT for Criteria Pollutants

The report, *Air Pollution Control Alternatives Analysis*, *November 2010* by Barr Engineering was prepared to address part of the BACT requirements The report reviews technologies for particulate matter (PM, PM_{10}, and $PM_{2.5}$), fluoride, lead, sulfur dioxide, carbon monoxide, volatile organic compounds, nitrogen oxides (NO_x), and greenhouse gas (GHG) emissions. The details on the proposed NO_x emission reduction technology are summarized below. The GHG technologies are summarized in Chapter 5.4, Cumulative Climate Change. Additional air pollution control measures are reported in Section 4.2.3.3.1 of Chapter 4.2, including the use of a dry scrubber for control of SO2, and a baghouse for control of PM, PM10, and PM2.5 emissions from the taconite indurating furnace.

Nitrogen Oxide Reduction Technology for Indurating Furnace

NO_x would be an air pollutant emitted from the indurating furnace. Emissions controls were analyzed for compatibility with the 744 m2 furnace being proposed. This a larger indurating furnace at the pellet plant compared to the 464 m2 (4 meters wide by 110 meters long) furnace in the original MSI project. Aker Metals Inc. (Aker), the technology supplier for the indurating furnace, and Fives (pronounced feeves) North American Combustion (Fives NA), the natural gas burner designers, were engaged by Essar to study a gas burner technology intended to be in compliance with federal and state NO_x emission standards at maximum and reduced (turn down) pellet-making capacities. This "Low NO_x Study" evaluated an application of ultra low NO_x natural gas burners (low NO_x LE burners) in a custom-designed combustion chamber for an iron ore pellet plant indurating furnace. The Low NO_x option was compared to a standard traveling grate furnace that uses inspirating natural gas burners. Inspirating natural gas burners are the type typically in use at most straight grate indurating furnaces currently in operation and were the basis of uncontrolled NO_x emission rates in the MSI FEIS and air permit application. In summary the Low NO_x Study included the following:

- Summary of relevant experience, data, and references for similar applications,
- Numerical simulation using Computational Fluid Dynamics (CFD) for a standard inspirating burner and the low NO_x LE burner,
- Evaluation of other technical information to compare to the estimated CFD NO_x emission rates associated with providing process gas at approximately 2400 °F to feed into the iron ore bed,
- Bench scale testing of both a standard inspirating burner and the Low NO_x LE Burner,
- Estimated fuel usage and oxidant (i.e. air) flows,
- Preliminary drawings showing overall combustion system arrangement and dimensions, and
- Summary of technical options evaluation, technical data, and calculations.

Initial discussions with Aker indicated that constraints of >70% NO_x reduction with a fuel penalty of no greater than 30% were required to make the application of Low NO_x LE Burners on this project viable. Concluding the engineering analysis, Aker and Fives NA were able to report that both these constraints could be readily achieved for the proposed 744 m^2 indurating furnace operating for low flux (7.0 mmtpy) and high flux (6.5 mmtpy) pellets at a full or turndown production rate. The study results point to an opportunity to reduce NO_x emissions from the indurating furnace at the source (see Illustration 3.1) and thereby potentially eliminate the need for add-on NO_x emission controls on the exhaust stacks. To further evaluate the viability of this promising burner technology, a quarter (¼) scale trial of the Fives Low NO_x LE gas burner system would be completed prior to startup of the indurating furnace.

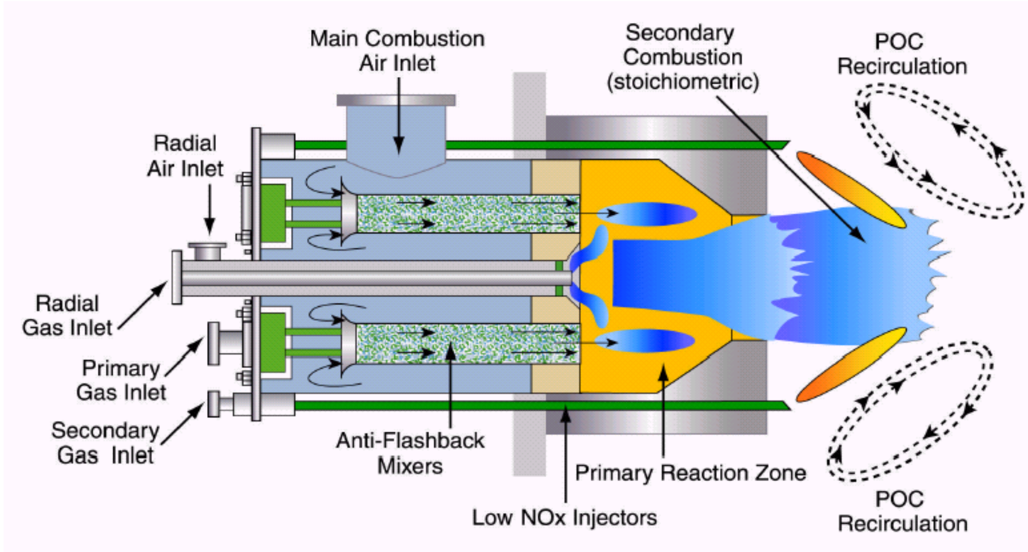


Illustration 3-1. Proposed Indurating Furnace Schematic Showing Low NO_x Emission Technology.

Essar has prepared the alternative analysis report cited above and is preparing the complete BACT analysis required for the Air Permit amendment application.

The Air Pollution Control (APC) Alternatives Report addressed the first 3 steps and part of the 4th step in the 5 Step BACT Process:

- Step 1 – Identify All Control Technologies
- Step 2 – Eliminate Technically Infeasible Options
- Step 3 – Rank Remaining Control Technologies by Control Effectiveness
- Step 4 – Evaluate Most Effective Control Technologies and Document Results

In Step 3 each technology was ranked based on its control efficiency or expected controlled emission rate. This provided the information for an understanding of the alternatives available and the degree of mitigation that each would provide. Step 4 of the BACT process evaluates the top ranking technologies with respect to other environmental impacts and in some cases cost effectiveness if the top ranking control technology is not selected. The other significant environmental impacts were identified in the last section of the APC alternatives report. However, no economic analyses were conducted because Essar was still obtaining from vendors the final technical and cost information. The economic analyses which is part of Step 4 of the BACT process is only required if a project proposer wishes to rule out a control technology in a final permit based on cost effectiveness (e.g. $/ton removed).

The BACT report being prepared for air permitting addresses the remainder of Step 4 and Step 5 (select BACT) that are not covered in the APC Report. Step 5 involves a final pollution control technology selection and details regarding permit limits, compliance demonstration methods, and recordkeeping and reporting which are needed for the air permit application. The SEIS Preparation Notice identified that BACT alternatives analysis would be performed. The selection of BACT, a requirement of permitting, is not a requirement of a state-only SEIS. However, the selection of BACT, a requirement of permitting, is not a requirement of a state-only SEIS. The BACT selection is therefore not included in this SEIS.

3.4 ALTERNATIVES CONSIDERED

In accordance with Minn. Rules part 4410.3000, subp. B(3), alternatives shall be evaluated and may exclude those that would not meet the underlying need for or purpose of the project; likely not have any significant environmental benefit compared to the project as proposed; or have another alternative, of any type, that will be analyzed and likely have similar environmental benefits, or similar environmental benefits but substantially less adverse economic, employment, or sociological impacts.

The MNDNR considered the following alternatives and project components of the proposed ESMM project in selecting alternatives to be evaluated in the SEIS.

- Air Pollution Control Technologies
- Alternative Mine Site and Plant Site
- Alternative Site(s) for the Additional Secondary Crusher and Concentrating Line
- Ore Processing Technology Alternatives
- Plant locations and onsite sanitary wastewater treatment systems (selective findings of MSI FEIS Section 3.3.3)
- Stockpiling Alternatives
- Crusher and Pellet Plant Location Alternatives
- Scale or Magnitude

Each of the above listed alternatives and project components are discussed below.

3.4.1 Air Pollution Control Technologies, Included in Supplemental Environmental Review

The proposed air pollution control technology alternatives included in this environmental review are described in Section 3.3.

3.4.2 Alternative Mine Site and Plant Site, Excluded from Supplemental Environmental Review

The original MSI FEIS addresses Alternative Sites in Section 3.3.1. Alternative sites were not evaluated in the MSI FEIS because they would not meet the underlying need for or purpose of the project. The rationale for this was that the "mineralization of the desired elements within the geologic deposit dictates the location of the mine." In a similar sense, MNDNR determined that an alternative processing plant site "would either not have significant environmental benefits over the current plant site or would not meet the underlying need and purpose of the project, which includes the integrated value-added process steps to produce steel."

The proposed ESMM project includes the addition of one or more components along the production line that allow for an overall increase in the rate of mining, crushing, concentrating, and resulting pellet production. Although the production increase realized through the proposed modifications would be substantial, there is little anticipated appreciable environmental benefit that would result from reconsideration of an alternative mine site because construction and land disturbance has already begun under the previously permitted action. The original MSI project justification that an alternative mine site would not meet the underlying need for the project, nor would an alternative processing plant site have significant environmental benefit over the current plant site, remain valid for the proposed ESMM project.

3.4.3 Alternative Site(s) for the Additional Secondary Crusher and Concentrating Line, Excluded from Supplemental Environmental Review

The proposed action includes addition of one secondary crusher and one concentrating line. The EQB "Guide to the Environmental Quality Board Rules" identifies additional factors that are to be considered regarding alternative sites. Because the proposed ESMM project involves additional components of a type and location already permitted, the MNDNR has identified only two questions relevant to this design feature. The response to the questions is described below.

Is the site where these features are to be located considered an integral component of the project or could they be built on other sites in the general area?

The proposed ESMM project would add the following process items:

one additional secondary crusher,

slightly larger fine and coarse ore storage,

one additional concentrating line,

additional filters and balling discs, and

longer indurating furnace.

These items are integral design elements to other features that would not be different from the original MSI project. Locating them at any other site or at any other location within the project boundary would not be feasible for efficiency of operations. This additional equipment would be located immediately adjacent to the equipment already permitted and planned for construction.

If the modifications project were not built, what is the likely use of the site and what environmental impacts would be associated with that use?

If the modifications to the project were not built, the use of the site would likely be according to the existing zoning. The City of Nashwauk accounts for a sizeable portion of the site, and currently has zoned the land for mining. Itasca County accounts for the remainder of the site, and currently has zoned the land for industrial purposes, including mining, except for small portions as farm and rural residential. Potential environmental impact would depend on the particular action proposed.

3.4.4 Ore Processing Technology Alternatives, Excluded from Supplemental Environmental Review

The original MSI FEIS noted that ore processing technology currently has two pellet induration processes that are commercially available (MSI EIS, Section 3.3.2.1.). The MSI EIS Scoping Decision committed the FEIS to present an evaluation of straight grate furnaces and grate kiln furnaces. Based on the results of the alternatives analysis, only the straight grate furnace was carried forward in the FEIS as part of the MSI Proposed Action. The MNDNR determined that the grate kiln furnace did not appear to have significant environmental benefit compared to the straight grate furnace.

The proposed ESMM project involves lengthening the originally proposed straight grate indurating furnace by an additional 76 meters. Thus the type of furnace technology would be the same as the original MSI project. Use of another type of furnace in conjunction with the existing line would not meet the underlying need and purpose of the project. In addition, the original MSI FEIS determined that application of a grate kiln furnace would likely not have any significant environmental benefit compared to the project as proposed. Therefore, the evaluation of ore processing technology alternatives is not justified for the proposed ESMM project.

3.4.5 Alternative Plant Locations and Onsite Sanitary Wastewater Treatment Systems, Excluded from Supplemental Environmental Review

The original MSI FEIS considered in Section 3.3.3 the alternative plant locations and onsite sanitary wastewater treatment systems. The resulting analyses provided the basis for selection of a proposed action that met the underlying need/purpose of the proposed MSI project as well as minimized potentially significant adverse environmental effects.

The proposed ESMM project does not appear to influence the environmental consequences associated with the plant location and onsite sanitary wastewater treatment systems. Given the modular nature of the proposed modifications at the site that is under construction, justification is present to support the conclusion that examination of other alternatives would not have any significant environmental benefit compared to the project as proposed.

3.4.6 Stockpiling Alternatives, Excluded from Supplemental Environmental Review

The original MSI FEIS included studies that addressed "development and evaluation of alternative designs and locations for stockpiles in an effort to provide substantial environmental benefits and/or substantial minimization of environmental impacts." The FEIS included development of an in-pit stockpiling conceptual plan that would not be implemented until year 10 of the project, and identified a number of factors that could potentially make this alternative not feasible.

The proposed ESMM project is based upon a review and modification of the original MSI project mine plan, and proposes to include in-pit stockpiling for waste rock storage. Essar considers the findings of the technical memorandum, Minnesota Steel FEIS – Stockpile Alternatives Development – FEIS Appendix I, still valid under the modified mine plan. Essar estimates that by increasing annual tonnage goals in the mine plan, mine development would allow for in-pit stockpiling sooner than originally anticipated (year 6 or 7, instead of year 10); seeMSI FEIS Section 3.3.3.2 and ESMM SEIS Section 3.2.2.

3.4.7 Crusher and Pellet Plant Location Alternatives, Excluded from Supplemental Review

Essar proposes that the location and orientation of the crusher and pellet plant would be modified from the original MSI project. The factors that support the proposed change in location and orientation of these project elements from the original MSI project configuration were considered in selecting and excluding alternatives for the ESMM SEIS. The determination of excluding alternatives to the crusher and pellet plant in the SEIS was made based upon whether adverse impacts that were not addressed with the original configurations would be possible. The original MSI project orientations of the major crushing, concentrating and pelletizing buildings were selected based on preliminary and limited geotechnical information developed to support development of conceptual engineering designs in support of the MSI environmental review process.

For detailed building and equipment engineering design proposed by Essar in late 2008, a substantial number of additional in-fill soil borings were evaluated to identify a more detailed profile of bedrock on which to place the foundations for the major buildings. The additional geotechnical information was the basis for the proposed shift in building locations that would allow for gravity flow of process streams in the concentrating area and proximity to bedrock for building foundations in the crushing, concentrating and pelletizing areas. By anchoring building foundations directly to bedrock, a more stable building foundation could be constructed to withstand the loads and vibrations associated with taconite processing. Also, by placing foundations on bedrock rather than a combination of soil and bedrock, the risk of uneven settlement would be reduced.

The building locations would be moved a few feet in most cases and remain well within the established project boundaries. The shifting of building locations also would shift building emission stack locations. Essar has submitted information to the MPCA to meet the requirements of Page A-6 "Ambient Air Modeling: Parameters Used in Modeling" of the original MSI project Title V Air Permit #06100067-003 for consideration. MPCA has reviewed and approved Essar's building shifts, and construction of currently permitted facilities is ongoing.

3.4.8 Scale or Magnitude Alternatives, Excluded from Supplemental Environmental Review

The original MSI FEIS determined that scale or magnitude alternatives were not supported for the project, principally because the infrastructure requirements to mine and process the ore "are such that alternative scale/magnitude would not meet the underlying need for or purpose of the project or would likely not have significant environmental benefit compared to the project as proposed." Given the nature of the proposed modifications for the ESMM project, the rationale from the original MSI FEIS appears to still be supported. The MNDNR has determined that such an alternative would not be evaluated in the SEIS.

3.5 INCORPORATION OF MITIGATION MEASURES IDENTIFIED THROUGH PUBLIC COMMENT

Public comments were accepted in accordance with publication of the Preparation Notice. Review of the public comments found no mitigation measures identified by the public.

4.1 Water Resources and Wild Rice

Chapter Summary:
This chapter addresses water resources and wild rice with respect to the proposed ESMM project. Existing hydrogeology, an updated water balance, updated water quality modeling, baseline water quality, and existing wild rice populations inform the potential environmental consequences of the proposed ESMM project.

Prior to the proposed ESMM project there would be Pits 1 and 2, Pit 5, and Draper Annex Pit transfer dewatering. During the proposed ESMM project there would be ongoing maintenance dewatering from Pit 5 and the Draper Annex Pits. Water would be used for stream augmentation from Pits 1 and 2 and the Hill Annex Pit. Initial mine pit dewatering would not affect downstream waters because this water would not have pollutants added by activities associated with the proposed ESMM project. The proposed ESMM project would provide the same augmentation of flows from the same proposed source waters as the original MSI project, and the original MSI FEIS evaluated augmentation water sources and impacts to public waters as a result of stream augmentation. Therefore, this SEIS does not address this issue. Based on the updated water balance, adequate water sources would still be available to meet the requirements necessary for stream augmentation.

Increased production, changes in the mine plan (i.e., pit and stockpile configurations), and design modifications of the facility operations have resulted in increases in overall water demand as compared to the original MSI project water balance. As a result, Pits 1 and 2 may be drawn down significantly by year 15, a change from the original MSI project.

As a result of mine plan modifications, groundwater inflows to Pit 5 and proposed Pit 6 were re-evaluated for the proposed ESMM project. The range of flows (2,250 gpm to 3,000 gpm) determined for the proposed ESMM project is anticipated to account for the increase in pit depth and area for combined Pit 5 and proposed Pit 6 and any uncertainties in the original MSI project estimate (2,250 gpm).

The tailings basin does not have a permitted surface water discharge. The deep groundwater seepage from the tailings basin, which is not captured by the lateral seepage collection system proposed along the toe of the exterior dams of the tailings basin, was re-estimated from the original MSI project based on site-specific geotechnical data, which was not available for the original MSI project. These data enabled two-dimensional seepage modeling on which a supplementary sensitivity analysis was conducted. The estimated deep seepage rate based on these new site-specific data and analyses resulted is a maximum (year 15) deep seepage rate of 199 gpm as compared to the maximum rate of 758 gpm estimated for the original MSI project.

Since the estimated deep seepage rate and water quality have changed as a result of the proposed ESMM project, an updated chemical balance was completed to evaluate the quality of tailings basin water and, therefore, deep seepage (Barr Engineering, 2010d). All tailings basin deep groundwater seepage is expected to ultimately reach Swan Lake. Seepage would flow initially to either Pickerel Creek, O'Brien Lake, or directly to Swan Lake (Figure 4.1-1). The updated chemical balance shows an increase in concentration of calcium, fluoride, and sodium compared to the original MSI project. The updated chemical balance shows a decrease in concentration of hardness, magnesium, nitrate + nitrite, phosphorus, sulfate, and total dissolved solids as compared to the original MSI project.

Tailings basin constituents data were then used to model the downstream water body effects, coupling the load and deep seepage values with Swan Lake nutrient data to estimate the incremental increase from the proposed ESMM project. Incremental Swan Lake sulfate concentration increases would be nearly an order of magnitude lower under the proposed ESMM project than under the original MSI project (values were predicted for varying lake outflow rates).

Based on 2010 sampling in Swan Lake, the average sulfate concentration for the main body of the lake, not including the Southwest Bay is 24 mg/L. The Southwest Bay, which is the only part of the lake having wild rice populations, is an isolated bay that is tributary to the main body of the lake; the main flowage through the lake does not flow through this bay. Swan River also has wild rice, and it is estimated that the water quality in Swan River at the outlet from Swan Lake would be of similar water quality as the main body of Swan Lake.

The current NPDES/SDS permit requires at least two years of water quality monitoring collected prior to the start-up of the tailings basin and two years of monitoring data collected during operation of the tailings basin. Data are used to evaluate the effectiveness of the monitoring well network and whether any adverse impacts occur to groundwater from the operation of the tailings basin. In accordance with special conditions of the permit, MPCA may require further evaluations of existing geotechnical information, additional geotechnical investigations and/or groundwater assessments to demonstrate the adequacy of the existing groundwater monitoring program. If upon analysis of the groundwater monitoring data the MPCA concludes that the operation of the tailings basin has caused adverse changes to groundwater quality, the proposed ESMM project would be subject to corrective actions, which could include, but are not limited to, additional monitoring, the installation of additional monitoring wells, geotechnical evaluations. Potential corrective actions would address groundwater quality, which in turn, would address any potential surface water impacts.

Mitigation would be accomplished through adaptive management, monitoring, special conditions of the existing NPDES/SDS permit, and stream augmentation. Adaptive management is a system of management practices based on clearly identified outcomes and monitoring to determine if management actions are meeting desired outcomes; and, if they are not, adaptive management results in management changes that would best ensure that outcomes are met or re-evaluated. Monitoring is a condition of the NPDES/SDS permit. The existing monitoring design is intended to identify groundwater and surface water quality before and after operation of the tailings basin to identify whether there is impact from the operation of the tailings basin or not. Essar is also monitoring lake levels on Oxhide, Snowball and Swan Lakes.

As part of the Water Appropriation Permit 2006-0433, a Stream Augmentation Plan must be submitted for Oxhide and Snowball Creek at least one year prior to completion of the dewatering of Pit 5 and the Draper Annex Pit, respectively. The Stream Augmentation Plan must comply with the recommended augmentation strategy described in the MSI FEIS. The permit will require Essar to conduct a hydrologic monitoring program in order to re-assess their water consumption needs and re-calculated available surface water and groundwater yields. The monitoring program is designed to allow ESMM and the MNDNR to refine Essar's water balance during later years of operation with a re-evalution of 1) the operation's water consumption, 2) available on-site surface water and groundwater yields, and 3) the need to acquire off-site water for processing or stream augmentation.

Project Alternatives Relevant to this Issue (see Chapter 3.0):

- Proposed Action (the proposed ESMM project)
- No Action Alternative (the original MSI project)

Regulatory Framework: refer to Chapter 2.0 for the status of these permits

- MNDNR: Permit to Mine
- MNDNR: Water Appropriation Permit
- MPCA: NPDES/SDS Permit for Industrial Wastewater Discharge and Stormwater Discharge for Industrial Activity (combined as one permit)
- MPCA: Section 401 Water Quality Certification

Cross-Referenced Chapters:

- Chapter 3.0 Proposed Action and Alternatives

Key Issues:

- Evaluating the proposer's plan for water appropriations compared to the original MSI project for maintaining zero surface water discharge
- Composition of water transferred between waters of the state and from seepage from the tailings basin
- The effects of changes in sulfate concentrations and/or water levels on wild rice growing in receiving water bodies

Documentation to Prepare Chapter 4.1:

1854 Treaty Authority. 2008. Wild Rice Monitoring and Abundance in the 1854 Ceded Territory (1998 - 2008).

2010 Wild Rice Management Workgroup. 2010. 350 Significant Wild Rice Waters in Minnesota. Last updated May 4, 2010.

Barr Engineering. 2010a. 2010 Water Quality and Wild Rice Monitoring Report. (Report ID: W5)

Barr Engineering. 2010b. Permit to Mine Amendment Application. (Report ID: MP1)

Barr Engineering. 2010c. Technical Memorandum: Essar Minnesota SEIS - Wild Rice Surveys and Water Quality Monitoring Protocol. (Report ID: W2)

Barr Engineering. 2010d. Water and Chemical Balance for a Proposed Pellet Production Rate of 6.5 MMTPY. (Report ID: W1)

Barr Engineering. 2010e. 2009 Water Quality, Hydrology, and Wild Rice Monitoring Year End Report. Prepared for U.S. Steel Corporation.

Barr Engineering. 2010f. Tailings Basin Design Report.

Barr Engineering. 2008. Essar Steel 2008 Discharge Monitoring Report (DMR) Summary Report.

Barr Engineering. 2006a. Yearly Water Balance Model. Prepared for Minnesota Steel Industries.

Barr Engineering. 2006b. Revised Dissolved Solids Modeling in Tailings Basin, and Expected Water Quality of Tailings Basin Water. Prepared for Minnesota Steel Industries.

Barr Engineering. 2006c. 2005 Surface Water Quality Monitoring for Pits, Lakes, and Streams within and Downstream of the Minnesota Steel Industries Project Area. Prepared for Minnesota Steel Industries.

Barr Engineering. 2006d. 2006 Surface Water Quality Monitoring within and Downstream of the Minnesota Steel Industries Project Area: Swan Lake, Tributary Streams and Mine Pits. Prepared for Minnesota Steel Industries.

Barr Engineering. 2006e. Pilot Plant Environmental Sampling (Concentrator and Pelletizer). Prepared for Minnesota Steel Industries.

Barr Engineering. Undated. Documentation and User's Guide for Meyer Method Watershed Yield Computer Program.

Berndt, M., Lappako, K, and Jakel, E. 1999. In-pit Disposal of Taconite Tailings: Geochemistry. University of Minnesota and Minnesota Department of Natural Resources.

Meyer, A. 1944. Elements of Hydrology; Second Edition. Chapter 6: Evaporation from Land Areas. New York: John Wiley & Sons, Inc.

Documentation to Prepare Chapter 4.1:

Minnesota Department of Natural Resources (Gleason, J., Adams, J. and Liljegren, M). 2006. Surface Water and Ground Water Yield for Minnesota Steel Industries Project near Nashwauk, Minnesota (Version 2).

Minnesota Department of Natural Resources. 2003. Field Guide to the Native Plant Communities of Minnesota: the Laurentian Mixed Forest Province. Ecological Land Classification Program, Minnesota County Biological Survey, and Nongame Research Program. MNDNR St. Paul, MN.

Minnesota Department of Natural Resources and U.S. Army Corps of Engineers. 2007. Minnesota Steel Final Environmental Impact Statement.

Wenck Associates, Inc. 2006. Swan Lake Nutrient Study (31-0067), Itasca County, Minnesota. Prepared for Minnesota Department of Natural Resources in Cooperation with Minnesota Pollution Control Agency and for Minnesota Steel Industries, LLC.

4.1.1 AFFECTED ENVIRONMENT

This section provides additional description to that provided in Sections 4, 5 and 6 of the MSI FEIS (MNDNR and USACE 2007). Some descriptions provided in the MSI FEIS are referenced and in some cases summarized.

4.1.1.1 Hydrogeology

The proposed ESMM project site coincides with the Canadian Shield in Minnesota and is characterized by partially exposed Precambrian bedrock, intermittent lakes, and significant topographic relief (MNDNR 2003). The MSI FEIS describes in Section 6.7.1 (Page 6-25) the geologic characteristics (MNDNR and USACE 2007). The site does not have sinkholes, shallow limestone formations or karst conditions. However, groundwater has filled the abandoned on-site pits and would flow into active mining areas and seep out of the proposed tailings basin. All tailings basin deep groundwater seepage is expected to ultimately reach Swan Lake. Seepage would flow initially to either Pickerel Creek or O'Brien Lake, or directly to Swan Lake (Figure 4.1-1).

4.1.1.2 Surface Waters of the State

Surface waters (waters of the state) include natural streams and lakes, as well as water bodies that resulted from groundwater infiltration and surface water runoff collection in abandoned mine pits. The MSI FEIS describes in Section 4.3.1 (Page 4-53 to 4-55) non-wetland surface waters in the vicinity of the project: Oxhide Creek/Oxhide Lake, Snowball Lake/Snowball Creek, O'Brien Creek/O'Brien Lake, Pickerel Creek, Little Sucker Lake, Sucker Brook, Swan Lake, and Little McCarthy Lake (MNDNR and USACE 2007). Figure 4.1-1 shows the locations of existing surface waters within the vicinity of the ESMM project.

4.1.2 ENVIRONMENTAL CONSEQUENCES

4.1.2.1 Potential Effects of Water Appropriations

4.1.2.1.1 Effects of Dewatering Discharge and Water Appropriations (Augmentation)

During initial pit dewatering (according to the current permit for the original MSI project) there would be transfers of water into downstream waters, but this water would not have pollutants added by activities associated with the proposed ESMM project. Pit 5 dewatering is currently being transferred from the existing mine pits to the Oxhide Creek Stilling Basin; water from the existing Draper Annex Pit (within proposed Pit 6) would be transferred to Snowball Lake prior to the start of mining activities. Once mining activities would begin, Pit 5 and proposed Pit 6 would no longer be considered waters of the state.

There would be no surface water discharge from the facility. The initial Pit 1 and 2, Pit 5, and Draper Annex Pit dewatering is a transfer of water between waters of the state. Water from Pits 1 and 2, and possibly the Hill Annex Pit, would be used for stream augmentation. Once construction begins, stormwater runoff will be collected and will not discharge to Pits 1 and 2. Eventually, as Pit 5 and proposed Pit 6 are mined, both the Ann and Sullivan Pits and the stormwater basins to be located in the crusher/concentrator area will be enveloped by Pit 5 and proposed Pit 6. At that time, stormwater from the facility will be directed into Pit 5 and proposed Pit 6 for storage and eventually to the production areas for use as process water. Pit 5 and proposed Pit 6 will have ongoing maintenance dewatering to the Ann and Sullivan Pits. Discharge will be regulated under the NPDES/SDS permit once mining activities (including road construction) begin that introduce pollutants to Pit 5 and proposed Pit 6.

As proposed in the original MSI project, runoff from industrial areas and maintenance dewatering would be directed to Ann and Sullivan natural ore pits located on site, which do not discharge surface water to downstream waters or Pits 1 and 2. Therefore, as was concluded in the MSI FEIS (MNDNR and USACE 2007), there would be no direct discharge of surface water containing pollutants from this project to downstream waters, including Swan Lake, Swan River, Oxhide Lake or Creek, Snowball Lake or Creek, Pickerel Creek, or O'Brien Lake or Creek.

Section 4.2.3.1 (Page 4-46 to 4-49) of the MSI FEIS describes the effects of appropriations on public waters and is summarized here in Table 4.1-2 (MNDNR and USACE 2007). Just like the original MSI project, the water diverted to the proposed ESMM project processes would substantially reduce flows to Oxhide Lake/Oxhide Creek and, to a lesser extent, flows to Snowball Lake/Snowball Creek. Section 4.3 of the MSI FEIS provides a more detailed description of the physical impacts of water appropriations on surface waters, including discharge rate changes to public waters. Section 4.5 of the MSI FEIS evaluated the potential water quality impacts to public waters associated with project-related water appropriations. Swan Lake and the Harrison/Hawkins/Halobe basins were all evaluated as augmentation water sources in the MSI FEIS. The Hill Annex Pit was evaluated for additional augmentation water if needed. The proposed ESMM project would provide the same augmentation of flows from the same proposed source waters as the original MSI project. Therefore, this SEIS does not address impacts to public waters as a result of stream augmentation, and Table 4.1-2 from the original MSI project is also applicable to the proposed ESMM project.

Augmentation flows to Oxhide Creek and Snowball Creek, which were determined as part of the MSI FEIS, were based on modeled streamflow impacts, not lake level impacts; hence the name "stream augmentation" and the default use of the term "creek" in the context of augmentation. Augmentation water would be pumped to Oxhide Lake and Snowball Lake, which flow into Oxhide Creek and Snowball Creek, and therefore, flow in each of these resources would be augmented.

Table 4.1-2. Water Appropriation Summary of the Original MSI Project and the Proposed ESMM Project

Water Body	Proposed Use of Water	Downstream Effect on MNDNR Public Waters
Pits 1 & 2	Dewatering: Partial dewatering of Pits 1 & 2 (and contiguous Harrison/Hawkins/Halobe/Hadley Pits) initially, to prevent flows to Pit 5 during mining. Normal Operations: Use excess and stored water for process water and stream augmentation	Initial Dewatering: Temporary increased flow to Oxhide Creek, Oxhide Lake and, ultimately, Swan Lake. Normal Operations: Eliminates overflow to Pit 5 and, ultimately, reduces flow to Oxhide Lake, Oxhide Creek, Swan Lake and Swan River.
Pit 5	Initial Dewatering: Lower water level to allow access to pit for mining – convey water to Oxhide Creek. Normal Operations Dewatering: Pump water and store in natural ore pits for process use.	Initial Dewatering: Temporary increased flow to Oxhide Creek and, ultimately, Swan Lake. Normal Operations Dewatering: Reduced flow to Oxhide Creek and, ultimately, Swan Lake.
Pit 6 (existing Draper Annex Pit)	Initial Dewatering: Lower water level to allow access to pit for mining – convey water to Snowball Creek. Normal Operations Dewatering: Pump water and store in natural ore pits for process use.	Initial Dewatering: Temporary increased flow to Snowball Creek and, ultimately, Swan River. Normal Operations: Reduced flow to Snowball Creek due to watershed area reduction.
Natural Ore Pit North of Pit 1 (Ann Mine)	Process water	No impacts – water comes from stormwater and pit dewatering.
Natural Ore Pit North of Pit 5 (Sullivan Mine)	Process water	No impacts – water comes from stormwater and pit dewatering.
Hill Annex Mine Pit	Future need (following initial Pit 5 dewatering) to appropriate water for Snowball Creek and Oxhide Creek augmentation (appropriation is not being requested at this time).	No impacts at this time[1]

1 At the time of the MSI FEIS, Hill Annex Pit was being pumped to Upper Panaca Lake and though the water quality effect was not quantified, it was not anticipated to be substantial; since this pumping is no longer occurring, there are no downstream effects related to Hill Annex Pit water as a result of the proposed ESMM project.

As part of the Water Appropriation Permits 2008-0065, 2008-0066, 2008-0067 and 2006-0433, a Stream Augmentation Plan must be submitted for Oxhide and Snowball Creek at least one year prior to the completion of the dewatering of Pit 5 and the Draper Annex Pit, respectively. The Stream Augmentation Plan must comply with the recommended augmentation strategy described in the MSI FEIS (MNDNR and USACE 2007). Based on the updated water balance (Barr Engineering 2010d), adequate water sources would still be available to meet the requirements necessary for stream augmentation as described in the MSI FEIS from Pits 1 and 2 and the Hill Annex Pit, if required.

4.1.2.1.2 Effect of Operations on Pit Water Balance

The water balance is the difference between the total water demand and the total supply available. Increased production, changes in the mine plan (i.e., pit and stockpile configurations), and design modifications of the facility operations have resulted in changes to the original MSI project water balance. Modifications to the Permit to Mine are identified in Table 4.1-3 for reference purposes (Barr Engineering 2010b). A summary of changes to facility operations are listed in Table 4.1-4.

Table 4.1-3. Permit to Mine Modifications

Mine Plan Modification	Mine Plan Reference (Barr Engineering 2010b)
Surface Ownership	Appendix 8-4, Figure 4-I.1
Phasing	Section 7 description with summary tables of phases and figures
Pit and Stockpile Footprints	Section 7B and Figure 7b.1
Waste Rock Disposal	Section 7B p.12 summary table; includes in-pit now
Tailings Basin Capacity	Section 7B p.15; height change
Reclamation	Section 7C p.15/16; tailings basin vegetative reference area
Blasting	Section 7D p.16/17; two blasts per week now (one per week for MSI)

Table 4.1-4. Comparison of Facility External Process Water Needs Between the Original MSI Project and the Proposed ESMM Project

Facility Operation	Original MSI Project	Proposed ESMM Project[1]	Reason for Change in Demand
Concentrator and pellet plant	589 gpm (3.8 mmtpy)	871 gpm (4.1 mmtpy) 1,380 gpm (6.5 mmtpy)	Higher waste ratio (i.e., more tailings), more detailed design of the scrubber system in the pellet plant with an increased evaporation loss, and other miscellaneous small losses that were not accounted for (filter press, gland seals, flushing losses, etc.)
DRI Plant	1,540 gpm	972 gpm (Phase 1 starting in year 4) 1,285 gpm (Phase 2 starting in year 10)	Refined design, which also accounts for water recovered from the wastewater treatment facility
Steel mill (melt shop and hot strip mill)	2,190 gpm	1,772 gpm (Phase 1 starting in year 5) 2,510 gpm (Phase 2 starting in year 10)	Refined design, which also accounts for water recovered from the wastewater treatment facility

[1] Water demand is based on a wet air pollution control system; if a dry or semi-dry system is installed the water demand would be lower.

The proposed ESMM project modified phasing calls for mining Pit 5 and proposed Pit 6 over a 15-year time period, compared to the original MSI project 20-year time period. This creates an increased average water demand and lower 15-year water levels for Pits 1 and 2. This is related to the modifications shown above. No direct surface discharges from the facility were included in the original MSI project, and none are proposed for the proposed ESMM project.

As in the original MSI project, the main consumptive uses of the proposed ESMM project include losses to the steel-making process, water that would fill voids in the tailings basin, and deep seepage through the bottom of the tailings basin to shallow groundwater. As in the original MSI project, the proposed ESMM project would conserve water and eliminate discharges of process water by treating and reusing water from its processing operations and collecting and reusing water from tailings basin lateral seeps.

The five major processes at the facility to process raw ore to finished product include (1) crushing and concentrating, (2) pellet processing, (3) direct reduction of iron (DRI), (4) the melt shop, and (5) the hot strip mill. Illustration 4.1-1 shows the revised water balance for the concentrator and tailings basin with the separate water reuse and recycle management strategy for the pellet plant, DRI plant, melt shop, and hot strip mill. Water would be discharged from the concentrator to the tailings basin as a slurry and recycled back to the concentrator after the tailings have settled out of the water. There would be no water returning to the concentrator or the tailings basin from the pellet plant, DRI plant, melt shop, and hot strip mill. Table 4.1-4 compares external process water needs of the concentrator and pellet plant, DRI plant, and steel mill (melt shop and hot strip mill) between the original MSI project and the proposed ESMM project.

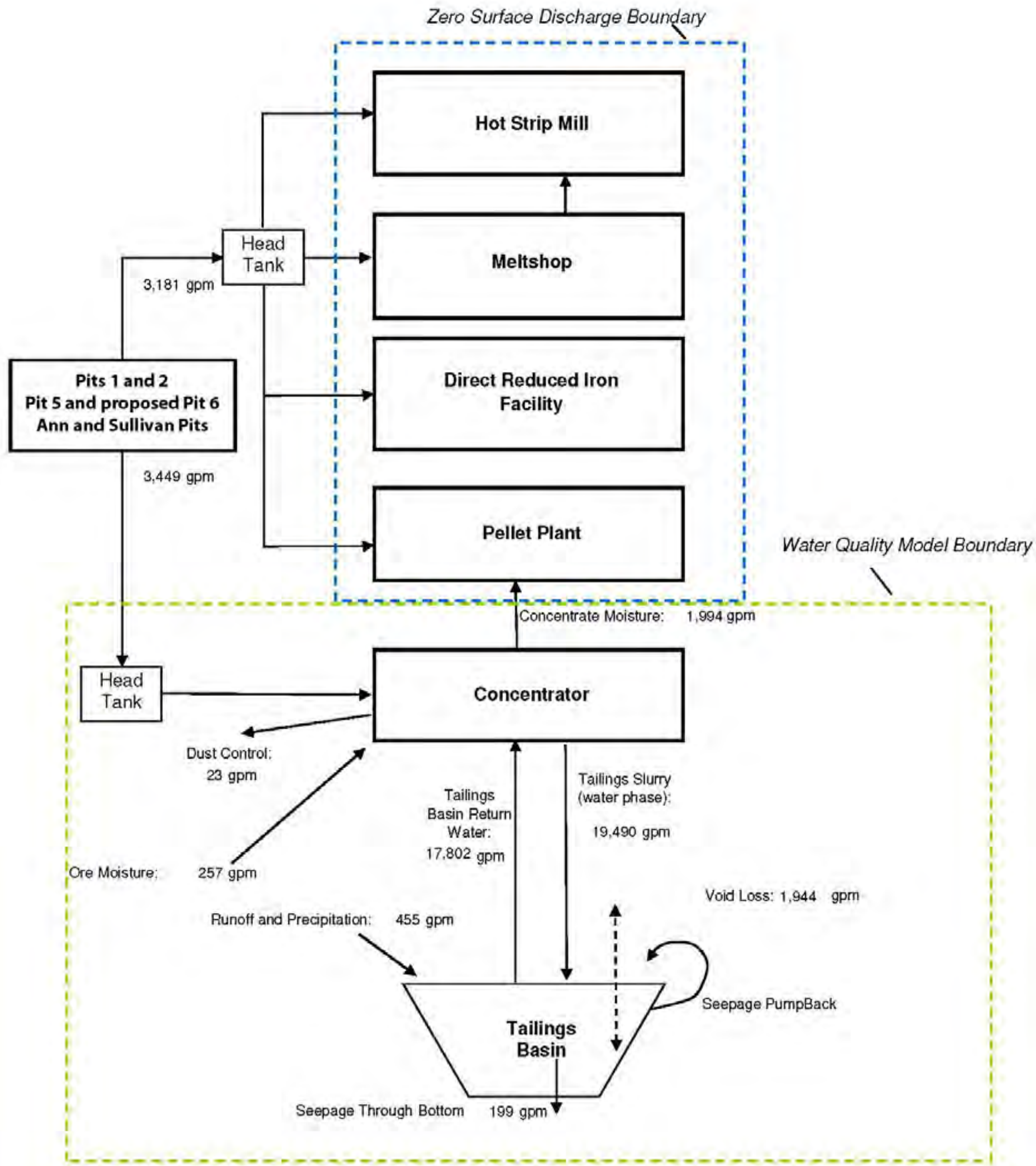


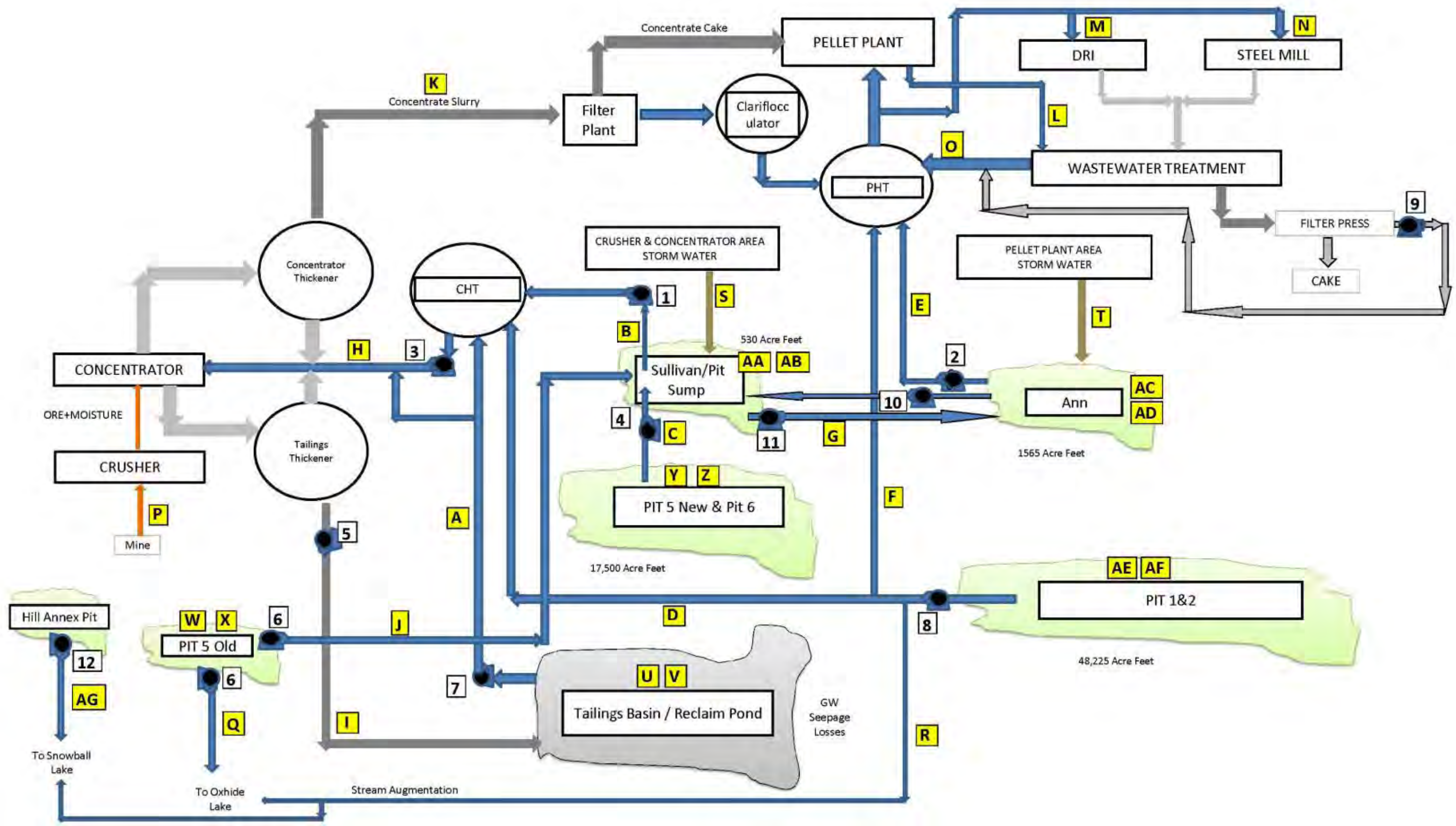
Illustration 4.1-1. Facility Water Balance for Year 15 for the Concentrator and Tailings Basin with Separate Water Reuse and Recycle Management Strategy for the Pellet Plant, DRI Plant, Melt Shop, and Hot Strip Mill Facility

As in the original MSI project, the proposed ESMM project would receive water from surface water runoff from the project impact area, from the watershed for Pits 1 and 2, Pit 5 and proposed Pit 6 (Pit 5 and proposed Pit 6 of the original MSI project would be combined into one larger and deeper pit under the proposed ESMM project), the Ann and Sullivan Pits, and from groundwater that enters Pits 1 and 2 and Pit 5 and proposed Pit 6 through the Biwabik Iron Formation. Pits 1 and 2 would not receive process water or surface water runoff in order to preserve the availability of the pits to remain as waters of the state to serve as augmentation water. Groundwater inflow to Pits 1 and 2 is estimated to be 1,606 gpm to 1,830 gpm dependent upon pit elevation (see Section 4.1.2.1.3 for groundwater inflow details). Illustration 4.1-2 describes facility water flow associated with the proposed ESMM project. Figure 4.1-1 and Figure 4.1-2 show year 1 and year 15 watersheds and flow directions. These watersheds have changed slightly from the original MSI project due to the changes in the mine plan (i.e., pit and stockpile configurations) and because two additional watersheds were included in the original MSI project (Snowball and Little Sucker Lakes), which actually do not contribute water to the facility.

Watershed runoff yields of the original MSI project water balance [described in Appendix I of the MSI FEIS (MNDNR and USACE 2007)] were based on WATBUD modeling results provided by the MNDNR, which are used for all watersheds of the proposed ESMM project except for yields associated with the tailings basin. Wet tailings and shallow tailings ponds have different runoff yields from normal uplands or deep water bodies, which make up the surrounding landscape. Therefore, the proposed ESMM project uses the Meyer model to model watershed yields from the tailings basin, and it does not require a history of water levels for calibration, unlike WATBUD.

The Meyer model is a computer program that estimates watershed yield based on precipitation versus evapotranspiration. The model was developed by Barr Engineering, based on work by Adolf Meyer (Meyer 1944; Barr Engineering undated), and has been used to study the hydrology of tailings basins at other locations on the Iron Range including the original MSI project. The climatic normal period (1971-2000) record of average monthly relative humidity, wind speed, temperature, and precipitation are inputs to the Model.

Table 4.1-5, Table 4.1-6, and Table 4.1-7 highlight the differences in the water balance between the original MSI project (4.1 mmtpy) (Barr Engineering 2006d) and the proposed ESMM project (6.5 mmtpy) (Barr Engineering 2010d).



Note :-

1. Pumps 10 and 11 are used for balancing the pit levels.
2. The feasibility of balancing the pits (Ann & Sullivan) through pumps 1 and 2 by making a branch in their discharge line will be checked during the detail engineering period.
3. The filtered water from the filter press will be pumped to the PHT as it can meet the quality of process water requirement.
4. Fire water will be provided from the concentrator and pellet plant head tanks.

Illustration 4.1-2. Facility Flow Diagram

Table 4.1-5a. Water Balance Summary for Normal Weather Conditions – 6.5 mmtpy[(1)(2)]

Water Demand / Supply Component	Average for Years 1 to 15 (gpm)	Years 1 to 10 (gpm)	Years 11 to 15 (gpm)
Water Demand			
Process water for steel production	2,615	2,025	3,794
Process water for pellet plant	1,313	1,279	1,380
Ore moisture recovery	(242)	(234)	(257)
Loss to tailings basin voids	1,826	1,767	1,944
Tailings basin loss to groundwater	138	115	183
Net Water Demand (2)	5,649	4,951	7,045
Water Sources (Normal Weather Conditions)			
Average surface water supply	1,970	1,937	2,034
Average groundwater supply	3,248-3,749	2,895-3,321	3,953-4,606
Tailings basin precipitation yield	230	197	298
Net Water Supply (3)	5,448-5,949	5,030-5,455	6,284-6,938
Net Water Balance (2)	**(201)-300**	**78-504**	**(761)-(108)**

Table 4.1-5b. Water Balance Summary for Normal Weather Conditions – 4.1 mmtpy per MSI FEIS[(1)(2)]

Water Demand / Supply Component	Average for Years 1 to 20 (gpm)	Years 1 to 10 (gpm)	Years 11 to 20 (gpm)
Water Demand			
Process water for steel production	3,378	3,030	3,727
Process water for pellet plant	259	243	275
Ore moisture recovery	(116)	(109)	(125)
Loss to tailings basin voids	819	735	904
Tailings basin loss to groundwater	570	382	758
Net Water Demand (2)	4,910	4,281	5,539
Water Sources (Normal Weather Conditions)			
Average surface water supply	1,858	1,811	1,905
Average groundwater supply	3,330	3,019	3,642
Tailings basin precipitation yield	257	211	302
Net Water Supply (3)	5,445	5,041	5,849
Net Water Balance (2)	**535**	**760**	**310**

(1) Normal Conditions: Based on expected steel production rates and expected groundwater increases from mine pit development; water sources do not include initial pit dewatering flows that discharge to Oxhide Creek. Normal conditions reflect the climate normal period 1971-2000.

(2) Water balance does not include water needed for stream augmentation. Any excess water would be used toward augmentation of Oxhide and Snowball Creeks; augmentation plans for Oxhide Creek and Snowball Creek would be developed prior to the end of dewatering of Pit 5 and Draper Annex Pit, respectively. As described in the MSI FEIS, Hill Annex Pit may also be used for Oxhide and Snowball Creek augmentation.

(3) Net water demand does not take into account the water stored in Pits 1 and 2, which is already permitted for appropriation under Appropriation Permit 2006-0433.

Table 4.1-6a. Water Balance Summary for Dry Weather Conditions – 6.5 mmtpy[(1)(2)]

Water Demand / Supply Component	Average for Years 1 to 15 (gpm)	Years 1 to 10 (gpm)	Years 11 to 15 (gpm)
Water Demand			
Process water for steel production	2,615	2,025	3,794
Process water for pellet plant	1,313	1,279	1,380
Ore moisture recovery	(242)	(234)	(257)
Loss to tailings basin voids	1,826	1,767	1,944
Tailings basin loss to groundwater	138	115	183
Net Water Demand (2)	5,649	4,951	7,045
Water Sources (Dry Weather Conditions)			
Average surface water supply	939	933	952
Average groundwater supply	3,248-3,749	2,895-3,321	3,953-4,606
Tailings basin precipitation yield	(316)	(342)	(265)
Net Water Supply (3)	3,871-4,372	3,486-3,911	4,640-5,293
Net Water Balance (2)	**(1,779)-(1,277)**	**(1,465)-(1,040)**	**(2,405)-(1,752)**

Table 4.1-6b. Water Balance Summary for Dry Weather Conditions – 4.1 mmtpy per MSI FEIS[(1)(2)]

Water Demand / Supply Component	Average for Years 1 to 20 (gpm)	Years 1 to 10 (gpm)	Years 11 to 20 (gpm)
Water Demand			
Process water for steel production	3,378	3,030	3,727
Process water for pellet plant	259	243	275
Ore moisture recovery	(116)	(109)	(125)
Loss to tailings basin voids	819	735	904
Tailings basin loss to groundwater	570	382	758
Net Water Demand (2)	4,910	4,281	5,539
Water Sources (Dry Weather Conditions, FEIS Updated with Water Source Data from above)			
Average surface water supply	939	933	952
Average groundwater supply	3,248-3,749	2,895-3,321	3,953-4,606
Tailings basin precipitation yield	(316)	(342)	(265)
Net Water Supply (3)	3,871-4,372	3,486-3,911	4,640-5,293
Net Water Balance (2)	**(1,039)-(538)**	**(795)-(370)**	**(899)-(246)**

(1) Dry Conditions: Rather than the normal climatic period of 1971-2000, the dry weather scenario models water years 1971-1972 recurring to show continuous dry conditions.

(2) Water balance does not include water needed for stream augmentation. Any excess water would be used toward augmentation of Oxhide and Snowball Creeks; augmentation plans for Oxhide Creek and Snowball Creek would be developed prior to the end of dewatering of Pit 5 and Draper Annex Pit, respectively. As described in the MSI FEIS, Hill Annex Pit may also be used for Oxhide and Snowball Creek augmentation.

(3) Net water demand does not take into account the water stored in Pits 1 and 2, which is already permitted for appropriation under Appropriation Permit 2006-0433.

Table 4.1-7a. Water Balance Summary for Wet wWeather Conditions – 6.5 mmtpy[1][2]

Water Demand / Supply Component	Average for Years 1 to 15 (gpm)	Years 1 to 10 (gpm)	Years 11 to 15 (gpm)
Water Demand			
Process water for steel production	2,615	2,025	3,794
Process water for pellet plant	1,313	1,279	1,380
Ore moisture recovery	(242)	(234)	(257)
Loss to tailings basin voids	1,826	1,767	1,944
Tailings basin loss to groundwater	138	115	183
Net Water Demand (2)	5,649	4,951	7,045
Water Sources (Wet Weather Conditions)			
Average surface water supply	3,068	3,102	3,001
Average groundwater supply	3,248-3,749	2,895-3,321	3,953-4,606
Tailings basin precipitation yield	332	363	271
Net Water Supply (3)	6,648-7,150	6,360-6,786	7,225-7,878
Net Water Balance (2)	**1,501**	**1,409-1,834**	**179-833**

Table 4.1-7b. Water Balance Summary for Wet Weather Conditions – 4.1 mmtpy per MSI FEIS[1][2]

Water Demand / Supply Component	Average for Years 1 to 20 (gpm)	Years 1 to 10 (gpm)	Years 11 to 20 (gpm)
Water Demand			
Process water for steel production	3,378	3,030	3,727
Process water for pellet plant	259	243	275
Ore moisture recovery	(116)	(109)	(125)
Loss to tailings basin voids	819	735	904
Tailings basin loss to groundwater	570	382	758
Net Water Demand (2)	4,910	4,281	5,539
Water Sources (Wet Weather Conditions, FEIS Updated With Water Source Data from above)			
Average surface water supply	3,068	3,102	3,001
Average groundwater supply	3,248-3,749	2,895-3,321	3,953-4,606
Tailings basin precipitation yield	332	363	271
Net Water Supply (3)	6,648-7,150	6,360-6,786	7,225-7,878
Net Water Balance (2)	**1,738-2,240**	**2,079-2,505**	**1,686-2,339**

(1) Wet Conditions: Rather than the normal climatic period of 1971-2000, the wet weather scenario models water years 1973-1974 recurring to show continuous wet conditions.
(2) Water balance does not include water needed for stream augmentation. Any excess water would be used toward augmentation of Oxhide and Snowball Creeks; augmentation plans for Oxhide Creek and Snowball Creeks would be developed prior to the end of dewatering of Pit 5 and Draper Annex Pit, respectively. As described in the MSI FEIS, Hill Annex Pit may also be used for Oxhide and Snowball Creek augmentation.
(3) Net water demand does not take into account the water stored in Pits 1 and 2, which is already permitted for appropriation under Appropriation Permit 2006-0433.

The water balance was modeled under three climatic scenarios: climate normal (1971-2000), extreme wet (recurring wet water years 1973-1974) and extreme dry (recurring dry water years 1971-1972) (Barr Engineering 2010d). In the original MSI project water balance, the wet and dry scenarios modeled were based on the period between 1931 and 2000. However, because the WATBUD results were only available from 1971-2000, for the proposed ESMM project, the wet and dry scenarios could not be modeled in the same manner as for the original MSI project.

Essar, with input from the MNDNR, updated the original MSI project year-by-year water balance to determine the sufficiency of groundwater and surface water supplies to meet the consumptive use needs of the proposed ESMM project (Barr Engineering 2010d). For some years, the annual water demand of the proposed ESMM project exceeds the annual water supplied by precipitation for the facility. When this occurs, the water demands would be met by appropriating water from the existing volume in Pits 1 and 2. Pits 1 and 2 would be used for process waters and stream augmentation. Under normal climatic conditions, low groundwater inflows from Pit 5 and proposed Pit 6, and stream augmentation rates suggested in the original MSI project, the maximum expected appropriation needed would be approximately 5,851 gpm (3,075 mgpy). This appropriation rate is within the limits of the existing Water Appropriation Permit 2006-0433, which states that appropriations from Pits 1 and 2 are not to exceed 7,000 gpm or 3,679 million gallons per year (mgpy). After completion of the SEIS process, MNDNR will amend the water appropriation permit to include updated water balances throughout the mine plan time period at certain years of operation. As a result of proposed greater use of water from Pits 1 and 2, Pits 1 and 2 may be drawn down significantly by year 15, which would be a change from the original MSI project (see Graphs 4.1-1 and 4.1-2).

4.1.2.1.3 Accounting for Groundwater Inflows to Pits

A mine plan modification entails combining Pit 5 and Pit 6 into one slightly larger and deeper pit (Barr Engineering 2010b). The bottom of Pit 6 would remain the same as proposed for the original MSI project, but Pit 5 would be an additional 40 feet deeper to match the bottom elevation of Pit 6 (1040′). These changes to the original MSI project triggered an evaluation of whether the original MSI project estimate of groundwater inflows to Pit 5 and proposed Pit 6 is appropriate for the proposed ESMM project.

The water balance is based, in part, on groundwater inflows and outflows, in particular, estimated groundwater inflows to Pits 1 and 2 and Pit 5 and proposed Pit 6. Groundwater inflow is defined as inflow from deep, bedrock water, not surficial groundwater inflow, which is already included in the surface water computations. The original MSI project used a constant 1,606 gpm for groundwater inflow to Pit 1, which was estimated for near pit-full condition. However, the proposed ESMM project proposes lowering both Pits 1 and 2 to approximately 1,120 feet in elevation by year 15, approximately 30 feet above empty (see Graph 4.1-1). This condition would result in inflow greater than 1,606 gpm. During development of the original MSI project, MNDNR modeled groundwater inflow using WATBUD for Pit 1 when near empty (elevations from 1150′ to 1287′), which resulted in an estimated groundwater inflow of 1,830 gpm (MNDNR 2006). For Pits 1 and 2, the proposed ESMM project uses the estimated inflow of 1,606 gpm for elevation above 1287′ and 1,830 gpm for elevations below 1287′ and includes a linear transition between the two inflow rates at and around 1287′.

To arrive at the best estimate groundwater inflow to Pit 5 and proposed Pit 6 for the original MSI project, year-to-year groundwater inflow was estimated separately by MNDNR and Barr Engineering. MNDNR first modeled Pit 5 using WATBUD modeling to calibrate to water levels and then calibrated an MLAEM model to WATBUD results in order to estimate groundwater inflow. Ultimately, Barr Engineering modeled the pits with MODFLOW, which was calibrated to DNR-agreed inflows for different water levels. The MODFLOW model resulted in an estimate of 2,133 gpm, which was approved by the MNDNR for the original MSI project. These modeling efforts are described in the 2006 water yield memo from Gleason, Adams, and Liljegren (MNDNR 2006) and the combined Pit 5 and Pit 6 groundwater inflow estimates are shown in Table 4.1-8.

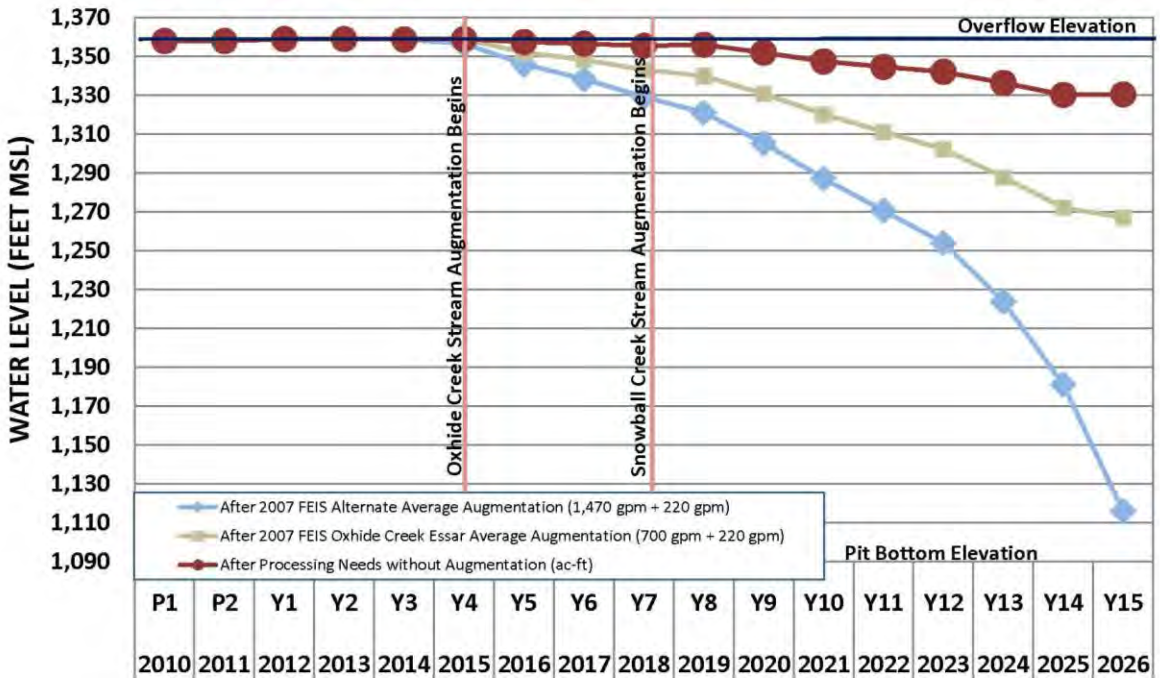
Table 4.1-8. Summary of Pit 5 and Proposed Pit 6 Groundwater Inflow Estimates

Source	Model	Pit 5 and proposed Pit 6 Combined Groundwater Inflows
MNDNR	WATBUD	430-1,930 gpm (varies with water level)
MNDNR	MLAEM	2,400 gpm
Barr[1]	MODFLOW	2,133 gpm

[1] 2,133 gpm was approved by the MNDNR for use in the original MSI project. However, the Water Appropriation Permit used a best estimate inflow of 2,250 gpm (a 50% increase in groundwater inflow compared to observed inflow in the existing Pit 5 when empty).

The original MSI project water balance ultimately used a range of flows from 1,500 gpm, which is the observed groundwater inflow to Pit 5 when it is empty and assumes no increase in groundwater inflow to Pit 5 and proposed Pit 6 under new pit development, to 3,000 gpm, which assumes a 100% increase due to pit modifications. In addition, the best estimate for Pit 5 groundwater inflow used in the original MSI project Water Appropriation Permit was considered to be 2,250 gpm, which represents a 50% increase from observed groundwater inflow to Pit 5.

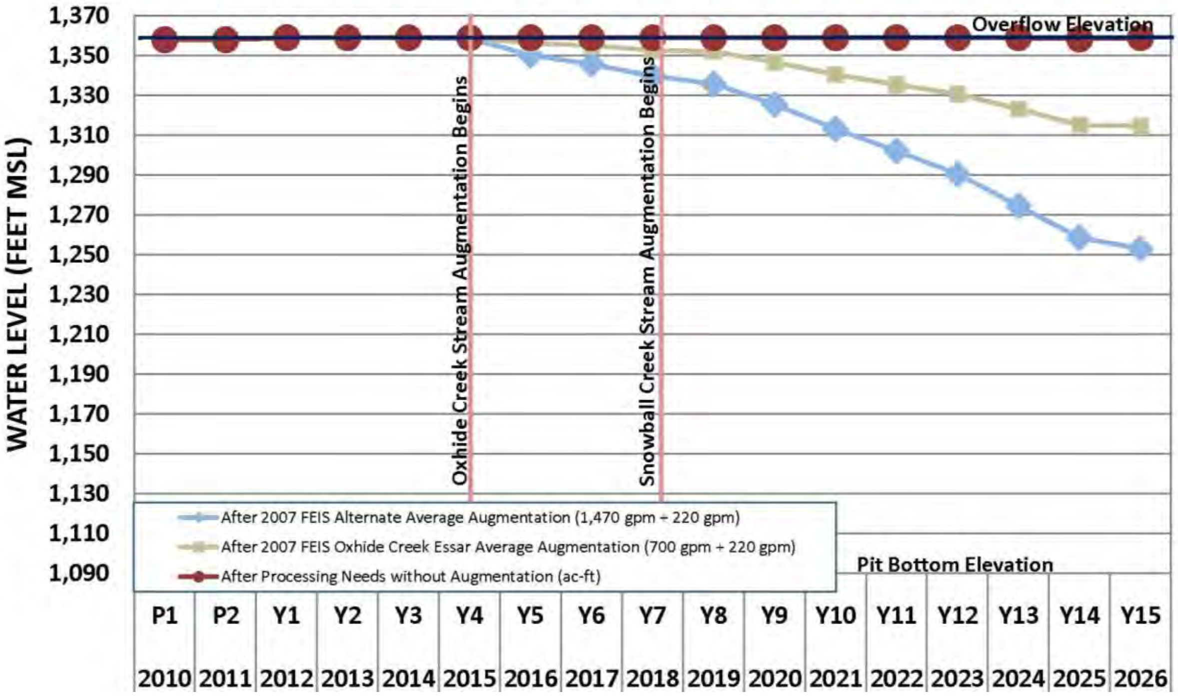
The MODFLOW model could be used for the proposed ESMM project by updating input data to account for the following modifications under the proposed ESMM project: higher Hill Annex pit water levels, progressively lower Pit 1 water levels, and lower Pit 5 bottom. However, an updated MODFLOW model would likely indicate only a slightly higher inflow for the new combined Pit 5 and proposed Pit 6 based on the slightly deeper portion of the pit. The modeling and related investigations conducted during review of the original MSI project provided a range of groundwater inflows that could be expected from Pit 5 and proposed Pit 6, and the original MSI project environmental review and permitting that was completed determined that there was no significant environmental impact as a result of predicted groundwater inflows to Pit 5 and proposed Pit 6. The proposed ESMM project uses the same best estimate as the Water Appropriation Permit determined during review of the original MSI project (2,250 gpm), which represents the 50% increase from observed inflows and lies within the range of values identified in the groundwater inflow modeling. The water balance for the proposed ESMM project ultimately evaluates a range of groundwater inflows to Pit 5 and proposed Pit 6, from 2,250 gpm (low) to 3,000 gpm (high), the latter of which represents a 100% increase in groundwater inflow from observed inflows (see Graphs 4.1-1 and 4.1-2) (Barr Engineering, 2010d). This range of flows is anticipated to account for the increase in pit depth and area for combined Pit 5 and proposed Pit 6 and any uncertainties in the original MSI project estimates.



Graph 4.1-1. Estimated Change in Pit 1 and 2 Water Level with Varying Demands and Low Groundwater Inflows to Pit 5 and Proposed Pit 6

Notes:

1. The starting water level for this figure is 1358.0 feet MSL (NGVD 29) based on water level measurements Dec. 2009.
2. This water balance reflects the following schedule: Pellet Plant startup in 2012 with DR/Steel Mill Phase 1 in 2015 and Phase 2 in 2021.
3. Stream augmentation rates are shown as: Oxhide Creek (varies, see legend, starting in about year 4) + Snowball Creek (220 gpm, starting in about year 7).
4. This figure assumes all stream augmentation would come from Pits 1 and 2. As discussed in the MSI FEIS, the Hill Annex Pit may also be used for augmentation.
5. This figure assumes stream augmentation would be constant rather than fluctuating with climatic patterns, as described in the MSI FEIS.
6. This figure is based on the low end of the range of groundwater inflows form the combined Pits 5 and proposed Pit 6.



Graph 4.1-2. Estimated Change in Pit 1 and 2 Water Level with Varying Demands and High Groundwater Inflows to Pit 5 and Proposed Pit 6

Notes:

1. The starting water level for this figure is 1358.0 feet MSL (NGVD 29) based on water level measurements Dec. 2009.
2. This water balance reflects the following schedule: Pellet Plant startup in 2012 with DR/Steel Mill Phase 1 in 2015 and Phase 2 in 2021.
3. Stream augmentation rates are shown as: Oxhide Creek (varies, see legend, starting in about year 4) + Snowball Creek (220 gpm, starting in about year 7).
4. This figure assumes all stream augmentation would come from Pits 1 and 2. As discussed in the MSI FEIS, the Hill Annex Pit may also be used for augmentation.
5. This figure assumes stream augmentation would be constant rather than fluctuating with climatic patterns, as described in the MSI FEIS.
6. This figure is based on the high end of the range of groundwater inflows form the combined Pits 5 and proposed Pit 6.

4.1.2.1.4 Effects of Closure on Pit Water Balance

In the original MSI project, Pits 1 and 2 were to be drawn down only a few tens of feet by year 20 (Barr Engineering 2006d). In the proposed ESMM project, Pits 1 and 2 could be drawn down over 230 feet (nearly totally dewatered) by the final year (year 15) under the conservative assumptions that average augmentation would be 1,690 gpm and Pit 5 and proposed Pit 6 would experience groundwater inflow at the lowest rate of the estimated range (2,250 gpm) (Barr Engineering 2010d). Assuming closure starting in year 16, it would take Pits 1 and 2 longer to fill and begin overflowing to Pit 5 (at which point natural runoff to Snowball and Oxhide Creeks would occur) as compared to the original MSI project. If Pits 1 and 2 continue being used for augmentation at 1,690 gpm after closure, the time for them to fill would be greatly extended.

After closure, the duration of augmentation and the source of water for augmentation are issues in terms of timing and cost. The condition of Pits 1 and 2 at closure would affect the cost for closure based on the cost and time period of augmentation pumping. Additional hydrologic modeling would be needed to predict the time it would take Pits 1 and 2 (and Pit 5 and proposed Pit 6) to fill and overflow, which would inform the cost and time period of augmentation pumping. This additional modeling was not required to be completed for this SEIS, but may be made a permit requirement during operations. A list of likely data collection requirements would be submitted to

Essar during the permitting process so the company is aware of the monitoring requirements deemed necessary to address the augmentation issues created by the drawdown of Pits 1 and 2.

If Essar intends to continue operating after the proposed ESMM project timeline, an additional environmental review process would have to be initiated. That environmental review process, whether a new EIS or another SEIS, would have to address issues associated with continued augmentation (e.g., securing alternative source water for continued operation). Before the end of Essar's expected 15 years of operation, the MNDNR would need to have more accurate water balance numbers from monitoring. Presumably Pits 1 and 2 would not have enough water for augmentation.

Whenever closure is sought, if Essar continues to use Pits 1 and 2 for augmentation, the MNDNR would need to know how long it would take the pit complex (Pits 5, 6, 1 and 2) to fill and begin out flowing. It could be many years, so financial assurance issues would become important and sufficient funds would need to be dedicated within an appropriate financial instrument. The Permit to Mine includes financial assurance for all activities in the permit including stream augmentation and starting year 1. It is not known at this time if there will be enough water in Pits 1 and 2 for 15 years of augmentation. If it appears that there is a reasonable chance Essar could run out of augmentation water, MNDNR would require, through an amended Water Appropriation Permit, necessary data collection and re-modeling of their water balance before Pits 1 and 2 are completely dewatered. Depending on those results, Essar may need to provide a MNDNR-acceptable contingency plan for continued augmentation.

4.1.2.2 Tailings Basin Deep Seepage

A seepage collection system (described in Chapter 3) is proposed along the toe of the exterior dams of the tailings basin in order to capture any lateral seepage that occurs. Deep seepage to groundwater would not be captured by this system. Deep seepage is defined as the seepage which does not appear on the ground surface near the dams. Surface waters downstream of the deep groundwater flow pathway would be expected to receive the deep seepage from the tailings basin. Seepage would flow initially to either Pickerel Creek or O'Brien Lake, or directly to Swan Lake (Figure 4.1-1).

As stated above, the lateral seepage collection system would be constructed along the toe of the exterior dams and would return lateral seepage (approximately 2,000 gpm) to the tailings basin. The tailings basin footprint and watershed area would be approximately 1,580 acres and 1,502 acres, respectively, in year 1. In year 15, the watershed area would be 1,138 acres.

A deep seepage estimate was completed as a part of the proposed ESMM project water and chemical balance report (Barr Engineering 2010d). The proposed ESMM project estimates year 15 deep seepage to be 199 gpm based on site-specific geotechnical data, two-dimensional seepage modeling, and a sensitivity analysis, as compared to the original MSI project's conceptual vertical seepage modeling, which lacked the new site-specific data. Deep seepage rates prior to year 15 were estimated using the same numerical model and material properties as for the 199 gpm estimate, but with modified boundary conditions that account for the planned construction schedule for the tailings disposal facility. Note that the proposed ESMM project water and chemical balances use an average seepage rate of 183 gpm for years 11-15 (e.g. Tables 4.1-5, 4.1-6 and 4.1-7), whereas 199 gpm is a maximum (year 15) seepage rate. Deep seepage loss was estimated to be 758 gpm in the original MSI project.

A comparison of the original MSI project to the proposed ESMM project is shown in Table 4.1-9, and the subsequent narrative describes how the potential deep seepage value was obtained.

Table 4.1-9. Tailings Basin Deep Seepage Comparison of the Original MSI Project to the Proposed ESMM Project

Project	Operation Condition (mmtpy)	Seepage (gpm)			
		1 Year	5 Year	15 Year	20 Year
Original MSI Project (MNDNR and USACE 2007)	4.1	382	382	----	758
Proposed ESMM Project (Barr Engineering 2010d)	4.1 (2 yr) / 6.5 (13 yr)	58	118	199	----

For the proposed ESMM project, site-specific geotechnical data and a detailed tailings basin design provided more accurate parameterization for deep seepage modeling. As a result, an alternative method to model deep seepage loss to groundwater was employed.

The original MSI project deep seepage estimate (758 gpm in year 20) was based on Darcy's Law assuming only vertical seepage through the bottom of the tailings basin (Barr Engineering 2006d). The model assumed 20 feet of underlying glacial till below deposited tailings, with an assumed permeability of 1.0x10-3 feet/day. The model also assumed that groundwater mounding reduced the head differential across the clay layer to 10 feet. This is a simplified model in that seepage is assumed to flow vertically and no horizontal component of flow is included. Results indicate seepage values increase with time which corresponds to increased pond head.

The analysis of deep seepage for the proposed ESMM project uses the two-dimensional SEEP/W module of Geo-Studio developed by GEO-Slope International, which accounts for seepage through and under the dams. The SEEP/W deep seepage estimate is considered more accurate because it uses measured rather than estimated permeability values and it takes advantage of detailed dam cross sections developed from borings performed since the MSI FEIS was completed. Estimating flow through and under the dams is a more realistic conceptual model, rather than assuming all seepage leaves the basin vertically through the bottom of the basin. Horizontal flow beneath the existing dams is what defines deep seepage in the simulations. Captured seepage is any flow which passes above the bottom of the existing dam. The tailings basin would have a seepage collection system around the entire perimeter, which is anticipated to capture flow above the bottom of existing embankment dams. Pond pump stations and pipes would deliver seepage and any accumulated runoff from the seepage collection system back to the tailings basin. The *Tailings Basin Design Report* provides additional detail (Barr Engineering 2010f).

SEEP/W uses the finite-element analysis technique to model the movement and pore-water pressure distribution within porous materials such as soils. SEEP/W has a comprehensive formulation, which makes it possible to analyze both simple and highly complex seepage problems. All models were checked for convergence, which indicates a computed value does not vary, between iterations, by more than a specified amount. Seepage modeling convergence was tested using hydraulic conductivity at individual Gauss points which computes the percentage of Gauss points which have a hydraulic conductivity within a specified tolerance. All models converged within reasonable prescribed tolerances, as identified in Attachment D of Appendix B of the updated water and chemical balance (Barr Engineering 2010d). Water balance for each 15 year model section was checked by comparing flow results across two flux lines. The first flux line was drawn parallel to the upstream slope of the tailings basin (inflow line). The second flux line was drawn as a vertical line just upstream of the existing starter dam. Similar flux values indicate an acceptable water balance. A comparison of inflow and outflow flux lines resulted in less than 1% difference for each of six model sections.

Each model section's geometry is based on existing conditions determined from topography of the existing area and stratigraphy from previous geotechnical investigations. The proposed dam and reservoir geometries are based on results from previously performed stability analyses models. The stability models determined allowable slopes for anticipated crest and pond elevations. Crest and pond elevations, estimated based on production and storage needs of the reservoir, were designed with the possibility of a 4-foot bounce, and are presented in the updated water and chemical balance (Barr Engineering 2010d). These numbers are subject to change depending upon actual operating rates.

Each material included in the model stratigraphy is defined as a region. Each region has a single permeability value associated with it for the modeling. Each permeability value is given a hydraulic k function number which acts as a reference label for what permeability function is applied to what material.

The bottom and right edges of the model are by default non flux boundaries. The top surface of the model includes two user defined boundary conditions. All nodes downstream of the dam crest have a seepage review face boundary condition applied; the upstream reservoir is modeled by applying a hydraulic head boundary condition equal to the anticipated pond elevation. The seepage face review boundary condition is set such that no flow (Q=0) is anticipated to cross the surface during the first iteration of the model, however flow across this surface is reviewed at each iteration and heads are computed for all nodes along the potential seepage face. Flux is then adjusted by the model as necessary and some seepage is allowed by the model to discharge across the surface if necessary. A second user defined boundary condition applied in all deep seepage models is the application of a fixed hydraulic head at a node along the upstream reservoir. This boundary condition has a head set equal to the estimated reservoir elevation for the 1, 5, or 15 year reservoir level. A total head condition was applied to the left side (downstream) edge of the model. The total head applied was set equal to a near surface hydrostatic head (a total head with elevation slightly less than the ground surface).

A number of Geo-Studio model sections have been developed since the MSI FEIS around the proposed Essar tailings basin perimeter and were created as a part of the tailings basin stability analysis for the original MSI project design. These sections are located where geotechnical investigations were carried out and therefore corresponding field and laboratory data exist at these locations. Geotechnical investigation locations were selected on the basis of anticipated deposits of older tailings and organic deposits. Selected design sections from this work were identified for inclusion in the deep seepage analysis. Sections from the proposed perimeter dam were included in the Geo-Studio analysis.

A flux section is a user-defined boundary which computes the instantaneous seepage volume rate which crosses the boundary. Calculation of deep seepage was made by first drawing a vertical flux section in native soil beneath the existing dams. The flux sections are oriented in the vertical direction to intercept the horizontal seepage. The bottom elevation of the seepage model corresponds with bottom of boring elevations obtained during the geotechnical investigation conducted at the site in 2006. Boring logs do not indicate whether boring termination was due to the presence of bedrock.

4.1.2.2.1 Clay Till Permeability

Geotechnical investigations including laboratory testing data and cone penetration testing (CPT) dissipation testing have been conducted since the MSI FEIS. These provided physically-based estimates for hydraulic conductivity of soils in and around the tailings basin; in particular, the clay till or clay alluvium that underlies a large portion of the site. However, the actual stratigraphy at the site is likely more complex than what can be interpreted from boring logs and simulated in a groundwater flow model. The assumption of laterally continuous, low permeability strata in the flow model presents uncertainty when the model results are used to estimate actual groundwater flow conditions. In addition, laboratory and CPT dissipation tests are known to underestimate fieldscale behavior of low permeability soils such as clay till. To address these issues, a sensitivity analysis was applied to the hydraulic conductivity of clay till and clay alluvium used in the flow model, and this provided a reasonable upper-limit hydraulic conductivity, and, therefore, deep seepage rate, for these materials (Barr Engineering 2010d). The three clay till hydraulic conductivity values applied to the model are shown in Table 4.1-10.

Table 4.1-10. Sensitivity Analysis Clay Till Hydraulic Conductivity Values and Resulting Year 15 Tailings Basin Deep Seepage

Case	Hydraulic Conductivity (cm/s)	Reasoning	Year 15 Deep Seepage (gpm)
1	$2.8x10^{-8}$	Arithmetic average value based on nine laboratory hydraulic conductivity tests conducted on undisturbed thin-wall samples	65
2	$1.4x10^{-7}$	Geometric mean of eight conductivity tests determined from in-situ CPT dissipation testing	119
3	$2.8x10^{-6}$	Sensitivity value selected as two orders of magnitude more conductive than the case 1 value.	199

The least permeable of these values is 2.8x10-8 cm/s, which is less than the previously assumed value. This value was determined as the arithmetic average permeability value from nine laboratory hydraulic conductivity tests (ASTM D5084). All material tested was undisturbed and obtained in the field through thin wall Shelby tube sampling (ASTM D11587). The second hydraulic conductivity value utilized for sensitivity is 1.4x10-7 cm/s and which was based on eight pore-pressure dissipation tests from CPT. The third hydraulic conductivity value used in the sensitivity modeling is 2.8x10-6 cm/s and was based on a chosen value two orders of magnitude more conductive than the laboratory test conductivity.

The sensitivity analysis results in a range in anticipated deep seepage flows in year 15 between 65 and 199 gpm. Upon review of the resultant data, the greatest magnitude hydraulic conductivity (2.8x10-6 cm/s) was selected for use with the water balance. All results presented in this report applied this hydraulic conductivity value to the clay till. This selected value represents a conservative (high-end) estimate of what the clay till conductivity and resulting deep seepage values are expected to be. Deep seepage estimates would be refined through the use of monitoring during the life of the tailings basin.

Where clay till or clay alluvium is absent, the most likely (natural) lower permeability material is silty sand till, which is estimated by Barr to have a hydraulic conductivity equal to 8x10-7 cm/s based on field and lab data [see Attachment C in the updated water and chemical balance (Barr Engineering, 2010d]. This hydraulic conductivity value is less than, but similar to, the high-end value used in the clay till permeability sensitivity analysis (2.8x10-6 cm/s). It is the MNDNR opinion that the sensitivity result based on the high-end hydraulic conductivity provides a simulation that reasonably compensates for the uncertainty associated with two remaining technical issues pertaining to deep seepage at the tailings facility:

- Uncertainty regarding the lateral continuity of the clay till or clay alluvium within and between the cross-sections
- Absence of seepage simulations along the eastern boundary of the facility, which according to the boring logs does not contain clay till or clay alluvium material over large areas

The anticipated year 15 deep seepage value is estimated to be 199 gpm. Lateral seepage is estimated to be approximately 2,000 gpm with pond elevations in year 15. The lateral seepage collection system is anticipated to handle this volume and return it to the tailings basin.

The performance of the dams would be monitored with instrumentation, regular inspections and ongoing geotechnical investigations in order to check the effectiveness of the lateral seepage collection system. Actual formation permeability would undergo additional investigation through instrumentation, slug testing, pumping tests at piezometer locations, additional laboratory testing and borings, and updated water balance calculations.

For this SEIS, the deep seepage estimate of 199 gpm, based on the sensitivity analysis performed using the hydraulic conductivity equal to two magnitudes form the original measured hydraulic conductivity, is considered a reasonable estimate for the proposed ESMM project. This decision is based on the uncertainty of the lateral continuity of the clay till or clay alluvium and the absence of seepage simulations along the east side of the tailings basin. Years 1 and 5, the other two years in which the dam and pond heights have been calculated, were modeled in Geo Studios using the same parameters as year 15. The year-by-year water balance uses the year 1, 5 and 15 modeled results with the interim years being interpolated to complete the yearly balance.

4.1.2.3 Potential Effects of Tailings Basin Deep Seepage on Downstream Water Bodies

The water quality of the deep seepage loss was evaluated in a chemical balance model to assess the potential effects (Barr Engineering 2010d). Since the estimated deep seepage rate and water quality have changed from that predicted for the original MSI project, an updated chemical balance was completed for the proposed ESMM project to evaluate the tailings basin water quality and, therefore, potential deep seepage effects on downstream water bodies (Barr Engineering 2010d).

4.1.2.3.1 Tailings Basin Water Quality

No water from the pellet plant, DRI plant, and steel mill is returned to the concentrator or tailings basin, so those processes were not included in water quality modeling. The tailings basin only receives precipitaton and water used to convey tailings to the basin from the concentrator. Tailings basin water quality has been estimated using two approaches: mass balance modeling in the same manner as was conducted for the original MSI project water chemical balance, and use of actual tailings basin data from an analog site

The water quality constituents evaluated were not exhaustive and are the same as those analyzed for the original MSI project (in Section 6.7.2, Table 6.7.1 of the MSI FEIS). The constituents are those expected to be present in the tailings basin water in dissolved form and hence have a potential to accumulate over time. The constituents include calcium, chloride, fluoride, magnesium, nitrogen, phosphorus, sodium, sulfate, and total dissolved solids. Other constituents that either adsorb extensively to particulates in water or precipitate readily from solution at the concentrations anticipated were not evaluated.

The tailings basin mass balance modeling approach has not changed from the original MSI project water chemical balance. The refinements in the designs and changes to the water balance have resulted in model updates. In the mass balance model, dissolved constituents are added to the tailings basin open water pools from the following sources:

- Crushing and wet concentrating of ore,
- Use of make-up water from Pits 1 and 2 and other water sources,
- Oxidation of sulfur on tailings deposited in the tailings basin, and
- Direct precipitation to the tailings basin.

As in the original MSI project, mass loading estimates from crushing and wet concentrating of ore were developed from a pilot plant study that was performed with MSI ore at the Midland Research Center (Table 4.1-11) (Barr Engineering 2006e). The filter size used to filter samples (5 µm) was too coarse to accurately discriminate between dissolved and suspended solids. Conventionally a 0.45 µm filter size would be used. In addition, the pilot study did not analyze the water for carbonate or bicarbonate species thereby preventing completion of a cation-anion balance. Despite these limitations, the same mass balance modeling that was performed for the original MSI project was completed for the proposed ESMM project for comparison of the results.

Tables 4.1-12 and 4.1-13 compare the proposed ESMM project to the original MSI project and to State water quality standards. The proposed ESMM project estimated annual mass of sulfate from the tailings to the tailings basin water as compared to the original MSI project is shown in Table 4.1-12. The estimated total loading of sulfate, for the proposed ESMM project as compared to the original MSI project is shown in Table 4.1-13. The mass balance model predicted average, maximum and minimum constituent concentrations for the tailings basin during the 15 years of mining and plant operations are shown in Table 4.1-14. Table 4.1-15 illustrates that the range of concentrations of all of the parameters predicted with the mass balance model are consistent with that for the original MSI project, although the updated concentrations typically have a smaller range between the minimum and maximum concentrations compared to the original MSI project.

Table 4.1-11. Estimated Loading from Ore Crushing and Concentrating Based on Pilot Plant Study with MSI Ore for Use in Mass Balance Modeling

Parameter	Net Mass Contribution (g/metric ton of ore feed)[1]
Ca + Mg Hardness as CaCO3	62
Calcium	-33
Chloride	2.6
Fluoride	0
Total Dissolved Solids[2]	208
Sulfate	6.7
Magnesium	33
Manganese	1.5
Nitrogen	0
Sodium	Not Available[3]

[1] Barr Engineering (2006e)
[2] Directly measured
[3] Not measured

Table 4.1-12. Estimated Annual Mass of Sulfate from Tailings to the Tailings Basin Water

Year	Annual Mass from Tailings to Tailings Basin Water (metric ton/year)	
	Proposed ESMM Project	Original MSI Project
1 - 5	349	148
6 - 10	424	218
11 - 15	445	
11- 20	NA	

Table 4.1-13. Estimated Total Loading of Sulfate to Tailings Basin Water

Year	Loading (g/metric ton of ore feed)	
	Proposed ESMM Project	Original MSI Project
1 - 5	35	30
6 - 10	36	31
11 - 15	35	33
11- 20	NA	

Table 4.1-14. Mass Balance Model Results: Concentration of Constituents in Tailings Basin Water and Groundwater Quality Standards

Constituent	Tailings Basin Concentration (mg/L)			GW Standards (mg/L)[1]		
	Average	Maximum	Minimum	MCL	HRL	sML
Calcium	21	23	19	--	--	--
Chloride	14	15	12	--	--	250
Fluoride	0.12	0.13	0.12	4	--	2
Hardness	488	510	391	--	--	--
Magnesium	106	110	83	--	--	--
Nitrate + Nitrite	0.7	0.8	0.5	<u>11</u>	<u>11</u>	11
Phosphorus	0.011	0.016	0.008	--	--	--
Sodium	5.3	5.7	5.1	--	--	--
Sulfate	96	101	79	--	--	250
Total Dissolved Solids[2]	760	790	606	--	--	500

[1]<u>Groundwater Criteria:</u>
sMCL - Secondary MCLs (40 CFR 143) based on aesthetics.
MCL - Maximum Containment Levels (40 CFR 141)
HRLs - Health Risk Limits (MN Rules 4717.7500)
Nitrate+Nitrate: Nitrate standard is 10 mg/L, and nitrite standard is 1 mg/L, for a total of 11 mg/L

[2]Total dissolved solids (TDS) shown in this table is not a result of the sum of listed cations and anions. The TDS was directly measured for the ore crushing and concentrating pilot study and in the evaluation of make-up water. It is estimated that the excess dissolved solids contributed by crushing and concentrating consist primarily of bicarbonates.

Table 4.1-15. Mass Balance Modeling Results: Concentration of Constituents in Tailings Basin Water for the Original MSI (2006 Average) and Proposed ESMM (2010 Average) Projects

Constituent	Tailings Basin Concentration (mg/L)					
	2010 Average	2006 Average	2010 Maximum	2006 Maximum	2010 Minimum	2006 Minimum
Calcium	21	19	23	20	19	12
Chloride	14	14	15	16	12	11
Fluoride	0.12	0.11	0.13	0.13	0.12	0.09
Hardness	488	522	510	611	391	313
Magnesium	106	115	110	136	83	69
Nitrate + Nitrite	0.7	1.5	0.8	1.8	0.5	0.8
Phosphorus	0.011	0.017	0.016	0.025	0.008	0.014
Sodium	5.3	4.8	5.7	6.2	5.1	4.1
Sulfate	96	101	101	116	79	67
Total Dissolved Solids[1]	760	825	790	967	606	506

[1]Total dissolved solids (TDS) shown in this table is not a result of the sum of listed cations and anions. The TDS was directly measured for the ore crushing and concentrating pilot study (Barr Engineering 2006e) and in the evaluation of make-up water. It is estimated that the excess dissolved solids contributed by crushing and concentrating consist primarily of bicarbonates.

Based on average concentrations, the constituents that show an increase in concentration compared to the original MSI project include calcium, fluoride, and sodium. The constituents that show a decrease in concentrations include hardness, magnesium, nitrate + nitrite, phosphorus, sulfate, and total dissolved solids. These changes in concentrations can be explained by the water balance flow parameter in the model, although the volume of make-up water needed for the concentrator has nearly doubled from the original MSI project with the increased rate of production.

As described, the pilot plant study resulted in the introduction of errors in the measurements based on which the mass loadings were estimated (Barr Engineering 2006e). In addition, the cation-anion balance is incomplete in the analysis. To provide better certainty of the proposed ESMM project estimates to be used in evaluating downstream water body effects, the final results of this water chemical balance modeling have been compared to existing tailings basin water quality monitoring data. Existing tailings basin water quality monitoring data from National Steel Pellet Company (National), now called Keewatin Taconite, is presented in Table 4.1-16 alongside the proposed ESMM project mass balance model results. National tailings basin water quality monitoring data are used as an analog for evaluation of potential deep seepage effects on downstream water bodies (Section 4.1.2.3.2).

Table 4.1-16. Concentration of Constituents in the Tailings Basin: Mass Balance Model Results Compared to Analog (Monitoring Data from National's Tailings Basin)

Constituent	Essar's Mass Balance Model Water Quality (mg/L)			National Steel's Reclaim Pond (mg/L)[1]			Inland Steel's Reclaim Pond (mg/L)[1]	LTV Steel's Reclaim Pond (mg/L)[1]
	Average	Max	Min	Average	Max	Min	Average	Average
Calcium	21	23	19	25	33	20	29	21
Chloride	14	15	12	22	25	19	51	33
Fluoride	0.12	0.13	0.12	0.98	1.14	0.85	2.74	8.50
Hardness[2]	488	510	391	202	239	178	241	201
Magnesium	106	110	83	34	38	31	41	36
Nitrate + Nitrite	0.7	0.8	0.5	2.2	3.4	0.7	0.6	1.1
Phosphorus	0.011	0.016	0.008	0	0.01	0	0.03	0
Sodium	5.3	5.7	5.1	33.5	37.8	28.8	26.2	117.0
Sulfate	96	101	79	52	65	42	48	120
Total Dissolved Solids[3]	760	790	606	374	Not available		394	630

[1]Data from Appendix V, Berndt, Lapakko, and Jakel, June 1999, In-Pit Disposal of Taconite Tailings: Geochemistry. Essar Steel's modeled water should only be compared to National Steel's sampled water. LTV and Inland Steel's water was provided for reference, but both those facilities recycle their process water, including that from the wet scrubber system. National Steel was not using a wet scrubber at the time of the sampling effort. There will not be any materials of combustion or scrubber water recycled through the Essar Steel tailings basin either.

[2]Hardness is calculated from calcium and magnesium.

[3]Total dissolved solids are calculated as the sum of all major cations and anions in the study, which is more extensive than this table of constituents.

Existing tailings basin water quality data in Table 4.1-16 were available from a 1999 study by Berndt, Lappako and Jakel at three existing taconite mining operations in Minnesota over a three year period (Berndt et al. 1999). These facilities include National near Keewatin, Inland Steel Mining Company (Inland) near Virginia, and LTV Steel Mining Company (LTV) near Hoyt Lakes. The 1999 report describes the process at each facility as follows:

> *National uses nothing beyond magnetic-separation to process their ore, Inland uses flotation to decrease SiO2 in their pellets, while LTV uses flotation and softens their water. Inland and LTV both use a wet scrubber system to remove particulates from their gas emissions, while National uses a dry mechanical collector. Possibly significant, is the fact that LTV placed 262,652 LT of sulfur bearing (3.19% average) hornfelsic waste rock from the Virginia formation and 31,468 LT of dolomitic limestone in their tailings basin in 1994 (LTV, 1996). These distinct differences in processing techniques and tailings basin construction lead to distinct differences in water quality at each site.*

Since the report by Berndt et al. (1999), additional information has become available indicating that the LTV tailings, rather than the hornfelsic waste rock, are the primary source of the sulfate found in LTV seeps.

Of the different operations represented in Table 4.1-16, the proposed Essar operation most resembles the National operation in that there would be magnetic separation and no products of combustion from the air pollution control system going to the tailings basin. Essar's operation is less than 10 miles west of National's operation. The 1999 data from National is representative of full scale operations with similar ore being processed with similar methods (magnetic separation with no scrubber water or materials of combustion being added). National's operation varies from that proposed by Essar due to variability in the ore, water budgets, make-up water quality, and because National's operation does not include a seepage collection system. This latter difference between the sites would tend to result in higher concentrations at Essar than those at National. Table 4.1-16 compares mass balance model results for Essar's tailings basin with National's 1999 water quality data, which accounts for scale, operational conditions, and environmental conditions.

4.1.2.3.2 Potential Effects on Downstream Water Bodies

Table 4.1-17 through Table 4.1-19 show predicted sulfate, hardness, and total dissolved solids contributions, respectively, from the tailings basin to downstream waters for early, mid, and late stages in ore feed. Each table shows the original MSI project results for comparison purposes. Predicted concentrations and loads are based on the analog model with the mass balance model results presented in parentheses for reference. For each of these constituents modeling predicts lower concentrations and loading compared to the original MSI project. In particular, the sulfate load from the proposed ESMM project is estimated to be approximately one million pounds less than that for the original MSI project for year 1 through 15. These results were expected in light of the lower estimate of deep seepage loss for the proposed project.

Table 4.1-17. Predicted Sulfate Contributions to Downstream Waters for Early, Mid, and Late Stages of Tailings

Year	Tailings Basin Loss to Groundwater (gpm)	Average Tailings Basin Sulfate Concentration (mg/L)[1]	Sulfate Load (lb/year)[1]
1-5	88	52 (84)	20,100 (32,500)
6-10	142	52 (100)	32,500 (62,300)
11-15	183	52 (96)	41,700 (77,100)
For comparison, original MSI project results are provided below:			
1-5	149	52 (110)	34,000 (65,000)
6-10	372	52 (116)	84,800 (190,000)
11-15	758	52 (116)	172,900 (390,000)
16-20	758	52 (67)	172,900 (220,000)

[1]Results include the analog model with the mass balance model results in parentheses for reference.

Table 4.1-18. Predicted Hardness Contributions to Downstream Waters for Early, Mid, and Late Stages of Tailings

Year	Tailings Basin Loss to Groundwater (gpm)	Average Tailings Basin Hardness Concentration (mg/L)[1]	Hardness Load (lb/year)[1]
1-5	88	202 (426)	77,900 (164,400)
6-10	142	202 (506)	126,200 (316,300)
11-15	183	202 (489)	161,800 (391,500)
For comparison, original MSI project results are provided below:			
1-5	149	202 (442)	132,000 (289,000)
6-10	372	202 (603)	329,600 (983,700)
11-15	758	202 (530)	671,600 (1,763,100)
16-20	758	202 (519)	671,600 (1,725,700)

[1]Results include the analog model with the mass balance model results in parentheses for reference.

Table 4.1-19. Predicted Total Dissolved Solids Contributions to Downstream Waters for Early, Mid, and Late Stages of Tailings

Year	Tailings Basin Loss to Groundwater (gpm)	Average Tailings Basin TDS Concentration (mg/L)[1]	TDS Load (lb/year)[1]
1-5	88	374 (655)	144,200 (252,500)
6-10	142	374 (785)	233,700 (490,400)
11-15	183	374 (760)	299,600 (608,800)
For comparison, original MSI project results are provided below:			
1-5	149	374 (698)	244,400 (456,300)
6-10	372	374 (966)	610,300 (1,576,500)
11-15	758	374 (834)	1,243,500 (2,772,000)
16-20	758	374 (815)	1,243,500 (2,708,400)

[1]Results include the analog model with the mass balance model results in parentheses for reference.

The stage modeling results indicate that the concentration of constituents in the tailings basin would increase early on, level off, and then decline in the later stage. The pattern is largely attributed to the result of deep seepage lost through the bottom of the tailings basin and the resulting mass lost from the system. That value is quite a bit smaller in the proposed ESMM project.

Tailings basin constituents data were then used to model the downstream water body effects, coupling the load and deep seepage values with Swan Lake nutrient data to estimate the *incremental* increase in Swan Lake sulfate concentration as a result of the proposed ESMM project. Maximum increases in sulfate concentrations predicted for Swan Lake are reported in terms of varying lake outflow rates (Table 4.1-20). Concentrations are based on the entire sulfate load from the tailings basin groundwater deep seepage completely mixing with the entire lake (except for Southwest Bay) during average, wet and dry inflows to Swan Lake. The model is a simple mixing tank model and therefore assumes the sulfate load is conservative without regard to natural or biological processes that may remove sulfate from the system. The model also assumes the time to reach equilibrium in the mixing zone is instantaneous. This model was developed in 2006 and is discussed in detail in the *Swan Lake Nutrient Study* (Wenck Associates, Inc. 2006). It consists of a spreadsheet model based on calculations in BATHTUB and MNLEAP. Based on this study, the Swan Lake summer stratified surface average sulfate concentration in 2005 was 20 mg/L. However, 2010 sampling in Swan Lake (see Section 4.1.2.4.1 Baseline Water Quality Monitoring of Downstream Waterbodies), resulted in average concentrations of 24 mg/L for the center of the lake (KSW5) and the southeast bay (KSW4), 23 mg/L for the west bay (KSW6), and 7 mg/L for the Southwest Bay (KSW7) (Barr Engineering 2010a). Based on these measurements, the average sulfate concentration for the main body of the lake, not including the Southwest Bay is 24 mg/L. The Southwest Bay has wild rice and is an isolated bay that is tributary to the main body of the lake, i.e., the main flowage through the lake does not flow through this bay.

Swan River also has wild rice, and it is estimated that the water quality in Swan River at the outlet from Swan Lake would be of similar water quality as the main body of Swan Lake. In the *Swan Lake Nutrient Study*, the incremental increase in sulfate concentrations were predicted (Table 9 of that report) (Wenck Associates, Inc. 2006). This prediction was made based on a simple calculation using the outflow of the lake, the inflow of the deep seepage (assuming instantaneous and complete mixing), and the sulfate load in the deep seepage. This calculation is updated in Table 4.1-20 using the same lake outflows, updated inflows from deep seepage, and the updated sulfate load from the proposed ESMM project. This evaluation results in mean sulfate concentration increase in Swan Lake of 0.3 mg/L with mean inflow. This compares to the original MSI project prediction (*Swan Lake Nutrient Study*) of 3.3 mg/L for mean inflows and a range from about 2 to 7 mg/L.

Table 4.1-20. Incremental Swan Lake Sulfate Concentration Increases for Different Lake Outflow Volumes

Swan Lake Outflow Parameter	Outflow[1] (acre-feet/year)	Swan Lake Background Sulfate Concentration (mg/L)1	Incremental Swan Lake Sulfate Concentrations with Dilution (mg/L) Proposed ESMM Project[2]	Incremental Swan Lake Sulfate Concentrations with Dilution (mg/L) Original MSI Project[1]
Mean	44,200	24	0.3	3.3
Minimum	20,400		0.8	7.4
Maximum	72,600		0.2	2.1
Standard Deviation	15,900			NA
Wet (Mean + S.D.)	58,600		0.3	2.5
Dry (Mean – S.D.)	29,900		0.5	5.2

[1]Outflow data and MSI FEIS data is provided in the *Swan Lake Nutrient Study* (Wenck Associates, Inc. 2006). The Swan Lake background sulfate concentrations were updated from 20 mg/L based on the results of the *2010 Water Quality and Wild Rice Monitoring Report, Version 1*.

[2]Proposed ESMM project data is based on year 11-15 load from Table 4.1-17.

The original MSI project has already been permitted for the estimated incremental increase, and the proposed ESSM project provides an order of magnitude reduction in this incremental increase.

To caution against potentially greater incremental increases in Swan Lake sulfate concentration, model input parameters were varied based on the deep seepage inflows and the sulfate concentrations in the deep seepage. If either the deep seepage flows (Table 4.1-21) or the deep seepage sulfate concentration (Table 4.1-22) increase by an order of magnitude, the increase in sulfate would be approximately equal to what was predicted in the original MSI project. Based on the sensitivity analysis completed for the deep seepage flows and the evaluation of constituents in existing tailings basins (Table 4.1-14 through Table 4.1-16), an order of magnitude increase in deep seepage flows or deep seepage sulfate concentration would not be anticipated under proposed ESMM project conditions.

Table 4.1-21. Sensitivity Analysis on Incremental Swan Lake Sulfate Concentration Increases with Respect to Deep Seepage Flow

	Tailings Basin Loss to Groundwater (gpm)	Average Tailings Basin Sulfate Concentration (mg/L)	Sulfate Load (lb/yr)	Incremental Swan Lake Sulfate Concentrations with Dilution (mg/L)
Minus 1 Order of Magnitude	18.3	52	4,174	0.0
2010 Model Approach	183	52	41,740	0.3
Plus 1 Order of Magnitude	1,830	52	417,403	3.5
Plus 2 Orders of Magnitude	18,300	52	4,174,033	34.5
MSI FEIS Results	758	67	220,000	3.3

[1]This flow represents the maximum loss to deep seepage (year 15), as compared to the year 11-15 average flow used in Table 4.1-17 and Table 4.1-20.

Table 4.1-22. Sensitivity Analysis on iIncremental Swan Lake Sulfate Concentrations with Respect to Deep Seepage Concentration

	Tailings Basin Loss to Groundwater (gpm)	Average Tailings Basin Sulfate Concentration (mg/L)	Sulfate Load (lb/yr)	Incremental Swan Lake Sulfate Concentrations with Dilution (mg/L)
Minus 1 Order of Magnitude	183	5.2	4,174	0.0
2010 Model Results	183	52	41,740	0.3
Plus 1 Order of Magnitude	183	520	417,403	3.5
Plus 2 Orders of Magnitude	183	5,200	4,174,033	34.5
FEIS Results (Wenck, 2006)	758	67	220,000	3.3

4.1.2.4 Potential Effects on Wild Rice

4.1.2.4.1 Baseline Water Quality Monitoring of Downstream Waterbodies

According to NPDES/SDS permit requirements baseline monitoring is a requirement of proposed action. Data are thus available for the original MSI project baseline monitoring prior to permit issuance, and monitoring has continued in accordance with the NPDES/SDS permit requirements. These data are applicable to the proposed ESMM project.

The current NPDES/SDS permit requires that at least two years of water quality monitoring be collected prior to the start-up of the tailings basin and two years of monitoring data collected during operation of the tailings basin. This includes surface water monitoring of the main body and north bay of Swan Lake (as well as Oxhide Lake, Snowball Lake & O'Brien Lake). Data are reported to the MPCA and used to identify adverse impacts to groundwater and surface water resources, which could trigger corrective actions. The following types of sites and the corresponding water quality constituents are included in monitoring requirements:

- **Groundwater (5 wells – 1 upgradient, 4 downgradient; monitoring site labels begin with 'MW'):** Alkalinity, calcium, chloride, chromium, cobalt, fluoride, hardness, iron, magnesium, manganese, mercury, molybdenum, nitrite + nitrate, pH, potassium, sodium, TDS, specific conductance, and sulfate.
- **Surface water [5 locations – Oxhide Lake, Snowball Lake, Swan Lake in the main body (KSW5) and Southwest Bay (KSW7), and O'Brien Lake; monitoring site labels begin with 'SW' or 'KSW']:** Chlorophyll a, Eh, iron, pH, DO, orthophosphate, phosphorus, TSS, specific conductance, sulfate, and water temperature.
- **Internal monitoring point (1 location – discharge of concentrator water to tailings basin):** calcium, chloride, elevation (relative to reference point), fluoride, hardness, magnesium, mass transported from facility (tons of tailings transported to tailings basin), nitrite + nitrate, phosphorus, sodium, TDS, and sulfate.

Site locations (Figure 4.1-3) are labeled using various codes, depending on the investigators. Alphanumeric codes (KSWx) were developed by the preparer's of the Keetac Expansion Project's 2009 monitoring report (Barr Engineering 2010e), and other codes such as GW-001, WS-001, SW-001 were developed by MPCA for the NPDES/SDS permit.

Additional water quality monitoring was conducted in conjunction with wild rice reporting. These monitoring sites are also shown in Figure 4.1-3 and begin with 'KSW'. Swan Lake had four water quality monitoring sites: one in the main lake, one in the southeast bay, and two in the Southwest Bay. Only Swan Lake underwent biweekly water quality monitoring throughout the entire 2010 growing season because it was the only water body within the vicinity that exhibited populations of wild rice. In the Southwest Bay, the location of wild rice populations, Monitoring Site KSW7 is located in shallow water (approximately 2- to 3-feet deep) near the outlet to the Swan River. The bay is attached to the main body of Swan Lake by a small channel. There are no other substantial inlets or outlets to Swan Lake Southwest Bay.

Water quality samples collected at the surface were analyzed for the following parameters: sulfate, calcium, magnesium, total iron, temperature, specific conductance (SC), pH, dissolved oxygen (DO), and oxidation-reduction potential (Eh or ORP). Additional subsurface samples were collected at Swan Lake (Site KSW5) at 4-meter depth intervals and were analyzed for total iron and sulfate. Water quality analyses consisted of unfiltered sulfate analysis by ion chromatography method (EPA 9056) and unfiltered total iron, total calcium, and total magnesium analyses (EPA 6010B). At Site KSW5 field measurements of temperature, pH, dissolved oxygen, and oxidation reduction potential (ORP) were collected at 2-meter intervals using a YSI® model 556 multiprobe or equivalent.

Ongoing surface water monitoring of the main body and north bay of Swan Lake (as well as Oxhide Lake, Snowball Lake and O'Brien Lake) is required by the NPDES/SDS permit. In previous years, the main body of Swan Lake has been monitored for sulfate concentrations by Minnesota Steel/Essar Steel in 2005-2009. These data are from the following sources:

- 2005 data: *2005 Surface Water Quality Monitoring for Pits, Lakes, and Streams within and Downstream of the Minnesota Steel Industries Project Area* Prepared for Minnesota Steel Industries (Barr Engineering 2006c)
- 2006 data: *2006 Surface Water Quality Monitoring within and Downstream of the Minnesota Steel Industries Project Area: Swan Lake, Tributary Streams and Mine Pits* prepared for Minnesota Steel Industries (Barr Engineering 2006d)
- *2008 data: Essar Steel 2008 DMR Summary Report* (Barr Engineering 2008)
- 2009 data: *2009 Water Quality, Hydrology, and Wild Rice Monitoring Year End Report* prepared for U.S. Steel Corporation (Barr Engineering 2010e)

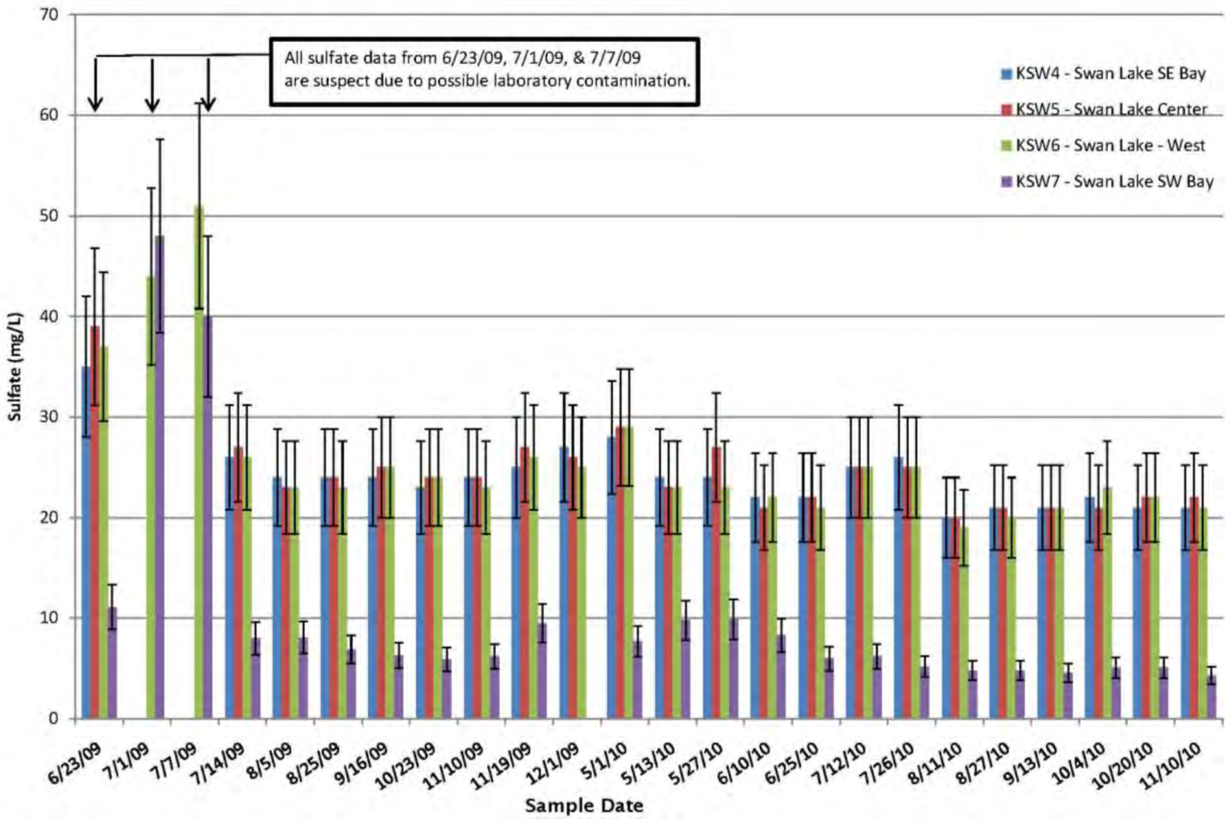
The turbidimetric method was used for 2005 and 2006 sulfate data but is no longer an approved Clean Water Act method per 40 CFR 136 and has not been used for more recent data analyses. Ion chromatography (EPA 9056) is the current method and has been used for all other sulfate data presented in this SEIS.

There would be additional monitoring of the maintenance mine pit dewatering from Pits 5 and proposed Pit 6 to the Sullivan and Ann Pits (flow, iron, oil & grease, pH, phosphorus and TSS) once mining activities begin; monitoring locations are not shown in Figure 4.1-3. Future monitoring will be determined at the time of permit reissuance based on data collected during the permit cycle. Future monitoring requirements have not been determined at this time.

Graph 4.1-3 illustrates the Swan Lake sulfate concentrations from sites monitored in 2010 in conjunction with wild rice monitoring for the proposed Essar project. Year 2009 sulfate data is also shown and from the *2009 Water Quality, Hydrology, and Wild Rice Monitoring Year End Report* prepared for U.S. Steel Corporation (Barr Engineering 2010e). The 2009 water quality sampling data provide additional time points in July which were collected in response to a late June water quality sample with an unusually high sulfate spike. The ion chromatography analytical method has an error range of 20 percent[1] according to laboratory documentation, which is represented by error bars in Graph 4.1-3. Sulfate concentrations in surface samples collected in 2010 from the main body of Swan Lake (KSW4, KSW5, and KSW6) ranged from 18 mg/L to 31 mg/L, and concentrations in Swan Lake Southwest Bay (KSW7) have from 4.3 mg/L to 9.9 mg/L. Swan Lake Southwest Bay has the lowest levels of sulfate (4.3 to 9.9 mg/L), and also contains the largest stand of wild rice. 2010 sampling in Swan Lake resulted in average concentrations of 24 mg/L for the center of the lake (KSW5) and the southeast bay (KSW4), 23 mg/L for the west bay (KSW6), and 7 mg/L for the Southwest Bay (KSW7).

[1] The error range of 20% comes from the % recovery limits for the sulfate laboratory control sample, which is 80-120% (+/- 20%). If the measured result is greater than 80%, but less than 120% of the expected result, the lab will consider the analysis to be *in control*. It can be assumed then, that the lab expects most results to be within a +/- 20% range of actual.

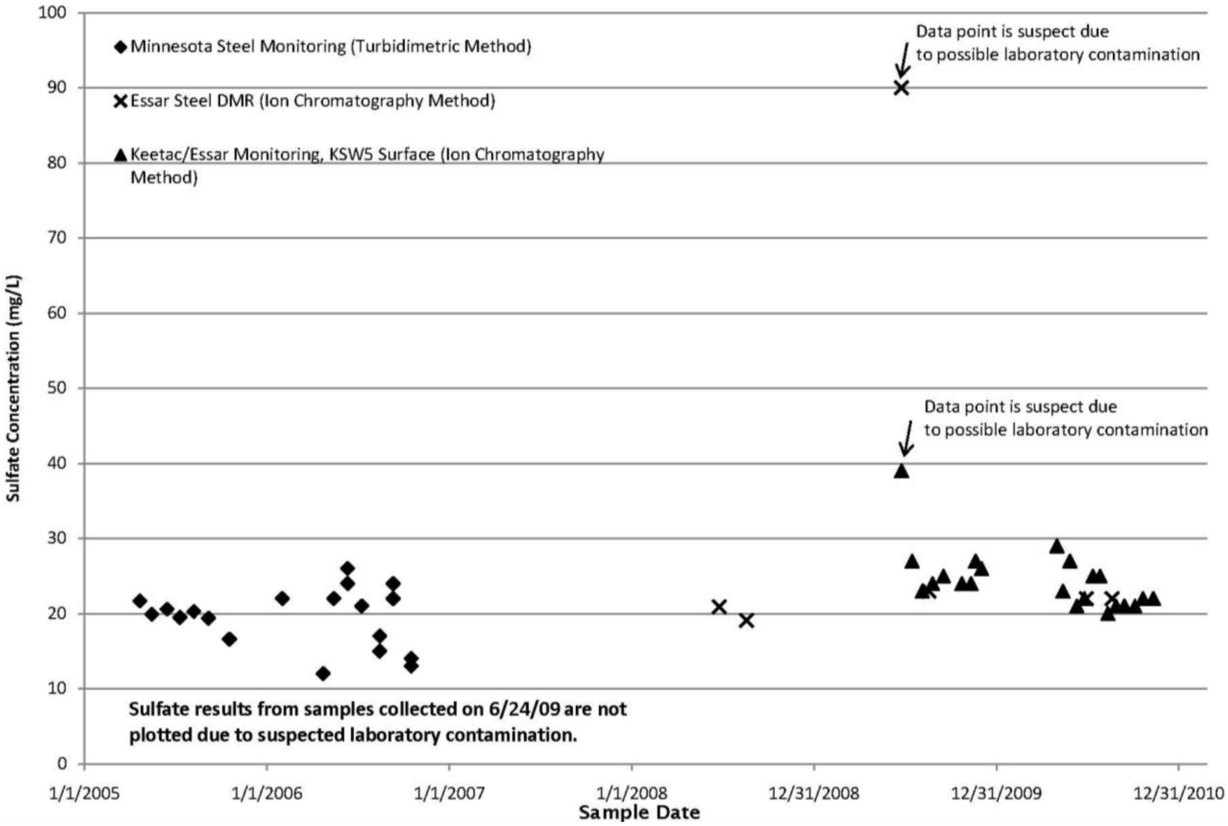
The Swan Lake vs. Southwest Bay mean sulfate value for the main body and Southwest Bay are notably different (24 vs. 7 mg/L). The connection between the Southwest Bay and the main body of Swan Lake is not well understood. As noted earlier, Southwest Bay contains the only mapped stands of wild rice in Swan Lake.



Graph 4.1-3. Ambient Swan Lake Sulfate Levels 2009-2010

Graph 4.1-4 illustrates a longer time period of sulfate data collected from the main body of Swan Lake from 2005 through 2010. Note that the Keetac monitoring data in Graph 4.1-4 is the same as the 2009 Site KSW5 data presented in Graph 4.1-3. Note the presence of a sulfate spike of 90 mg/L in 2009. Unusually high sulfate results occurred in two Swan Lake samples analyzed by Braun Intertec in 2010 as well. In 2010, these samples were immediately rerun, and results upon re-analysis were within typical range of sulfate concentration for Swan Lake. Braun Intertec Laboratory identified the most likely source of error as contaminated bottles used to feed samples into the ion chromatography analytical machine, and has since adopted additional bottle cleaning procedures for sulfate analyses. The 90 mg/L sulfate spike in 2009 (see Graphs 4.1-3 and 4.1-4) is attributed to laboratory error related to ion chromatography bottle contamination at Braun Intertec Laboratory Graph 4.1-4 illustrates an additional data point attributed to the same error.

These data provide an overall ambient evaluation but do not provide a detailed examination of sulfate concentrations within the wild rice stands of Swan Lake Southwest Bay. The mapped wild rice in Swan Lake is located in that bay of the lake, and the water quality in the bay was not predicted as part of the original MSI project.



Graph 4.1-4. Ambient Swan Lake Sulfate Levels 2005-2010

4.1.2.4.2 Wild Rice Populations in the Vicinity of the Proposed ESMM Project

Literature and field investigations were used to document and characterize wild rice in the project vicinity, in accordance with methods reviewed and approved in the *Essar Minnesota SEIS – Wild Rice Surveys and Water Quality Monitoring Protocol*, dated April 9, 2010; final revision June 15, 2010 (Barr Engineering 2010c).

Findings on inquiry to the interagency Wild Rice Management Workgroup on any recent additions to the historic wild rice records database were negative for the affected area (2010 Wild Rice Management Workgroup 2010). Field reconnaissance for wild rice was conducted from shore and by boat in late July 2010 on O'Brien Lake, Oxhide Lake, Snowball Lake, and Pickerel Creek. Findings were negative. This investigation provided a reconnaissance follow up to findings reported in the Water Quality, Hydrology, and Wild Rice Monitoring Year End Report for the Keetac Expansion Project (Barr Engineering 2010e) on literature review, historic aerial photography analysis, and ground surveys. The Keetac Report identified wild rice growth in Swan Lake, with the largest areas in the Southwest Bay.

Wild rice populations, identified in Swan Lake Southwest Bay and Swan River by examining natural and color infrared aerial photos from 2004 and 2008, and field reconnaissance from 2009, were surveyed in detail August 2010. The potential of using offsite infrared photo interpretation for additional future monitoring data was considered. Photographic interpretation accuracy is limited to natural vegetation stands including wild rice greater than 30% density. Photo interpretation and field survey results did not match completely; as such photo interpretation of population presence is no longer being used. Locations were surveyed and grids established in 2009 at Southwest Bay sites and in 2010 at Swan River sites. These populations were used to evaluate various physiological characteristics in situ (stem counts, height), and ex situ (total biomass, root biomass, seed biomass, and seed number).

Swan Lake Southwest Bay has wild rice populations on greater than 90 percent of the shore perimeter area, approximately 104 acres as shown in green shading on Figure 4.1-4. The shaded area was approximately 50-75% of wild rice, interspersed with lilypads and open water. Casual qualitative comparisons of some of the population characteristics have been made, and variations were not considered noteworthy for additional analysis. Water depth was approximately 4 feet throughout Southwest Bay, and anecdotally, water clarity was very good. The substrate was loose sediment with very few cobbles or boulders.

The Swan River site consisted of seven point locations as shown in Figure 4.1-4. Rice density was approximately <10% at most point locations including those within approximately one mile downstream from the outlet of Swan Lake. A stand with density approximately 10-25% and another >75% was identified more than approximately one mile downstream from the outlet of Swan Lake. Swan River wild rice was approximately 80-90% purity. The Swan River substrate was quite rocky in the middle, with somewhat deeper, looser sediment along the edges in the vicinity of the rice.

Studies by resources management organizations [e.g. MNDNR, 1854 Treaty Authority (2008)] show similar findings of the potential detrimental effect of water level increases during the floating leaf stage of wild rice. As an annually seeding grass species, the roots weakly anchor the stems into the mucky substrate relative to persistent perennial root systems. Weak anchoring coupled with the force of buoyancy of the floating leaves causes the plants to be vulnerable to uprooting as the floating leaves pull up with water level increases of any appreciable degree. In the early stage of leaf and root growth, the roots are very weakly anchored, although leaves may not be mature and fully free-floating, but natural current and wave action can be strong enough to uproot an entire stand. Uprooting effects may be variable depending on the extent and vigor of adjacent stands of bulrushes or other more robust species occupying the waterward position in the aquatic system. Wild rice populations are also thought to be vulnerable to decline as a result of sediment loading to the substrate during the seed germination stage. Based on water balance study results and permit requirements, the proposed ESMM project is not anticipated to cause water fluctuations or sediment loading to water bodies known to contain wild rice.

The environmental consequences of the proposed ESMM project on wild rice populations are being considered with respect to the potential for the incremental increase in water column sulfate concentrations compared to that of the original MSI project. Detailed analysis of the tailings basin shows a reduction in deep seepage and a lower incremental increase in sulfate concentrations in Swan Lake (and Swan River) as compared to the original MSI project. Given the lower proposed incremental increase in downstream sulfate concentrations and the distance from the wild rice stands (located in the Swan Lake Southwest Bay and on the Swan River), the ground water/surface water monitoring requirements of the existing permit would be sufficient to identify and address incremental seepage and/or sulfate increases before seepage can affect wild rice. Monitoring of ground water monitoring wells surrounding the tailings basin will be used to identify any increases in loading from tailings basin seepage prior to the seepage reaching surface waters.

4.1.3 Mitigation

The NPDES/SDS and Water Appropriation permits could be used to implement approved mitigation actions.

4.1.3.1 NPDES/SDS Permit Components

4.1.3.1.1 Adaptive Management

Adaptive management is a system of management practices based on clearly identified outcomes and monitoring to determine if management actions are meeting desired outcomes; and, if not, facilitating management changes that would best ensure that outcomes are met or re-evaluated. Adaptive management recognizes that knowledge about natural resource systems is sometimes uncertain.

The NPDES/SDS permit for the proposed ESSM project would take into consideration the process for relating adaptive management, facility water quality monitoring, and operational and maintenance procedures.

4.1.3.1.2 Monitoring

As a condition of the NPDES/SDS permit, monitoring is already being (and would continue to be) conducted to evaluate whether unanticipated operational or maintenance procedures lead to exceedances in any water quality standards.

The water quality monitoring protocol associated with wild rice studies conducted for the Essar Steel SEIS is described on Page 3 of the June 15, 2010 Technical Memorandum *Essar Minnesota SEIS - Wild Rice Surveys and Water Quality Monitoring Protocol* (Barr Engineering 2010c).

Essar is monitoring lake levels on Oxhide, Snowball and Swan Lakes. Low flow seepage from the proposed tailings basin (199 gpm), predicted to reach Swan Lake via groundwater, was considered too low to warrant monitoring flow or water level, respectively, of these water bodies.

4.1.3.1.3 Special Conditions of the Existing NPDES/SDS Permit

The MPCA has developed special conditions for Essar's permit in addition to the sampling requirements already identified. The original MSI project permit expires July of 2012. The tailings basin is not likely to be operational long enough before the permit expires to collect enough data to do any sort of comparison. The special conditions and monitoring requirements would be evaluated by the MPCA for the next permit reissuance. The following paragraphs are special conditions taken from the existing permit.

Chapter 1.2.2.2

After two years of operation of the tailings basin the Permittee shall submit a Comprehensive Groundwater Evaluation Report (Report). The Report shall include a summary of at least two years of groundwater monitoring data collected prior to the start-up of the tailings basin and two years of monitoring data collected during operation of the basin. The purpose of this Report is to assess any potential impacts from the tailings basin to groundwater and to evaluate the effectiveness of the monitoring well network and the need for further groundwater monitoring *requirements or limitations. The Report shall be submitted to the MPCA no later than one year prior to permit expiration.*

Chapter 1.3.3.1

The MPCA may require the Permittee to conduct further evaluations of existing geotechnical information, conduct additional geotechnical investigations and/or ground water assessments to demonstrate the adequacy of the existing ground water monitoring program in assessing water quality impacts. The requirement to conduct additional geotechnical evaluations and/or ground water assessments shall be based upon clear indications of adverse ground water quality impacts due to the operation of the facility. The MPCA's determination that additional evaluations are required shall be consistent with Minn. R. 7060.0500, and with the ground water Limits and Monitoring Requirements section of this permit. Such determinations shall be made consistent with Minnesota rules and applicable court decisions. The Permittee reserves all legal rights to contest the validity or reasonableness of any such determination by the MPCA.

Chapter 1.3.3.2

If after the analysis of the annual report (dike seepage report) required by Section 1.4 of Chapter 5 of this Permit, the MPCA concludes that the operation of the tailings basin has caused adverse changes to groundwater quality, the MPCA shall notify the Permittee. As used in this permit, "adverse changes" are site and constituent specific and will be determined through detection of constituents attributable to tailings disposal (including but not limited to sulfate, chloride, fluoride, hardness, calcium, magnesium, and total dissolved solids) in relation to available baseline data as well as established Health Risk Limits (HRLs). Unless a different time period is established in the notice, within 60 days of receipt of notice of adverse changes from the MPCA, the Permittee shall submit a report that identifies the Permittee's proposed actions in response to the MPCA's notice. These actions may include additional monitoring, the installation of additional monitoring wells, and/or implementation of other corrective actions. The report must include a work plan and time table for all proposed actions. Following review and approval of the report by the MPCA, the Permittee shall implement the actions as approved or modified by the MPCA.

4.1.3.2 Water Appropriation Permit

4.1.3.2.1 Stream Augmentation

Section 4.3.2 of the MSI FEIS reviews the physical impacts to streams and lakes from the original MSI project (not different from the proposed ESMM project), and then describes the development of augmentation plans for Oxhide and Snowball Creeks (MNDNR and USACE 2007). Swan Lake, Pits 1 and 2, and the Harrison/Hawkins/Halobe basins were all evaluated as augmentation water sources in the original MSI project. The Hill Annex pit was evaluated for additional augmentation water if needed.

As part of the Water Appropriation Permit 2006-0433, a Stream Augmentation Plan must be submitted for Oxhide and Snowball Creek at least one year prior to the completion of the dewatering of Pit 5 and the Draper Annex Pit, respectively. This Stream Augmentation Plan must comply with the recommended augmentation strategy described in the MSI FEIS (MNDNR and USACE 2007). The amended MNDNR Water Appropriation permit for ESMM will require Essar to conduct a hydrologic monitoring program in order to re-assess their water consumption needs and re-calculate available surface water and ground water yields. This information will be used to determine the need and timing of stream augmentation water beyond year 15, regardless of closure or continued operations.

The recommended stream augmentation strategy in the original MSI project (total average stream augmentation to Snowball and Oxhide Creeks of 1,700 gpm) remains the same in the proposed ESMM project. The water balance provides for stream augmentation from Pits 1 and 2, which will receive groundwater and surface water runoff only from undisturbed areas.

Hydrologic monitoring for the MNDNR Water Appropriation permit will be designed to allow ESMM and the MNDNR to refine Essar's water balance during later years of operation. This refinement will facilitate a re-evaluation of 1) the operations water consumption, 2) available on-site surface water and groundwater yields, and 3) a re-assessment of the need to acquire off-site water for processing or stream augmentation. Hydrologic monitoring data needs will be detailed in the appropriation permit, but will generally include local precipitation, water levels on all affected natural and pit water lakes, metered measurement of all pit pumping rates and volumes, and determination of pit bathymetrics, as necessary. This information will be necessary for planning, regardless of whether Essar closes down after 15 years or proposes continued operations and additional environmental review.

4.2 Air Quality

Chapter Summary

This chapter describes air pollutant emissions that would likely result from constructing and operating the proposed ESMM project and evaluates potential effects on the environment. There is considerable attention given to project design and mitigation measures taken to meet the regulations and federal guidelines established to ensure attainment and maintenance of acceptable air quality.

The chapter is organized according to the following sections:

Section 4.2.1, Affected Environment, describing the regulatory framework, ambient air quality standards, the PSD regulations, state and federal performance standards, and the study area boundaries.

Section 4.2.2, Environmental Consequences, presenting the pollutants of interest that would change, the calculated emissions and their sources, and modeled dispersion of air emissions and potential impacts.

Section 4.2.3, Mitigation, providing a statement that all standards are met except for visibility in Class I areas and briefly summarizing the measures being considered in preparation of the Air Permit.

Project Alternatives Relevant to this Issue (see Chapter 3.0):

- Proposed Action (proposed ESMM project) and associated Technology Alternatives.
- No Action Alternative (the original MSI project).

Cross-Referenced Chapters:

- Chapter 3.0 Proposed Action and Alternatives
- Chapter 4.3 Human Health Risk Assessment
- Chapter 5.1 Cumulative Air Quality Class I Particulates (PSD) and Visibility
- Chapter 5.2 Cumulative Air Quality Class I Acid Deposition & Ecosystem Acidification
- Chapter 5.3 Cumulative Mercury Deposition
- Chapter 5.4 Cumulative Climate Change
- Appendix B GHG Comparisons for Operational Items

Key Issues:

- Emissions of criteria, greenhouse gas, hazardous and toxic air pollutants.
- Compliance with air quality ambient standards and incremental deterioration limits.
- Air emissions control methods and technologies.
- Impacts at surrounding Class I areas to visibility, ecosystem acidification, and sensitive flora and fauna.

Documentation for Preparing Chapter 4.2

Barr Engineering. 2010a. Air Pollution Control Alternatives Analysis, Draft, Version 1. November 2010.

Barr Engineering. 2010b. Mercury Control Technology Evaluation, Version 2. September 2010.

Barr Engineering. 2010c. Class II Area Air Dispersion Modeling Report. December 2010.

Barr Engineering. 2010d. Climate Change Evaluation Report, Draft, Version 1. September 2010.

Barr Engineering. 2010e. Class I Air Dispersion Modeling Protocol. April 2010.Barr Engineering. 2011a. Class I Air Modeling Report, Essar Proposed Project Modifications. January 2011.

Barr Engineering. 2011b. Class I Air Modeling Report. January 2011.

Barr Engineering. 2011c. Emissions Inventory Calculation Spreadsheets. January 2011.

Barr Engineering. 2011d. Class I Air Modeling Report. January 2011.

Barr Engineering. 2011e. Class II Modeling Protocol Addendum. February 2011.

NPS 2010. "Federal Land Managers' Air Quality Related Values Work Group (FLAG), Phase I Report-Revised (2010)." Natural Resource Report NPS/NRPC/NRR-2010/232. October 2010.

Adams, et al. 1991. "Screening Procedures to Evaluate Effects of Air Pollution on Eastern Wildernesses Cited as Class I Air Quality Areas." USDA, Forest Service, Northeast Forest Experiment Station, General Technical Report NE-151. September 1991.

Minnesota Pollution Control Agency (MPCA), 2009. A Strategy Framework for Implementation of Minnesota's Statewide Mercury TMDL, October, 2009.

Minnesota Department of Natural Resources and U.S. Army Corps of Engineers 2007. Minnesota Steel Final Environmental Impact Statement. June 2007.

4.2.1 AFFECTED ENVIRONMENT

4.2.1.1 Regulatory Framework

The Federal Clean Air Act (CAA), including all currently effective amendments, is the basis for air quality-related regulations that apply to the proposed ESMM project. It is codified at United States Code Title 42, Chapter 85, Sections 7401 – 7671q. The primary portions of the CAA that regulate stationary sources of air pollutant emissions are codified in administrative rules at 40 CFR Parts 51, 52, 60, 61, 63, and 70 through 76. Minnesota regulations also enforce CAA stationary source requirements and state-specific requirements at Minn. R. 7001 through 7021.

The Federal CAA and Minnesota's air quality regulations include four primary tools to reduce air quality impacts from stationary source air pollutant emissions:

- Minnesota and national ambient air quality standards (MAAQS and NAAQS);
- Best available control technology (BACT) requirements;
- Incremental pollutant concentration limits (increments) in areas with clean air;
- Industry- and source-specific performance standards for criteria and hazardous air pollutants (HAPs)[1].

4.2.1.1.1 Ambient Air Quality Standards

Title 40 CFR 50 and Minn. R. 7009 provide limits to acceptable ambient air concentrations of the following air pollutants: sulfur dioxide (SO_2), particulate matter (PM, Minnesota only), particulate matter with an aerodynamic diameter less than 10 microns (PM_{10}), particulate matter with an aerodynamic diameter less than 2.5 microns ($PM_{2.5}$), carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2), and lead (Pb). The concentration limits are known as Minnesota and national ambient air quality standards (MAAQS and NAAQS). They are designed to protect health, including the health of sensitive populations, and public welfare.

Table 4.2-1 lists current MAAQS and NAAQS for each criteria pollutant and for each defined averaging period.

[1] Criteria pollutants are a small group of compounds for which USEPA has established ambient concentration limits. Hazardous air pollutants (HAPs) are generally present in the atmosphere in much lower concentrations than the criteria pollutants but are of special concern due to their toxicity. Federal regulations define 187 specific HAPs.

Table 4.2-1. Minnesota and National Ambient Air Quality Standards (June 2010)

Pollutant	Averaging Time	Air Quality Standard Concentration	
		Minnesota	National
Ozone (O_3)	8 hour	0.08 ppm (a)	0.075 ppm (b)
Carbon Monoxide (CO)	1 hour	35 µg/m³ (30 ppm) (c)	40 µg/m³ (35 ppm) (c)
	8 hour	10 µg /m³ (9 ppm) (c)	10 µg /m³ (9 ppm) (c)
Nitrogen Dioxide (NO_2)	1 hour	–	100 ppb (d)
	Annual	100 µg/m³ (0.05 ppm)	0.053 ppm
Sulfur Dioxide (SO_2)	1 hour	1,300 µg/m³ (0.5 ppm) (c)	75 ppb (e)
	3 hour	1,300 µg/m³ (0.5 ppm) (f)	0.5 ppm (c)
	3 hour	915 µg/m³ (0.35 ppm) (g)	–
	24 hour	365 µg/m³ (0.14 ppm) (c)	0.14 ppm (c)
	Annual	80 µg/m³ (0.03 ppm)	0.03 ppm
	Annual	60 µg/m³ (0.02 ppm)	–
Particulate Matter	24 hour	260 µg/m (c)	–
	24 hour	150 µg/m (c)	–
	Annual	75 µg/m	–
	Annual	60 µg/m	–
Particulate Matter <10 microns (PM_{10})	24 hour	150 µg/m (c)	150 µg/m (h)
	Annual	50 µg/m	–
Particulate Matter <2.5 microns ($PM_{2.5}$)	24 hour	65 µg/m (i)	35 µg/m (j)
	Annual	15 µg/m	15 µg/m (k)
Lead (Pb)	90-day rolling avg.	–	0.15 µg/m (l)
	Quarterly	1.5 µg/m (m)	–
Hydrogen Sulfide (H_2S)	30 minutes	70 µg/m³ (0.05 ppm) (n)	–
	30 minutes	42 µg/m³ (0.03 ppm) (o)	–

Notes:

(a) Daily maximum 8-hour average; the standard is attained when the average of the annual fourth-highest daily maximum 8-hour average ozone concentration is less than or equal to the standard.

(b) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.

(c) Maximum concentration not to be exceeded more than once per year.

(d) To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb.

(e) To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 ppb.

(f) Not to be exceeded more than once per year in Air Quality Control Regions 128, 131, and 133.

(g) Not to be exceeded more than once per year in Air Quality Control Regions 127, 129, 130, and 132.

(h) Not to be exceeded more than once per year on average over 3 years.

(i) The standard is attained when the 98th percentile 24-hour concentration is less than or equal to the standard.

(j) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 $\mu g/m^3$.

(k) To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 $\mu g/m^3$.

(l) Calculated using three-month rolling average.

(m) Maximum arithmetic mean averaged over a calendar quarter.

(n) 1/2 hour average not to be exceeded over two times per year.

(o) 1/2 hour average not to be exceeded over two times in any five consecutive days.

Areas with observed ambient concentrations below the MAAQS and NAAQS are designated as attainment areas. Areas for which no measured ambient concentration data are available are designated as unclassifiable and are assumed to be in attainment. Areas with measured ambient concentration data indicating an MAAQS or NAAQS exceedance are designated non-attainment for each specific pollutant with an observed exceedance. All of Minnesota is currently designated as either attainment or unclassifiable.

The MPCA, which administers Minnesota and federal air quality regulations, will allow construction of the proposed ESMM project, and any stationary source of air pollutant emissions, only if it can demonstrate that its emissions will not cause or contribute to an exceedance of an MAAQS or NAAQS. MPCA implements this restriction through its air quality permitting requirements (Minn. R. 7007).

4.2.1.1.2 PSD NSR

Minnesota administers the federal Prevention of Significant Deterioration (PSD) New Source Review (NSR) regulations at Minn. R. 7007.3000 by incorporating 40 CFR 52.21. These rules, which are generally referred to as PSD regulations, apply to "major" new sources or "major" modifications. PSD major new sources are those that have the potential to emit 100 tons per year or more of a regulated pollutant if the facility belongs to one of 28 listed industry categories or 250 tons per year or more of a regulated pollutant for non-listed facilities. A recent amendment to the federal air quality regulations established additional PSD major source and major modification thresholds for greenhouse gases (GHGs) of 100,000 and 75,000 metric tons per year of carbon dioxide equivalents (CO2e), respectively. Major modifications are those that occur at an existing major source and that result in a "significant net emissions increase" for one or more regulated pollutants. The regulations define significant net emissions increase thresholds for specific pollutants.

The original MSI facility was permitted as a PSD major stationary source, and the proposed ESMM project would constitute a PSD major modification. This decision was made considering that the MSI-permitted facility had already begun construction. The PSD requirements would be the same regardless of whether it was classified as a new source or major modification. Consequently, PSD NSR regulations would apply to the proposed ESMM project.

Two of the most significant PSD requirements that would apply to the proposed ESMM project relate to emissions controls and ambient air quality impacts. These are described in the following subsections.

BACT

PSD major sources and major modifications are required to reduce air emissions using best available control technology (BACT). BACT is defined as follows:

> "Best available control technology means an **emissions limitation** (including a visible emission standard) based on the maximum degree of reduction **for each pollutant subject to regulation under the Act** which would be emitted from any proposed major stationary source or major modification which the Administrator, on a **case-by-case basis**, **taking into account energy, environmental, and economic impacts and other costs**, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant. In no event shall application of best available control technology result in emissions of any pollutant which would exceed the emissions allowed by any applicable standard under 40 CFR parts 60 and 61. If the Administrator determines that technological or economic limitations on the application of measurement methodology to a particular emissions unit would make the imposition of an emissions standard infeasible, a design, equipment, work practice, operational standard, or combination thereof, may be prescribed instead to satisfy the requirement for the application of best available control technology. Such standard shall, to the degree possible, set forth the emissions reduction achievable by implementation of such design, equipment, work practice or operation, and shall provide for compliance by means which achieve equivalent results." (*Emphasis added*.) [40 CFR 52.21(b)(12)]

Note that BACT determinations are required for each regulated pollutant that would be emitted at an affected facility in significant quantities. They are based on case-by-case analyses of available technologies or methods; technical feasibility; and energy, environmental, and economic impacts. To support this SEIS, Essar has analyzed potentially available control technologies related to each emissions source affected by the proposed ESMM project (Barr, 2010a). Potential control technologies and methods are discussed below in Section 4.2.2.3.1. MPCA would make final BACT determinations and include them as emissions limits in a modified air quality permit. Assessments of potential air quality impacts described in this SEIS assume proposed controls and associated emissions would be at least as stringent as those ultimately required in the final permit modification.

As a new and expanded source of mercury emissions, the proposed ESMM project would be required to adhere to the Mercury TMDL policy MPCA adopted in October 2009 (MPCA, 2009). One of the requirements of that policy is that new and expanding sources of mercury emissions install best available controls. The selected BACT will be determined during the permit process. BACT emission rates determined during permitting will be equal to or lower than emissions assumed in the SEIS. Essar has evaluated alternative mercury emissions control technologies for the proposed new indurating furnace and has proposed a control method which achieves no net increase of mercury emissions above the original MSI project; the control method and how no net increase is accomplished are described in Section 4.2.2.3.

PSD Increments and AQRVs

PSD regulations limit allowable ambient concentration increases beyond baseline concentrations for NO_2, SO_2, PM_{10}, and $PM_{2.5}$.[2] These limits are known as PSD increments and have been defined for two types of areas: Class II and Class I areas.[3] Class II areas include all areas that are not designated as Class I. Class I areas are those areas such as national parks and certain wilderness areas over a specified size. Minnesota contains two Class I areas: the Boundary Waters Canoe Area and Voyageurs National Park. Air quality impacts were evaluated for these areas and for nearby Isle Royale National Park on Lake Superior and the Rainbow Lake Wilderness Area near Hayward, Wisconsin.

Table 4.2-2 lists applicable Class I and Class II PSD increments. Essar has demonstrated compliance with these increments as described in Section 4.2.2.4.4.

Table 4.2-2. Class I and Class II PSD Increments

Pollutant	Averaging Period	Maximum Allowable Increase (μg/m³)
Class I Areas		
$PM_{2.5}$	Annual arithmetic mean	N/A
	24-hr maximum	N/A
PM_{10}	Annual arithmetic mean	4
	24-hr maximum	8
Sulfur dioxide	Annual arithmetic mean	2
	24-hr maximum	5
	3-hr maximum	25
Nitrogen dioxide	Annual arithmetic mean	2.5
Class II Areas		
$PM_{2.5}$	Annual arithmetic mean	N/A
	24-hr maximum	N/A
PM_{10}	Annual arithmetic mean	17
	24-hr maximum	30
Sulfur dioxide	Annual arithmetic mean	20
	24-hr maximum	91
	3-hr maximum	512
Nitrogen dioxide	Annual arithmetic mean	25

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[2] $PM_{2.5}$ increments were promulgated October 20, 2010 ["40 CFR Parts 51 and 52, Prevention of Significant Deterioration (PSD) for Particulate Matter Less Than 2.5 Micrometers ($PM_{2.5}$)—Increments, Significant Impact Levels (SILs) and Significant Monitoring Concentration (SMC); Final Rule." *Federal Register* 75 (20 October 2010): 64864-64907]. They take effect October 20, 2011. Because the proposed project is expected to have submitted a complete application (as determined by the MCPA) for an air quality construction permit before that date, the new increments would not apply.

[3] A third area classification, Class III, is defined in the regulations but has never been implemented. Class III areas may be defined by states wishing to allow additional economic growth within a specific region.

For any period other than an annual period, the applicable maximum allowable increase may be exceeded during one such period per year at any one location.

In addition to demonstrating compliance with MAAQS, NAAQS, and PSD increments, air quality analyses are required to evaluate impacts to air quality-related values (AQRVs). Federal Land Managers (FLMs) are assigned "an affirmative responsibility under Section 165 of the CAA to protect and enhance the AQRVs of Class I areas from the adverse effects of air pollution" (NPS 2010). They are also assigned specific roles related to visibility protection within the PSD NSR rules. One of the ways FLM agencies execute these responsibilities is to identify AQRVs and related guideline thresholds for each Class I area within their jurisdiction. AQRVs evaluated for this study are:

- SO_2 effects on flora and fauna.
- Acid deposition effects on aquatic and terrestrial ecosystems resulting from emissions of sulfur and nitrogen compounds.
- Impacts to visibility.

Visibility is a unique AQRV in that it has a regulatory definition of adverse impact as:

> "[V]isibility impairment which interferes with the management, protection, preservation or enjoyment of the visitor's visual experience of the Federal class I area. This determination must be made on a case-by-case basis taking into account the geographic extent, intensity, duration, frequency, and time of visibility impairment, and how these factors correlate with: (1) times of visitor use of the Federal class I area, and (2) the frequency and timing of natural conditions that reduce visibility." (Id. §51.301(a))

Each responsible FLM must make this determination relative to a proposed construction project and its projected impacts to the Class I area for which he or she is responsible.

4.2.1.1.3 Performance Standards

Federal and Minnesota air quality regulations place certain technology-based emissions limits and other conditions on specific types of equipment or industrial operations. These regulations are generally referred to as performance standards. Performance standards have been established for limiting emissions of criteria pollutants and for limiting emissions of hazardous air pollutants (HAPs). New Source Performance Standards (NSPS) limit criteria pollutant emissions from defined categories of equipment and industrial processes. Minn. R. Chapter 7011 includes state-specific performance standards and incorporates by reference the federal NSPS at 40 CFR Part 60. National Emissions Standards for Hazardous Air Pollutants (NESHAP) limit emissions of HAPs from defined categories of equipment and industrial processes. Minn. R. Chapter 7011 includes state-specific performance standards and incorporates by reference the federal NESHAP at 40 CFR Parts 61 and 63. The Part 63 NESHAP are often referred to as MACT standards because they require application of emissions control technologies that meet a defined standard of "maximum achievable control technology."

Following are some NSPS, NESHAP, and Minnesota performance standards would likely apply to the proposed ESMM project:

- NSPS Subpart LL, Standards of Performance for Metallic Mineral Processing Plants;
- NESHAP Subpart RRRRR, National Emission Standards for Hazardous Air Pollutants for Taconite Ore Processing;
- Minn. R. 7011.0150, Standards of Performance for Preventing Particulate Emissions from Becoming Airborne;

- Minn. R. 7011.1000 -1015, Standards of Performance for Industrial Process Equipment;
- Minn. R. 7017.2001- 2060, Standards of Performance for Performance Tests;
- Minn. R. 7017.1000 – 1020, Standards of Performance for Continuous Monitors.

The final air quality permit would ensure compliance with all applicable standards.

4.2.1.2 Project Impact Area

As described earlier in this study, the proposed ESMM project would be located in the northeast section of Minnesota at a previously mined area with currently approved plans for mining and steel manufacturing operations (the original MSI project). Specific areas requiring impacts analyses, and the types of analyses required, are determined based on Significant Impact Levels (SILs). These are pollutant- and averaging period-specific thresholds that help identify whether a modeling demonstration must evaluate cumulative impacts by expanding to include emissions from nearby facilities and background concentrations as well. If proposed project emissions of a particular pollutant result in impacts below that pollutant's SIL, a cumulative impacts demonstration is *not* required. Impacts exceeding the SIL are deemed significant, and modeling results are evaluated to determine the furthest distance from the modeled facility at which this is true. This furthest distance becomes the radius of a circular significant impact area within which cumulative air quality impacts must be evaluated.

SILs have been defined both for Class I and Class II areas, and they are applied in demonstrations of compliance with NAAQS, MAAQS, and PSD Increments. Class I area impact analyses are generally only required for those areas within 300 km of the proposed project.

4.2.1.2.1 Class II Area Air Quality

All airsheds within Minnesota, including those surrounding the Essar facility have either demonstrated or are assumed to be in compliance with all MAAQS and NAAQS. Table 4.2-3 lists existing background concentrations of applicable criteria pollutants and compares related air quality standards.

Table 4.2-3. Background Pollutant Concentrations and Related MAAQS/NAAQS (Concentrations in μg/m^3)

Pollutant	Averaging Period	Background Concentration	Standard[6]	Reference
PM_{10}	Annual	11	50	1
	24-Hour	30	150	1
$PM_{2.5}$	Annual	5.6	15	2
	24-Hour	15.7	35	3
SO_2	Annual	2	60	1
	24-Hour	4	365	1
	3-Hour	10	915	1
	1-Hour	7.7	197	4
NO_2	Annual	7	100	1
	1-Hour	28	188	5
CO	8-Hour	345	10,000	1
	1-Hour	575	40,000	1

1. Background Concentrations reflect Option 2 values from the MPCA's Standardized Air Modeling (SAM) spreadsheet ['SAM Background Values' tab in

SAM09293_HLBSEP2009_OptionA.xls]. Option 2 = Option 1 x 0.8. Option 2 values are appropriate to use when modeling nearby sources.

2. $PM_{2.5}$ annual background concentration is the 2007 - -2009 average annual concentration from the Virginia, MN monitor.
3. $PM_{2.5}$ 24-hour background concentration is the 2008 - -2010 average high-2nd-high concentration from the Virginia, MN monitor multiplied by the 0.95 factor.
4. SO_2 1-hour background concentration is the 2007-2009 1-hour High 4th High SO_2 concentration for 442 Monitor (Rosemount, MN) with 80% reduction for Option.
5. NO_2 1-hour background concentration represents 2003-2005 1-hourmax daily H8H concentration from Cloquet, MN monitor with 80% reduction for Option 2.
6. NAAQS and MAAQS are typically identical. The more stringent of the two is listed in cases where they are different. See Table 4.2-1 for a detailed listing of NAAQS and MAAQS.

4.2.1.2.2 Class I Area Air Quality

Air quality at all four surrounding Class I areas is currently in compliance with all MAAQS/NAAQS and Class I increments. A discussion of metrics used to describe existing conditions is included in Barr Engineering's Class I area modeling report (Barr, 2011a). Applicable background conditions are addressed within the discussion of Class I modeling results in Section 4.2.2.4.

4.2.2 ENVIRONMENTAL CONSEQUENCES

4.2.2.1 Project Alternatives

The proposed ESMM project and alternatives under consideration for this SEIS are described in Chapter 3.0. Impacts to air quality described in this chapter incorporate the effects of emissions control technologies as described herein. These or greater levels of control would be included as enforceable requirements in the facility's revised air quality permit. Under the No Action alternative, the facility would continue to operate as described in the MSI FEIS and as required by the terms and limits in the existing air quality permit (Minnesota Air Emission Permit No. 06100067- 001).

During review of air-related analyses for the proposed ESMM project, erroneous statements were found to have been made within the MSI FEIS text related to hot charging pellets to the DRI process. The MPCA has determined that the analyses for air modeling and permitting for the MSI project correctly utilized pellets at a temperature close to or at the ambient temperature as feed pellets to the DRI.

4.2.2.2 Pollutants of Interest

The proposed ESMM project would result in increased or decreased air emissions of the following classes of air pollutants:

- Criteria and PSD pollutants. Criteria pollutants are the common and pervasive air pollutants for which USEPA has established ambient air quality standards, the NAAQS and state MAAQS.

  PSD pollutants are assigned "significant" emissions thresholds in the PSD regulatory program [refer to 40 CFR 52.21(b)(23) and 40 CFR 166(b)(23)(i)]. Those that the proposed ESMM project would be expected to emit are: all of the criteria pollutants, particulate matter (PM), nitrous oxides (NO_x), fluorides (F), and sulfuric acid mist (H_2SO_4).

- Greenhouse gases. USEPA currently has identified and regulates six gases that contribute to global warming. The principal greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases.

- Hazardous air pollutants (HAPs). The Federal Clean Air Act identifies 187 hazardous air pollutants of special concern at 42 USC Section 7412(b) (Section 112 of the CAA).
- Compounds of potential interest (COPI). These are specific toxic air pollutants included in human health and ecological risk assessments described in Chapters 4.3 and 4.4, respectively.
- Mercury and acid gases. Deposition of these pollutants is of special concern due to identified ecological and human health impacts. Impacts from these emissions are discussed in Chapter 5.3 (mercury deposition) and Chapter 5.2 (acid deposition).

4.2.2.3 Emission Sources and Potential Emissions

4.2.2.3.1 Emissions Sources

The proposed ESMM project includes the following new or modified sources of air pollutant emissions:

Increased production rate. As described in Section 3.0 of this SEIS, the primary objective of the proposed ESMM project is to increase the facility's taconite pellet production capacity. The original MSI FEIS and Air Permit #06100067 presented pellet production capacity as 3.8 million metric tons per year.[4] The proposed ESMM project would be capable of producing up to 7.0 million metric tons per year of low flux pellets, 6.5 million metric tons per year of high flux pellets, or some combination of the two pellet types. The low flux pellet scenario has a slightly higher capacity because less heat is required to produce pellets with lower amounts of fluxing agent. Heat is required for oxidation of the iron and for conversion of the fluxing agents. This thermal chemical process is called induration. If a pellet specification calls for more fluxing agent, more heat is required to indurate that pellet. For air dispersion modeling purposes, the scenario with the highest air emission rate on a source-by-source and pollutant-by-pollutant basis was used as the modeled air emission rate.

Essar proposes to achieve this pellet production increase by increasing mining rates and decreasing the total project duration from 20 to 15 years (Chapter 3.0 goes into detail on project duration and available ore at site). This would result in increased short-term and annual emissions of particulates, and some HAPs and COPI, due to intensified mining activities such as drilling, blasting, and excavating. It would also increase throughput rates, and therefore air emission rates, for ore and waste rock processing operations.

Larger mining trucks. The original MSI project included the use of 200-ton mining trucks. The proposed ESMM project would use 240-ton trucks, effectively reducing engine exhaust and road dust emissions by requiring fewer trips to transport the same amount of material.

An additional secondary crusher. This would result in increased particulate emissions. Note that many HAPs and COPI exist in particulate form at typical ambient conditions.

Increased fine and coarse ore storage areas. This would potentially result in increased particulate emissions due to wind-blown dust.

An additional concentrating line. Material handling operations in the dry portion of this line would result in increased particulate emissions. Most of the concentrating process, however, is a wet process that produces negligible air emissions.

[4] Air quality impacts assessments were based on 110 percent of this value (4.1 million metric tons) to account for potential future design refinements.

A redesigned indurating furnace. The furnace planned in the original MSI project would be replaced by a larger furnace with different design features. The increased processing capacity would result in increased emissions of particulate, NO_2, SO_2, CO, VOC, fluorides. Uncontrolled mercury emissions would also increase, but proposed control measures are expected to result in a net decrease in mercury emissions from the furnace.

The proposed pellet production rate increase could potentially increase emissions from all operations through the pelletizer process and up to the DRI process (see the MNDNR 2007 MSI FEIS for a complete description of the facility's processes). The additional pellets produced in the pellet plant would be "high flux" pellets that would be shipped off-site and would not proceed through the DRI and steel production processes.

For the purpose of supporting this SEIS, Essar has evaluated alternative emissions control technologies and incorporated into its design those that are proposed as satisfying regulatory requirements. The emission rates and potential impacts presented in this SEIS are based on inclusion of those proposed controls. If any individual proposals are deemed unacceptable, the most likely result would be a required emission rate reduction. In that case, impacts presented herein would be overestimated and would not require re-evaluation. Conversely, if for any reason emissions estimates increase during the air quality permitting process, MPCA staff would require re-evaluation of impacted regulatory analyses (such as MAAQS and NAAQS compliance demonstrations). Essar would not be issued a permit to construct unless they could demonstrate compliance with all applicable air quality regulations and guidelines.

Projected potential pollutant emission rates and dispersion modeling results reported below for the most part include the effect of control technologies and methods to which commitment was made in the MSI FEIS and which are included in the facility's current air quality permit. Two new air emissions control technologies are explicitly included in the proposed ESMM project: 1) the new indurating furnace design would incorporate inherent low NO_x emitting burners, and 2) activated carbon injection would be added to the furnace exhaust system with the intent of reducing mercury emissions.

Indurating furnace NO_x emissions control. The pelletizer system's indurating furnace would be the largest single source of NO_x emissions in the entire facility, emitting approximately 55 percent of total plant-wide NO_x. The new, proposed furnace would incorporate burner and combustion chamber technology designed to limit NO_x formation. As a result, the new furnace would be able to process 60 percent more pellets with only an estimated 21 percent increase in NO_x emissions relative to the original MSI project. Barr Engineering's report Air Pollution Control Analysis (Barr, 2010a) describes alternative NO_x control technologies evaluated for the new indurating furnace and the bases for selecting the low emissions design.

Indurating furnace mercury emissions control. Ore that would be processed through the indurating furnace contains trace amounts of mercury, a portion of which would be liberated and exhausted to the atmosphere. Essar has evaluated alternative technologies to control mercury emissions from the proposed new indurating furnace and has proposed installing an activated carbon injection system. The activated carbon adsorbs elemental mercury, the primary form expected in the furnace exhaust. Spent activated carbon with adsorbed mercury would then collect in the downstream particulate matter control device. Essar expects to achieve at least 50 percent mercury emissions reduction with activated carbon injection and has committed to evaluating and reporting site-specific performance, which would then be considered in the new air quality permit. Barr Engineering's report Mercury Control Technology Evaluation (Barr, 2010b) describes alternative mercury emissions control technologies evaluated for the new indurating furnace and the basis for selecting activated carbon injection.

In addition, Essar is evaluating alternative multi-stage particulate matter and SO_2 emissions control systems to replace the wet scrubber incorporated into the current design of the indurating furnace exhaust system. Potential control efficiency improvements associated with these options have not been included in impacts modeling demonstrations, however.

Following are the remaining emissions control technologies and methods as reported in the MSI FEIS and proposed for the ESMM project:

- Clean fuels (natural gas) for SO_2, NO_x, particulate and HAPs;
- Good combustion practices for CO, VOC, particulate and HAPs;
- Enclosures with fabric filters or wet or dry scrubbers for particulate and HAPs;
- Low NO_x, ultra low NO_x, and oxy fuel burners for NO_x;
- Absorber / wet or dry scrubber for SO_2, fluorides, and sulfuric acid mist;
- Lead, fluoride and sulfuric acid mist control performance monitored via SO_2 and PM emissions limits;
- Best practices for fugitive dust control via a fugitive dust control plan.

4.2.2.3.2 Potential Emissions

The following table summarizes, for specific process areas and for the entire plant, potential emissions of PSD pollutants and compares them to emission rates reported in the MSI FEIS. Note that the primary changes occur in mining and crushing, where emissions are estimated to be reduced, and in the pelletizer system. Particulate emissions reductions in the mining and crushing areas of the facility would result from increased haul truck capacities and an optimized road layout. Emissions increases in the pelletizing system would result from increased pellet production. Emissions from the concentrating process would be relatively unchanged because the ore is processed with water, which considerably limits particulate emissions, and because the system's only source of combustion emissions is independent of material throughput. Changes in emissions within the steel mill result primarily from slight changes in emissions calculation methods.

Table 4.2-4. Facility-Wide Potential Emissions of PSD Pollutants (tons per year) (Barr, 2011c)

Area & Project	CO	F	H_2S	H_2SO_4	NO_x	Pb	PM	PM_{10}	$PM_{2.5}$	SO_2	VOC
Mining & Crushing											
ESMM	---	0.001	---	---	---	0.013	1461	398	62.7	---	---
MSI	---	0.002	---	---	---	0.020	1733	484	(a)	---	0.37
%Change	---	-34%	---	---	---	-35%	-16%	-18%	---	---	---
Concentrator											
ESMM	2.48	---	---	---	10.9	0.001	495	237	40.8	0.24	0.36
MSI	2.48	---	---	---	10.9	0.001	489	233	(a)	0.24	0.36
% Change	0.0%	---	---	---	0.0%	0.06%	1.2%	1.7%	---	0.0%	0.0%
Pelletizer											
ESMM	93.7	90.2	---	1.30	963	0.152	339	578	576	480	45.6
MSI	64.4	0.97	---	0.86	794	0.099	210	356	(a)	172	30.1
% Change	50%	9238%	---	50%	21%	53%	62%	63%	---	179%	52%
Direct Reduced Iron (DRI)											
ESMM	482	0.006	52.6	---	196	0.004	133	122	114	5.83	28.2
MSI	540	0.007	65.2	---	241	0.004	145	132	(a)	6.78	31.0
% Change	-11%	-14%	-19%	---	-19%	-9.0%	-8.7%	-7.6%	---	-14%	-9.2%
Steel Mill											
ESMM	3049	4.60	---	0.052	459	1.37	86.5	132	100	242	203
MSI	3082	4.56	---	0.052	460	1.36	85.9	131	(a)	242	202
% Change	-1.1%	0.9%	---	0.0%	-0.4%	0.1%	0.7%	0.4%	---	-0.2%	0.9%
Slag Processing											
ESMM	---	1.37	---	---	---	---	13.7	6.28	1.50	---	---
MSI	---	1.36	---	---	---	---	13.6	6.24	---	---	---
% Change	---	0.5%	---	---	---	---	0.5%	0.5%	---	---	---
Total											
ESMM	3,631	96.2	52.6	1.35	1,628	1.53	2,527	1,473	895	728	277
MSI	3,689	6.90	65.2	0.92	1,505	1.49	2,677	1,343	(a)	421	263
Change	(59)	89	(13)	0	123	0	(149)	131	895	307	14
% Change	-1.6%	1294%	-19%	47%	8.1%	3.1%	-5.6%	10%	---	73%	5.3%

(a) $PM_{2.5}$ emissions were not quantified for the MSI FEIS.

The values shown in Table 4.2-4 represent annualized emission rates in units of tons per year. In most cases, modeled emission rates, which are modeled on an hourly basis, were simply calculated using a conversion factor of 8760 hours per year assuming the particular source would operate every hour of the year. For example, if an emissions source would emit 4.38 tons per year of a pollutant and would operate continuously, its emission rate would be modeled as 1 pound per hour [(4.38 ton/yr) * (2000 lb/ton) * (1 yr / 8760 hrs) = 1.0 lb/hr].

Some sources, such as an emergency generator or fire pump engine, clearly would not be expected to operate full-time, so they were modeled using one emission rate to demonstrate compliance with short-term average ambient standards (three-hour SO_2 or 24-hour PM_{10}, for example) and a different hourly emission rate to demonstrate compliance with annual average ambient standards such as annual NO_x. Barr Engineering's reports *Class II Area Air Dispersion Modeling Report* (Barr, 2010c) and *Class I Modeling Report* (Barr, 2011b) provide detailed descriptions of modeled emission rates.

Table 4.2-4 indicates several emissions changes that cannot be attributed simply to the proposed ESMM project changes as described in Chapter 3.0. Following is a brief discussion of factors that influenced the calculation of proposed ESMM project emissions and the comparison to published MSI rates. Barr 2011c contains detailed calculations and calculation methodologies.

- High flux vs. low flux pellet production—As noted above in Section 4.2.2.3.1 and in Chapter 3.0, the proposed ESMM project includes two pellet production scenarios: production of up to 6.5 million metric tons per year of high flux blast furnace grade pellets or 7.0 million metric tons per year of low flux, DRI feed grade taconite pellets or some combination. Each scenario results in different potential emissions. Table 4.2-4 presents, for each operations area and for each pollutant, the maximum emission rate that would result from either scenario. In some cases, one pollutant's maximum emissions in a given operations area may result from the high flux pellet production scenario while a different pollutant's maximum emissions for the same operations area may result from the low flux pellet production scenario. This is partly because the two scenarios have different effects on material handling and combustion source emissions. Particulate pollutants derive mostly from material handling, while gaseous pollutants such as NO_x and CO result primarily from fuel combustion.

- Road material revision—MSI emissions calculations assumed mine road surfaces would be similar in composition to the mined ore. It has since been determined that road surfaces will be similar in composition to waste rock. These two materials have different fluorine and lead contents, which leads to reductions in mine area emissions for these elements that are greater than the reductions in general particulate matter. Particulate matter reductions result from mine layout and operations design changes that reduce haul truck vehicle miles traveled.

- Updated emission factors—Some factors used for calculating air emissions based on material throughputs and equipment design capacities have been updated since emissions were calculated for the original MSI project. Most notably, these emission factor changes affected fluorine emissions from the pelletizer system and SO_2 emissions from an emergency generator associated with the DRI system. SO_2 emissions from the indurating furnace, which is part of the pelletizer system, increased partly based on updated information provided by the supplier of the scrubber currently required in the MSI permit.

- DRI system baseline throughput correction—Although production capacity of the DRI system was correctly reported in the MSI FEIS (MNDNR, 2007), emissions for that system were incorrectly calculated based on a higher production capacity.

This was corrected in the proposed ESMM project emissions calculations, resulting in an apparent reduction in emissions.

- Updated DRI equipment design— Other changes in DRI system emissions relative to MSI project emissions estimates can be attributed to refined design analyses. Essar has determined that less heat would be required for the process than originally estimated. This would lead to reduced fuel usage and, therefore, reduced combustion-related emissions.

The entire facility would have the potential to emit up to 89.8 tpy of total HAPs. This would be an increase relative to the original MSI project who's potential to emit total HAPs is 54.6 tpy. Chlorine is the individual HAP with the highest facility-wide potential emission rate at 22.5 tpy for the proposed ESMM project. See Chapter 4.3 for a discussion of potential HAP and other COPI emissions and how they were used in an assessment of human health risks related to the proposed ESMM project.

The proposed ESMM project would have the potential for total direct (scope 1) emissions of greenhouse gases (GHG) at a rate of up to 2.29 million metric tons per year of CO_2e, not including terrestrial emissions sources (defined in Chapter 5.4) These emissions would result from combustion of fuel in stationary and mobile equipment and processing of various materials throughout the entire process. The following table shows potential project GHG emissions that would result from fuel combustion and from physical and chemical processing. It also summarizes total emissions and compares proposed ESMM project emissions with MSI emissions. Emission rates are provided in units of million metric tons per year of CO_2e.

Table 4.2-5. Potential GHG Direct Emission Rates (million m.t./yr CO_2e) (Barr, 2011c)

Emission Source Category	ESMM	MSI
Fuel combustion	0.80	0.70
Processing	1.49	1.26
Total	2.29	1.96

See Chapter 5.4 for a breakout of these GHG emissions, as well as terrestrial and indirect emissions. See also Barr, 2010d for detailed descriptions of GHG emissions calculation methods.

4.2.2.4 Air Dispersion

4.2.2.4.1 Methodology

Environmental professionals commonly use mathematical models to predict numerical impact values that would be expected to result from a change in the environment. USEPA has recommended, for permitting purposes, the use of two specific models to predict impacts to air quality and AQRVs resulting from a proposed source of air pollutant emissions. One model, known as AERMOD, is a short-range transport model and is the default regulatory model for predicting impacts within 50 km of a new emissions source. The other model, known as CALPUFF, is a long-range transport model and is the default regulatory model for predicting impacts between 50 and 300 km of a new emissions source. Both of these models were used to quantify air quality impacts that could potentially result from the proposed ESMM project.

Both AERMOD and CALPUFF calculate an emitted pollutant's concentration at a specific location and time based on provided characteristics of the emission source, prevailing meteorological conditions, and surrounding terrain. The points at which pollutant concentrations are calculated are referred to as receptors and are characterized by their distance and direction from the emissions source and their elevation.

Emissions sources are characterized as point sources, from which an exhaust stream exits a well defined structure such as a smoke stack, or fugitive sources. They are generally defined by their location and size and, for point sources, by the temperature and flow rate of the exhaust stream. Both source types are also defined by the hourly emission rate of each modeled pollutant.

Hourly meteorological conditions are provided to the model using data files containing various parameters measured at observation stations. Primary parameters used by the models include wind speed, wind direction, and ambient temperature. Both models combine data from surface and upper air measurements to calculate parameters used in the dispersion calculations.

Terrain data are entered into the model in the form of data files containing gridded elevation measurements within the model domain. The models use these data, generally provided by USGS, to assign receptor elevations and to characterize changes within an exhaust plume as it responds to terrain features.

In addition to the above model inputs, both models can simulate eddy effects (called downwash) from buildings surrounding an emissions point source. They are also capable of simulating deposition and plume depletion effects. Both models can combine impacts from many sources to calculate cumulative concentrations. They can also process the typically tens of thousands of concentrations calculated for each modeled hour and receptor to identify peak impacts averaged over a specified time period.

The following references provide guidance that was generally followed in performing the modeling analyses used to support this SEIS:

- MPCA Air Dispersion Modeling Guidance for Minnesota Title V Modeling Requirements and Federal Prevention of Significant Deterioration (PSD) Requirements (Version 2.2); October 20, 2004.
- USEPA Guideline on Air Quality Models, 40 CFR Part 51 Appendix W, November 2005.
- Model user guides and supporting documentation posted on USEPA's Support Center for Regulatory Atmospheric Modeling web site:

  (http://www.epa.gov/ttn/scram/dispersion_prefrec.htm#aermod)
- EPA-454/R-98-019, Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts, December 1998.
- "Federal Land Manager (FLM) Recommendations on Class I Area Analyses." Provided by Trent Wickman, Air Resource Specialist, Superior National Forest and Duluth, Minnesota.
- Federal Land Managers' Air Quality Related Values Workgroup (FLAG). Phase I Report (December 2000, Revised Draft June 2008, and Revised 2010).

Methods used for modeling analyses conducted for this SEIS were described in detail and approved by MPCA staff as were the analyses results. Detailed methods and results are described in Barr 2010c, Barr 2011e, and Barr 2011b.

AERMOD Methodology

AERMOD generally assumes a Gaussian distribution of concentrations within an exhaust plume, where the direction and shape of the distribution are determined by hourly meteorological values and initial plume characteristics. The model was used to predict temporally and spatially distributed ambient air pollutant concentrations resulting from project emissions and emissions from other nearby emissions sources. Model results were then compared to MAAQS and NAAQS and to Class II area PSD increments. AERMOD results were also entered into other models used to quantify health risks associated with mercury deposition and human and environmental exposure to other toxic air pollutants (see Chapters 4.3, 4.4, and 5.3).

Following are brief descriptions of primary inputs to AERMOD analyses performed in support of this SEIS. See Barr, 2010c for detailed descriptions of AERMOD model inputs.

Sources – Modeling analyses included maximum emissions from all modified, new, and unmodified emissions sources associated with the proposed ESMM project. These sources can be classified as follows.

- Point sources. These include furnaces, heaters, boilers, generator engines, baghouses, and cooling towers.
- Haul roads.
- Wind erosion sources.
- Mine pit source. This source combines emissions resulting from all mining activities occurring in a single pit. Mining activities include drilling, haul truck traffic, and truck loading and unloading.

Following are the nearby facilities that were included in the demonstrations of MAAQS/NAAQS and PSD Class II increment compliance:

- Minnesota Power Inc. – Boswell Energy Center,
- Hawkinson Construction Co. – Nonmetallic,
- Blandin Paper Co.,
- Potlatch-Grand Rapids and Cook Energy Center,
- US Steel – Keewatin Taconite,
- United Taconite LLC – Fairlane Plant,
- Hibbing Public Utilities Commission,
- Hibbing Taconite Co.,
- US Steel Corp. – Minntac,
- Mesaba Energy West (Excelsior).

Background Concentrations – Analyses of compliance with MAAQS/NAAQS typically add a representative background concentration to model-predicted values. Refer back to Table 4.2-2 for the ambient background concentrations used to compare impacts from the proposed ESMM project with MAAQS/NAAQS. Background values are not added to modeled results for analysis of PSD increment impacts.

Meteorological Data – AERMOD analyses performed for this SEIS used surface meteorological data collected at the Chisholm-Hibbing airport during the years 2001 through 2005. These data were combined with upper air data collected during the same period at the International Falls, MN airport.

Receptors – MAAQS/NAAQS and PSD Class II increment analyses were conducted using a receptor grid designed as follows:

- 100 m spacing along ambient air boundary with 50 m spacing in areas of maximum impact;
- 100 m spacing beyond the ambient air boundary (i.e., property boundary) to 500 m;
- 250 m spacing from 500 m to 3 km beyond the ambient air boundary;
- Polar grid every 10 degrees from 3 km to 15 km beyond the ambient air boundary.

Modified receptor grids were used for environmental, human health, and mercury risk analyses (see Chapters 4.3, 4.4, and 5.3).

CALPUFF Methodology

CALPUFF is more complex than AERMOD and requires more inputs. It is categorized as a "puff model" because, rather than creating a new, instantaneous plume for each new hour of meteorological data as does AERMOD, it periodically creates a new puff of emissions from each modeled source. It then tracks each puff as it travels across the model domain and interacts with terrain and other puffs.

CALPUFF was used for this SEIS to predict impacts at Class I areas to PSD increments, flora and fauna, visibility (specifically, regional haze), and acid deposition rates resulting from sulfur and nitrogen emissions. Approximate distances of the Class I areas from the ESMM site are:

- Boundary Waters Canoe Area Wilderness, 80 km (50 mi),
- Isle Royale National Park, 280 km (175 mi),
- Rainbow Lake Wilderness, 170 km (105 mi),
- Voyageurs National Park, 100 km (62 mi).

Following are brief descriptions of primary inputs to CALPUFF analyses performed in support of this SEIS. See Barr 2011b for detailed descriptions of CALPUFF model inputs.

Sources – Modeling analyses included emissions from all modified, new, and unmodified point sources associated with the proposed ESMM project except those sources such as back-up and emergency generators that operate only intermittently. These were described in the above discussion of AERMOD inputs.

In addition to sources associated with the proposed ESMM project and with the permitted MSI project, average actual emissions from surrounding facilities were also included in the Class I area increment modeling analyses. The specific sources and their emission parameters were identified by Essar with input and approval from MPCA.

CALPUFF requires speciation of particulate emissions into coarse particulate matter (PMC), fine particulate matter (PMF), organic carbon (OC), secondary organic aerosol (SOA), sulfate (SO_4), and elemental carbon (EC). It also calculates emission rates of nitrate (NO_3) and nitric acid (HNO_3) that result from chemical transformation of NO_x and SO_2.

Background Concentrations – Analyses of acid deposition and visibility impacts rely on various types of background conditions such as humidity; ozone, ammonia, and SO_2 concentrations; existing acid deposition rates; and visibility parameters.

Meteorological Data – CALPUFF modeling analyses used meteorological data representing the years 2002 through 2004 and collected from:

- A regional prognostic mesoscale model,
- 88 surface meteorological observation stations,
- four upper air meteorological observation stations, and
- 99 precipitation stations.

Receptors – Class I area impacts were evaluated at receptor locations selected by the National Park Service. They can be viewed at the web address:

http://www2.nature.nps.gov/air/Maps/Receptors/index.htm

4.2.2.4.2 MAAQS and NAAQS Impacts

Air dispersion modeling performed by Essar and approved by MPCA demonstrated continuing compliance with all MAAQS and NAAQS should the proposed ESMM project be approved, constructed, and operated. Table 4.2-6 summarizes Class II area modeling results and compares them to the applicable most stringent standards.

Table 4.2-6. Class II Air Dispersion Modeling Results Summary (Barr, 2010c; Barr, 2011e)

Model Run	Pollutant	Averaging Period	Standard (µg/m³) [1]	Maximum Modeled Concentration (µg/m³) [2]	Background (µg/m³) [3]	Total Modeled Concentration (µg/m³) [4]	Percent of Standard
PSD Increment	PM_{10}	24-hour	30	25	--	25	84%
		Annual	17	3.6	--	3.6	21%
	SO_2	3-hour	512	41	--	41	8%
		24-hour	91	12	--	12	13%
		Annual	20	1.6	--	1.6	8%
	NO_2	Annual	25	3.9	--	3.9	16%
NAAQS/MAAQS	PM_{10}	24-hour	150	24	30	54	36%
		Annual *	50	5.8	11	17	34%
	$PM_{2.5}$	24-hour	35	15	15.7	31	88%
		Annual	15	1.6	5.6	7.2	48%
	SO_2	1-hour	197	163	7.7	171	87%
		3-hour**	915	108	10	118	13%
		24-hour	365	30	4	34	9%
		Annual***	60	3	2	5	8%
	NO_2	1-hour	188	138	28	166	88%
		Annual	100	13	7	20	20%
	CO	1-hour	40000	265	575	840	2%
		8-hour	10000	81	345	426	4%
	Lead	Quarterly	0.15	0.0027	--	0.0027	2%

[1] The NAAQS and MAAQS are the same unless otherwise specified. The more restrictive standard is listed.

* Annual PM_{10} standard is MAAQS only

** 915 µg/m3 is SO_2 3-hour standard for Northern Minnesota. NAAQS is 1300 µg/m³.

*** 60 µg/m³ is SO_2 annual MAAQS. NAAQS is 80 µg/m³.

[2] SO_2 1-hour NAAQS is 5-year average of maximum daily 1-hour H_4H concentrations.

NO_2 1-hour NAAQS is 5-year average of maximum daily 1-hour H_8H concentrations.

CO averaging periods use H_1H concentrations.

SO_2 3- and 24-hour averaging periods are H_2H concentrations

PM_{10} 24-hour increment is H_2H of five individual years.

PM_{10} 24-hour NAAQS is H_6H over five years.

$PM_{2.5}$ 24-hour NAAQS is 5-year average of daily H_1H concentrations.

Annual concentrations are highest of five individual years.

H_1H monthly value used to compare to lead quarterly standard.

[3] Background concentrations reflect Option 2 "Rest of MN" values taken from an updated MPCA Background Concentrations Table from the Standardized Air Modeling Spreadsheet (SAM V09293). The 24-hr $PM_{2.5}$ background concentration represents the 2007-2009 average H2H $PM_{2.5}$ concentrations from the Virginia, MN monitor. 1-Hour NO_2 background concentration represents 2004-2005 1-hour max daily H_1H concentration from Cloquet, MN monitor. SO_2 1-hour background is 2009 1-hour High 1st High SO_2 concentration for 442 Monitor (Rosemount, MN) with 80% reduction for Option 2.

[4] NAAQS/MAAQS concentration includes modeled concentration plus background.

4.2.2.4.3 Class II Increments

Air dispersion modeling performed by Essar and approved by MPCA demonstrated compliance with PSD Class II increments should the proposed ESMM project be approved, constructed, and operated. Table 4.2-7 summarizes PSD Class II increment compliance demonstration results and compares them to the relevant increments.

Table 4.2-7. PSD Class II Increment Demonstration Results (Barr, 2010c; Barr, 2011e)

Pollutant	Average Period	Peak Modeled Conc. (μg/m^3)	Class II Increment (μg/m^3)	% of Increment
PM_{10}	24-hour	25	30	84%
	Annual	3.6	17	21%
SO_2	3-hour	41	512	8%
	24-hour	12	91	13%
	Annual	1.6	20	8%
NO_X	Annual	4	25	16%

4.2.2.4.4 Class I Increments

Class I area modeling showed that impacts from the facility-only (original MSI project combined with modifications from the proposed ESMM project) are expected to be below defined "significant impact levels" (SILs) for all but the 24-hour PM_{10} and SO_2 increments. (See Section 4.2.1.2 for more on SILs.) Because PM_{10} and SO_2 impacts exceeded their respective SILs, modeling analyses that included appropriate nearby facilities (the cumulative impact) were conducted for these pollutants to demonstrate compliance with their respective Class I area increments. Note that for cumulative analysis, only the 24-hr average PM_{10} and SO_2 PSD increments were modeled. Table 4.2-8 summarizes these modeling results.

Table 4.2-8. Class I Area Increment Modeling Results (Barr, 2011d)

Pollutant	Averaging Period	USEPA Class I Increment (μg/m^3)	USEPA SIL (μg/m^3)	Facility-only (μg/m^3)	Cumulative Impact (μg/m^3)
SO_2	3-hour	25	1	0.578	---
	24-hour	5	0.2	0.211	4.59
	Annual	2	0.1	0.007	---
NO_X	Annual	2.5	0.1	0.020	---
PM_{10}	24-hour	8	0.3	0.499	2.57
	Annual	4	0.2	0.023	---

4.2.2.4.5 Class I AQRVs

Flora and Fauna

Lichen species have been shown to be especially sensitive to elevated atmospheric SO_2 concentrations and have therefore been chosen as an indicator for damage to flora and fauna from air pollution. The most sensitive lichen species are only present when annual average SO_2 concentrations are less than 40 µg/m³ (Adams, et al., 1991). FLMs have established a screening level "green line concentration" threshold of 5 µg/m³ of SO_2 as the concentration below which adverse effects are not expected.

Table 4.2-9 shows modeled concentrations that would result at each of the four surrounding Class I areas from the project contribution (original MSI and modifications of the proposed ESMM project) plus appropriate background values. All of the resultant total concentrations (cumulative projects) are less than the FLM screening level green line concentration. It can therefore be concluded that SO_2 emissions from the proposed ESMM project would not be expected to damage flora and fauna in the surrounding Class I areas.

Table 4.2-9. CLASS I Analysis Results for Effects on Flora and Fauna (Barr, 2011d)

Location	Background Air Concentration[1] (µg/m³)	Modeled Project Contribution[2] (µg/m³)	Total Projected Air Concentration (µg/m³)	Green Line Concentration[3] (µg/m³)
BWCAW	1.2	0.007	1.2	5
Isle Royale National Park	2.0	0.001	2.0	5
Rainbow Lake Wilderness	1.6	0.004	1.6	5
Voyageurs National Park	0.7	0.007	0.7	5

[1]Mean annual SO_2 concentrations (µg/m³)

[2]Modeled ambient air concentration in Class I area using the CALPUFF modeling system.

[3]Green line concentration from Adams et al.

Acid Deposition

Many aquatic and terrestrial ecosystems are susceptible to degradation from exposure to acids and acid precursors that originate in the atmosphere and deposit on the surface. Resulting acidification can adversely affect terrestrial and aquatic plants and animals. Effects of acid deposition are complex and vary significantly among individual ecosystems. To help protect against the effects of acid deposition, FLMs have established screening-level concentrations and deposition rates for the two primary acid precursor air pollutants, sulfur oxides (mainly SO_2) and nitrogen oxides (NO_x).

The National Park Service (NPS) and the US Forest Service (USFS) have set different types of screening values. The NPS requires major new or modified sources located in the eastern part of the country to demonstrate through modeling that the proposed project would not result in total sulfur and total nitrogen deposition rates of more than 0.01 kilogram per hectare per year (kg/ha/yr). This value is the eastern region deposition analysis threshold (DAT) and is discussed in NPS, 2010. It applies to both terrestrial and aquatic ecosystems.

The USFS applies a separate approach to screening-level evaluations of air pollution impacts to Class I wilderness areas for which it is the responsible FLM. Adams, 1991 identifies "green line" thresholds for eastern region Class I areas below which "it [is] fairly certain that no significant change would be observed in ecosystems that contain large numbers of sensitive components." Separate green line thresholds have been defined for terrestrial and aquatic ecosystems. In both cases, modeled impacts from the proposed project are to be added to existing background values for comparison to the green line thresholds. Terrestrial green line thresholds, which apply to the entire region, are:

- 5 $\mu g/m^3$ annual average ambient SO_2 concentration
- 100 $\mu g/m^3$ 3-hour maximum ambient SO_2 concentration
- 5 to 7 kg/ha/yr total sulfur deposition
- 5 to 8 kg/ha/yr total nitrogen deposition

Area-specific aquatic green line thresholds are:

- BWCAW: 7.5 to 8.0 kg/ha/yr total sulfur deposition; 9 to 10 kg/ha/yr total sulfur plus 20 percent of total nitrogen deposition
- Rainbow Lake Wilderness: 3.5 to 4.5 kg/ha/yr total sulfur deposition; 4.5 to 5.5 kg/ha/yr total sulfur plus 20 percent of total nitrogen deposition

Adams, 1991 observes "a given deposition rate of N has 20 percent of the acidification effect of the same rate of S deposition." That is why one of the aquatic ecosystem green line thresholds is expressed in terms of total sulfur deposition plus 20 percent of total nitrogen deposition.

Table 4.2-10 presents modeled results of terrestrial impacts and compares them to the appropriate green line threshold or DAT. Table 4.2-11 presents similar information for aquatic system impacts. In all cases, modeled impacts are below guideline thresholds.

Table 4.2-10. CLASS I Analysis Results for Terrestrial Impacts (Barr, 2011d)

Location [2]	Pollutant	Background Data [1]	Model Air Concentration or Calculated Project-Related Deposition[3]	Total Concentration or Deposition	Green Line Value or Deposition Analysis Threshold [4 5]
BWCAW	Ann. Ave SO_2 (|Mg/m^3)	1.2	0.007	1.2	5 |g/m^3
	3-hour max SO_2 (|Mg/m^3)	10.8	0.578	11.4	100 |g/m^3
	Total Sulfur (kg/ha/yr)	2.85	0.005	2.86	5-7 kg/ha/yr S
	Total Nitrogen (kg/ha/yr)	4.75	0.007	4.76	5-8 kg/ha/yr N
Isle Royale National Park	Total Sulfur (kg/ha/yr)	2.15	0.001	2.15 [6]	0.01 kg/ha/yr S
	Total Nitrogen (kg/ha/yr)	3.85	0.001	3.85 [6]	0.01 kg/ha/yr N
Rainbow Lake Wilderness	Ann. Ave SO_2 (|Mg/m^3)	1.6	0.004	1.6	5 |g/m^3
	3-hour max SO_2 (|g/m^3)	14.4	0.206	14.6	100 |g/m^3
	Total Sulfur (kg/ha/yr)	2.98	0.002	2.98 [6]	5-7 kg/ha/yr S
	Total Nitrogen (kg/ha/yr)	5.88	0.003	5.88 [6]	5-8 kg/ha/yr N
Voyageurs National Park	Total Sulfur (kg/ha/yr)	1.84	0.007	1.85 [6]	0.01 kg/ha/yr S
	Total Nitrogen (kg/ha/yr)	3.87	0.007	3.88 [6]	0.01 kg/ha/yr N

[1] Annual average SO_2 (μg/m^3) concentrations calculated from data (1991-1993) in Table 1[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

Highest 3-hour SO_2 set equal to annual average SO_2 x 9.0, in accordance with EPA Guideline [6].

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 database (http://www.epa.gov/castnet) for Voyageurs National Park. (1996-2002).

[2] Modeled air concentration in each Class I area.

[3] Model estimated ambient air concentrations using the CALPUFF modeling system.

[4] Green line concentration from Adams et al, 1991. DAT is based on National Park Service Guidance for the Eastern U.S.

[5] S = Sulfur, N = Nitrogen.

[6] Majority of total concentration or deposition is due to background. The modeled air concentration contributes less than 1 percent to the total concentration. Total concentration value is not relevant for the NPS areas.

Table 4.2-11. Screening Analysis Results for Potential Aquatic Effects (Barr, 2011d)

Location	Pollutant [1]	Background Deposition[2] (kg/ha/yr)	Estimated Project-Related Deposition (kg/ha/yr)	Total Deposition [3] (Project + Background) (kg/ha/yr)	Green Line Value or Deposition Analysis Threshold[4] (kg/ha/yr)
BWCAW	Total Sulfur	2.85	0.005	2.86	7.5-8.0
	Total S + 20% of Total N	3.80	0.007	3.81	9-10
Rainbow Lake Wilderness	Total Sulfur	2.98	0.002	2.98	3.5-4.5
	Total S + 20% of Total N	4.16	0.003	4.16	4.5-5.5

1 S = Sulfur, N = Nitrogen.
2 Annual wet deposition data from NAPD database (**http://nadp.sws.uiuc.edu**).
3 Highest modeled deposition used in the assessment.
4 Green line concentration from Adams et al, 1991. Deposition Analysis Thresholds based on National Park Service guidance for the eastern U.S.

Visibility

Visibility impairment is defined at 40 CFR 51.301(x) as, "Any humanly perceptible change in visibility (visual range, contrast, coloration) from that which would have existed under natural conditions." FLMs are charged with affirmative responsibility to manage Class I areas and have a responsibility to protect the air quality related values (including visibility).

Impacts to visibility in the form of uniform haze were evaluated for BWCAW, Voyageurs National Park, and Isle Royale National Park. Visibility impacts were not estimated for the Rainbow Lake Wilderness because visibility has not been established as an AQRV for that area.

Particles in the atmosphere can absorb and scatter light that travels between an observer and the object being observed, thus reducing the visibility of the object. This effect can be quantified using the concept of light extinction. The change in light extinction resulting from a change in particle concentration is denoted by the term "beta extinction" (Δb_{ext}), which is inversely proportional to another visibility parameter, "visual range." Scientists have quantified light extinguishing capacities of different types of atmospheric particles and developed equations and models that relate particulate concentrations to light extinction.

In support of this SEIS and ongoing air quality permitting, Essar has proposed and followed a detailed screening-level analysis procedure that was approved by the FLMs responsible for the surrounding Class I areas (Barr, 2010e).

The screening procedure incorporates the following steps: 1) use a long-range transport air dispersion model (CALPUFF) to quantify concentrations of various particulate types that would result from the proposed project; 2) translate the modeled concentrations into light extinction values; and 3) compare those values against prescribed background values to determine change in visibility. The guideline level of concern for uniform haze impacts agreed to for this analysis is any 24-hour average change in light extinction of 5% or more, relative to prescribed annual average natural conditions, in any modeled year.

Table 4.2-12 shows the maximum 24-hour average Δb_{ext} value modeled for each of the Class I areas evaluated. It also indicates the maximum number of days in any one of the three modeled years that Δb_{ext} exceeded 5% and 10%.

Table 4.2-12. Summary of Class I Visibility Impacts Screening Analysis (Barr, 2011d)

Parameter	BWCAW	Isle Royale National Park	Voyageurs National Park	FLM Level of Concern
Maximum Δb_{ext} (%)	16.1	6.2	17.24	>5
Max annual days with Δb_{ext} > 5%	26	1	10	1
Max annual days with Δb_{ext} > 10%	2	0	1	1

Because the screening-level analysis resulted in impacts above the FLM threshold of concern at all three Class I areas of concern, Essar has committed to further investigations and implementation of mitigating measures as needed to demonstrate Class I visibility impacts below the FLM threshold of concern. The following section describes potential mitigation measures to achieve this result.

Note that the original MSI project also demonstrated possible adverse impacts to visibility at surrounding Class I areas. The current air quality permit mitigates these impacts by limiting actual facility-wide annual NO_x emissions and prescribing alternate methods for offsetting actual emissions in excess of the limit.

4.2.3 MITIGATION

As described above, air dispersion modeling of emissions from the proposed ESMM project has demonstrated acceptable impacts to MAAQS, NAAQS, PSD Class I and Class II increments, and Class I AQRVs with the exception of visibility.

Although current modeling analyses indicate potential significant adverse visibility impacts at nearby Class I areas, Essar would be required to mitigate those impacts before MPCA would issue a revised air quality permit required to construct the proposed ESMM project. Potential mitigation measures include accepting a lower NO_x emission limit than currently proposed. This would be contingent on results of one-quarter-scale pilot tests planned for the proposed new indurating furnace design. Other potential mitigation measures include installing add-on NO_x controls to the furnace exhaust system, reducing NO_x emissions from other sources within the facility or at nearby facilities, or purchasing and retiring tradable NO_x or SO_2 emissions allowances from sources impacting the surrounding Class I areas. Any of these mitigation measures would need to be successfully incorporated into the visibility impacts screening analysis to gain FLM approval.

Several air quality impact mitigation measures in general are incorporated into the proposed ESMM project design. They include:

- Using larger trucks and optimizing the mine plan to reduce haul truck vehicle miles traveled, thereby reducing particulate and HAP/COPI emissions.
- Implementing emissions control technologies that are currently required by the current MSI air quality permit. Examples include material handling baghouses, implementation of a dust control plan, and control of indurating furnace PM and SO_2 emissions.
- Using an indurating furnace design that produces lower NO_x emissions per unit of pellet production.
- Reducing mercury emissions from the indurating furnace using activated carbon injection.
- Monitoring emissions as required by the MPCA.
- Limiting GHG emissions primarily through various energy efficiency measures described in Chapter 5.4 and Appendix B of this SEIS.

4.3 Human Health Risk Assessment

Chapter Summary

This section presents the findings of a Supplemental Human Health Screening Level Risk Assessment (SHHSLRA) that was completed for the proposed ESMM project (Barr, 2011a). The assessment was completed in accordance with an MPCA approved *Work Plan for a Supplemental Human Health Screening-Level Risk Analysis* (May 27, 2010). The assessment addresses risks from air related emissions of hazardous air pollutants. No sources of water related pollutant emissions were identified for inclusion in the risk assessment.

A Human Health Screening Level Risk Assessment (HHSLRA) was conducted for the original MSI project (Barr, 2007). This is the HHSLRA that was referenced in the March 2010 Preparation Notice for the Supplemental EIS and formed the basis for the MPCA-approved May 2010 Supplemental HHSLRA Work Plan. The scope of work focuses the current assessment by using the prior risk assessment to limit the number of pollutants and number of exposure locations to be addressed. The current assessment only addresses those pollutants that were identified in the original MSI project risk assessment to have an individual cancer risk that is greater than or equal to 1 $x10^{-6}$ (one in one million) or a non-cancer hazard quotient greater than or equal 0.1 (chronic or acute). These criteria are applied after increasing risk estimates for the original MSI project by a factor of 1.6 to account for the increased emissions associated with the proposed ESMM project (Chapter 4.2 provides details of the emissions).

In accordance with standard practice, this risk assessment evaluates the incremental increased risk associated with pollutants to be released by the proposed action. In other words, it evaluates that additional risk that is associated with the proposed ESMM project. There is an existing level of risk associated with natural and man-made chemicals in the environment not associated with existing or proposed mining operations. Risks associated with the No Action Alternative, (the original MSI project) were addressed in a prior risk assessment and presented in the MSI FEIS. However, in addition to the incremental increased risk associated with the proposed ESMM project, this assessment does evaluate risk from exposure to pollutants emitted into air from existing nearby industrial facilities and current pollutant concentrations in ambient air. This assessment of risk associated with both the proposed action and other sources is called the Cumulative Air Emissions Risk Analysis.

Risk assessments are generally recognized to consist of four essential parts: exposure assessment, toxicity assessment, risk characterization (which presents the quantitative risk results), and uncertainty assessment (which presents the qualitative evaluation of the assessment). To conform to standard presentation formats for environmental impact statements, the exposure assessment and toxicity assessment are addressed in Section 4.3.1, Affected Environment. This section describes the ways in which site characteristics are considered in determining exposure and toxicity. The risk characterization and uncertainty assessment sections of the risk assessment are addressed in Section 4.3.2, Environmental Consequences. This subsection presents the findings of the risk assessment and provides information to help inform the interpretation of the results.

The risks presented in this assessment are below MPCA (2007) facility risk guideline levels of concern for all exposure scenarios; cancer risk of 1 x 10-5 (one in one hundred thousand) and non-cancer hazard quotient of 1.0. Accordingly, few mitigation actions are identified. Possible mitigation measures for achieving risk reductions focus on those chemicals that produce the greatest amount of risk. Options include improving fuel efficiency in mining operations to reduce pollution emissions and the application of best management practices to reduce wind-blown dust generation from stockpiles and truck traffic. Ultimately, the air quality permit will contain conditions to ensure emission rates are at or below those used in this risk assessment.

Regulatory Framework

As an overall regulatory tool, this risk assessment may accompany the facility's air or water discharge permit application. A full description of the applicable regulatory framework, permits, and approvals for air permitting is provided in Chapter 4.2. Water permitting is addressed in Chapter 4.1. The mitigation section of this chapter of the SEIS identifies the measures being evaluated for permitting to reduce exposure and generally assure protection of the public health.

Documentation for Preparing Chapter 4.3

Barr, 2011a. Supplemental Human Health Screening-Level Risk Analysis, prepared for Essar Steel Minnesota LLC, Version 1, January, 2011.

Barr, 2011b. Essar EI Review, e-mail from Trevor Shearen, MPCA to Kevin Kangas, ESML and Lori Stegink, Barr, February 25, 2011.

Barr, 2007. Human Health Screening-Level Risk Assessment. Prepared for Minnesota Steel Industries, LLC. February 2007.

Finlayson-Pitts and Pitts, 1986. Finlayson-Pitts, B. and JN Pitts, Jr. 1986. Atmospheric Chemistry. Pp. 29-37; 523-549. John Wiley and Sons.

Minnesota Department of Health (MDH), 2001. Statement of Need and Reasonableness. Proposed Permanent Rules Relating to Health Risk Values; Minnesota Rules, Parts 4717.8000 to 4717.8600, August 2001.

Minnesota Pollution Control Agency (MPCA), 2008. Minnesota Mercury Risk Estimation Method (MMREM) for the Fish Consumption pathway: Impact Assessment of a nearby Emission Source, Version 2.0, November.

Minnesota Pollution Control Agency (MPCA), 2007. Air Emissions Risk Analysis (AERA) Guidance, Version 1.1, September.

Stenink, 2011. Essar HF IRAP Modeling, email to Kristie Ellickson, MPCA, March 15.

Vogt, 2008. e-mail from Darren Vogt, Environmental Director, 1854 Treaty Authority, with attached letter from John Persells, Minnesota Chippewa Tribe Water Quality to Kristie Ellickson, MPCA, December 19.

4.3.1 AFFECTED ENVIRONMENT

Various aspects of mining operations will cause pollutants to be emitted to the air. Such releases may result in adverse health impacts if the pollutants are transported off-site such that humans may come into contact with the pollutant. The degree of risk associated with exposure is dependent upon the concentration of the pollutant at the point of exposure, the amount of time over which exposure occurs, and routes by which the pollutant enters the body. To assess each of these processes, the methodology for assessing risk involves:

- Emissions Inventory: How much pollutant will be released to the air?
- Water Discharge: How much pollutant will be released to surface water or groundwater?
- Pollutant Transport Assessment: How might pollutants emitted to air disperse with distance and also deposit onto soil or water? What is the concentration of the emitted pollutant at points of maximum potential exposure in air, soil, and water?
- Land Use and Exposure Scenario Determinations: At what locations are maximum potential exposures likely to occur? What kinds of land uses exist now or may exist in the future at these locations of maximum potential exposure?
- Toxicity Assessment: How toxic are the pollutants at the expected levels of exposure?

The methods used (Barr, 2011a) to assess each of these components of the risk assessment are described in the subsections that follow. The results of the risk assessment, that is the quantitative and qualitative estimates of risk, are provided in Section 4.3.2.

4.3.1.1 Hazardous Air Pollutant Emissions for Risk Assessment

All equipment or processes that have the potential to emit pollutants into the air are identified in an emission inventory. Sources of emissions include both point sources such as stacks or vents and non-point sources (also called fugitive emissions) such as wind-blown particles from stockpiles, heavy equipment activity and blasting. The inventory for the proposed ESMM project addressed all operations within the mine site boundary: mine area operations, concentrator, pellet plant, DRI Unit, steel mill, and tailings basin.

The rate at which pollutants would be emitted from each identified emission source is estimated from stack testing data if available, or from published emission factors (U.S. EPA's AP-42 or FIRE databases), mass balance information, engineering calculations and judgments, regulatory limits, or vendor information. The emission inventory was completed using maximum permitted rates or the maximum operating capacity of each emission unit. This approach is consistent with MPCA (2007) risk assessment guidance.

The results of the emission inventory are shown in Table 4.3-1. The table shows how emissions for specific chemicals changed from that used for the original MSI project. The differences are due to many factors that vary depending on the source and the chemical. These factors can include the proposed increased rate of mining, use of different equipment (such as larger mine trucks or the indurating furnace at the pellet plant), use of improved emission control equipment, and new information on emission control factors. The emission inventory produced by Barr and dated January 14, 2011 was reviewed and approved by MPCA. The air emission inventory forms the basis for assessing exposure and risk.

Table 4.3-1. Hazardous Air Pollutant (HAP) Emission Estimates*

Chemical Name	A Minnesota Steel Project Total Facility Emissions (lb/hr)	B ESMM Project Total Facility Emissions (lb/hr)	C Difference (lb/hr) (C=B-A)	D Calculated Percent Change (B-A)/A
Acenaphthene	3.07E-04	3.66E-04	5.90E-05	19%
Acenaphthylene	6.23E-04	7.33E-04	1.10E-04	18%
Acetaldehyde	9.16E-03	7.03E-03	-2.13E-03	-23%
Acrolein	1.71E-03	1.21E-03	-4.98E-04	-29%
Aluminum Compounds	2.66E+00	2.94E+00	2.79E-01	10%
Anthracene	9.66E-05	1.10E-04	1.37E-05	14%
Aluminum Oxide	2.60E+00	2.26E+00	-3.43E-01	-13%
Antimony Compounds	7.30E-04	8.76E-04	1.46E-04	20%
Arsenic	1.33E-01	1.50E-01	1.73E-02	13%
Arsenic (III)	1.25E-04	7.41E-05	-5.09E-05	-41%
Arsenic (V)	1.25E-01	1.40E-01	1.52E-02	12%
Barium Compounds	1.39E-02	1.39E-02	8.65E-06	0%
Benzene	1.09E-01	6.92E-02	-3.98E-02	-37%
Benz(a)anthracene	5.57E-05	6.19E-05	6.21E-06	11%
Benzo(a)pyrene	2.00E-05	2.32E-05	3.17E-06	16%
Benzo(b)fluoranthene	7.41E-05	8.81E-05	1.40E-05	19%
Benzo(g,h,i)perylene	4.11E-05	4.77E-05	6.61E-06	16%
Benzo(k)fluoranthene	1.84E-05	2.13E-05	2.88E-06	16%
Beryllium Compounds	4.82E-04	5.01E-04	1.87E-05	4%
Boron Compounds	4.42E-03	3.65E-03	-7.68E-04	-17%
1,3 Butadiene	3.06E-04	2.61E-04	-4.47E-05	-15%
Butane	4.08E+00	4.45E+00	3.71E-01	9%
Cadmium Compounds	1.39E-02	1.41E-02	1.92E-04	1%
Calcium Carbonate	3.52E-02	3.40E-02	-1.19E-03	-3%
Calcium Compounds	1.30E+01	1.68E+01	3.84E+00	30%
Calcium oxide	1.26E+01	1.63E+01	3.67E+00	29%
Carbon monoxide	1.07E+03	1.14E+03	6.89E+01	6%
Chloride salts	5.36E-01	5.37E-01	1.11E-03	0%
Chlorine	3.21E+00	5.13E+00	1.92E+00	60%
5-Chloro-2-methyl-4-isothiazolin-3-one	4.10E-05	2.61E-05	-1.49E-05	-36%
Chromium Compounds	3.98E-01	4.87E-01	8.87E-02	22%

Chemical Name	A Minnesota Steel Project Total Facility Emissions (lb/hr)	B ESMM Project Total Facility Emissions (lb/hr)	C Difference (lb/hr) (C=B-A)	D Calculated Percent Change (B-A)/A
Chromium total	7.88E-02	1.35E-01	5.66E-02	72%
Chromium (III)	9.05E-03	3.73E-03	-5.32E-03	-59%
Chromium, hexavalent	2.67E-03	3.62E-03	9.51E-04	36%
Chrysene	1.02E-04	1.21E-04	1.95E-05	19%
Cobalt Compounds	3.72E-03	4.07E-03	3.50E-04	9%
Copper Compounds	6.15E-02	6.20E-02	5.33E-04	1%
Dibenz(a,h)anthracene	2.86E-05	3.25E-05	3.91E-06	14%
Dichlorobenzenes	2.33E-03	2.54E-03	2.13E-04	9%
Dimethylbenzo(a)anthracene, 7,12-	3.11E-05	3.39E-05	2.81E-06	9%
Ethane	6.03E+00	6.57E+00	5.40E-01	9%
Fluoranthene	3.19E-04	3.61E-04	4.19E-05	13%
Fluorene	1.04E-03	1.17E-03	1.26E-04	12%
Dichlorotolyltriazole	2.05E-06	1.30E-06	-7.45E-07	-36%
Ferro niobium	1.44E-02	1.44E-02	2.52E-05	0%
Fluorine, Flourides	2.86E+00	2.80E+01	2.51E+01	877%
Fluoride Salts	2.89E+00	3.48E+00	5.91E-01	20%
Formaldehyde	3.33E-01	4.45E-01	1.12E-01	34%
Hexane	3.50E+00	3.81E+00	3.15E-01	9%
Hydrogen Chloride (as Cl)	2.76E+00	4.74E+00	1.98E+00	72%
Hydrogen Fluoride (as F)	2.75E-01	2.64E+01	2.61E+01	9495%
Indeno(1,2,3-cd)pyrene	3.25E-05	3.75E-05	5.02E-06	15%
Iron	3.00E+02	3.06E+02	6.23E+00	2%
Iron II	9.39E+01	9.57E+01	1.76E+00	2%
Iron III Oxide	2.09E+02	2.33E+02	2.43E+01	12%
Isoparafinic petroleum distillate	4.10E-05	4.43E-05	3.32E-06	8%
Lead	4.03E-01	5.65E-01	1.62E-01	40%
Lithium Compounds	1.03E-03	1.33E-03	3.03E-04	29%
Magnesium Compounds	2.36E+01	1.89E+01	-4.73E+00	-20%
Magnesium nitrate	4.10E-05	4.43E-05	3.32E-06	8%
Magnesium oxide	2.39E+01	2.06E+01	-3.29E+00	-14%
Manganese	4.43E+00	4.08E+00	-3.51E-01	-8%
Manganese Dioxide	4.32E+00	3.95E+00	-3.68E-01	-9%

Chemical Name	A Minnesota Steel Project Total Facility Emissions (lb/hr)	B ESMM Project Total Facility Emissions (lb/hr)	C Difference (lb/hr) (C=B-A)	D Calculated Percent Change (B-A)/A
Mercury Compounds	1.26E-02	1.19E-02	-7.42E-04	-6%
Methylcholanthrene, 3-	3.50E-06	3.81E-06	3.15E-07	9%
Methylnapthalene, 2-	4.67E-05	5.09E-05	4.16E-06	9%
Molybdenum Compounds	2.18E-03	2.36E-03	1.77E-04	8%
Naphthalene	1.82E-02	1.17E-02	-6.54E-03	-36%
Nickel Compounds	5.14E-02	6.44E-02	1.30E-02	25%
Nitrogen dioxide (1-hour)	6.40E+02	7.37E+02	9.74E+01	15%
Pentane	5.05E+00	5.51E+00	4.60E-01	9%
Phenanthrene	2.83E-03	3.31E-03	4.77E-04	17%
Phosphorous Compounds	2.58E-01	2.33E-01	-2.50E-02	-10%
Phosphorous Total	1.86E-01	1.24E-01	-6.19E-02	-33%
Potassium Compounds	5.81E-01	1.23E+00	6.50E-01	112%
Propane	3.11E+00	3.39E+00	2.81E-01	9%
Potassium Oxide	4.64E-01	4.62E-01	-2.15E-03	0%
Propylene	3.70E-01	2.27E-01	-1.43E-01	-39%
Pyrene	2.80E-04	3.22E-04	4.21E-05	15%
Selenium Compounds	8.82E-04	9.53E-04	7.14E-05	8%
Silicon Compounds	3.45E+02	2.65E+02	-7.96E+01	-23%
Silicon Dioxide	3.45E+02	1.62E+02	-1.83E+02	-53%
Silver Compounds	2.59E-04	2.30E-04	-2.91E-05	-11%
Sodium Carbonate	5.45E-02	1.04E-01	4.99E-02	92%
Sodium Compounds	5.11E-01	5.77E-01	6.55E-02	13%
Sodium Molybdate	4.10E-05	4.43E-05	3.32E-06	8%
Sodium Nitrate	4.10E-05	4.43E-05	3.32E-06	8%
Sodium Oxide	4.55E-01	4.68E-01	1.30E-02	3%
Sodium Tolytriazole	4.10E-05	4.43E-05	3.32E-06	8%
Strontium Compounds	1.05E-02	1.05E-02	-2.73E-05	0%
Sulfur Compounds	8.63E+00	5.77E+00	-2.86E+00	-33%
Sulfur Dioxide	1.21E+02	1.99E+02	7.76E+01	64%
Sulfuric Acid	2.48E-01	3.84E-01	1.36E-01	55%
Thallium	2.25E-03	4.47E-03	2.22E-03	99%
Tin Compounds	1.37E-03	3.75E-03	2.38E-03	174%
Titanium Compounds	1.01E-01	1.09E-01	8.31E-03	8%

Chemical Name	A Minnesota Steel Project Total Facility Emissions (lb/hr)	B ESMM Project Total Facility Emissions (lb/hr)	C Difference (lb/hr) (C=B-A)	D Calculated Percent Change (B-A)/A
Toluene	4.51E-02	3.11E-02	-1.40E-02	-31%
Titanium Dioxide	1.07E-01	1.19E-01	1.17E-02	11%
Vanadium Compounds	4.02E-02	4.46E-02	4.37E-03	11%
Xylene	2.65E-02	1.64E-02	-1.01E-02	-38%
Zinc Compounds	4.34E+00	4.34E+00	-1.86E-04	0%
Polycyclic Organic Material	2.39E-02	1.83E-02	-5.55E-03	-23%
TetraCDD, 2,3,7,8-	6.33E-07	2.02E-08	-6.13E-07	-97%
PAH	7.86E-02	1.81E-03	-7.68E-02	-98%
Total HAP	16.2	46.6	30.3	187%
Total	3266	3335	69	2%

*ESMM emissions are based on the January 14, 2011 version of the emissions inventory. Maximum emission rates for both high and low flux pellet plant scenarios are used. Emission inventory refinements conducted after January 14, 2011 (Barr, 2011b) are minor for HAPs and would not be expected to change fundamental conclusions about risk.

Shaded rows identify chemicals retained for supplemental analysis of chronic risk, and underlined text identifies chemicals assessed for acute risk. Diesel particulate matter is not listed but was also assessed for noncancer chronic toxicity. See text for additional explanation.

As previously stated, this assessment only addresses those pollutants that were previously identified in the risk assessment for the original MSI project to have an individual cancer risk that is greater than or equal to 1 x10^{-6} (one in one million) or a non-cancer hazard quotient greater than or equal 0.1 (chronic or acute). These criteria are applied after increasing risk estimates by a factor of 1.6 to account for the increased emissions from the pellet plant. Diesel particulate matter and silicon dioxide were also assessed because noncancer chronic toxicity values had become available. Table 4.3-1 identifies by shading those pollutants that were retained for this assessment.

Excluded Sources and Operating Conditions

Consistent with AERA guidance (MPCA, 2007), emissions from emergency diesel-fired generators are not included in the emission inventory as they are likely to have an insignificant impact on the assessment (Barr, 2011a). The emergency generators emit primarily nitrogen oxides (NO_x) and diesel particulate. They would be run only on a short term basis for emergencies and as needed for testing. Because process sources have significantly higher levels of NO_x emissions, and because the generators would likely be located internally to the site and emissions would not travel as far as tall stack sources, it is assumed that generator emissions would be unlikely to add significantly to the NO_x impacts assessed for process sources. The same is true for natural gas space heaters.

Emissions associated with blasting in the mine are not included in the emission inventory. Blasting events are intermittent and short duration. Accordingly, they are assumed to be insignificant for acute and chronic risk estimates. However, no information is provided about how frequent these events might occur, and there is uncertainty about the potential magnitude of the impacts.

Facility startup, shutdown, and upset conditions were also not considered in the emission inventory. Rates of pollutant emissions can be higher during such events; however, they are intermittent and of short duration. Accordingly, excluding these events from the emission inventory is not expected to have a large effect on overall conclusions about risk.

Included Background Sources for Cumulative Air Emissions Risk Analysis

Background sources of pollutants are identified to support an assessment of the cumulative risk from exposure to both the proposed new sources of air emissions and existing sources coming from the upwind direction. The cumulative risk assessment used both ambient air measurement data and estimated emissions from large nearby emission sources.

Ambient air monitoring data were obtained from MPCA for the 2005 to 2007 time period for the following locations: Virginia, MN, Hibbing, MN, and Cloquet, MN. To ensure that the true average concentration was not underestimated, the 95 percent upper confidence limit of the arithmetic mean air concentration was used to estimate background air concentrations.

Additionally, four nearby projects/facilities were initially considered for their potential to add to the background concentrations of pollutants represented by the ambient monitoring data: 1) Excelsior Energy, Mesaba Energy Project; preferred site near the town of Taconite, about 18 kilometers southwest of the ESMM site, 2) U.S. Steel Keewatin Taconite, existing facility and the Keetac Expansion Project; approximately 12 kilometers east of the Essar Project; 3) Hibbing Taconite (Hibbing), located about 17 kilometers east/northeast of the ESMM project; and 4) Laurentian Energy (Hibbing), about 20 kilometers east of the ESMM project. Based on an assessment of distance and direction from the proposed ESMM project, locations of ambient monitoring stations, and directions of prevailing winds, MPCA approved the selection of the existing U.S. Steel Keewatin Taconite facility and the Keetac Expansion Project as an additional background source to include in the cumulative risk assessment. Cumulative risk assessment project locations and ambient air monitoring stations are shown on Figure 5.3-1 (a figure which also includes additional information related to cumulative mercury deposition analysis).

4.3.1.2 Water Releases

No water related sources of pollutants were identified for inclusion in the risk assessment. While assessment supporting the EIS and permitting for the original MSI project included the possibility of a wastewater discharge coming from the tailings impoundment, no such discharge permit was sought. The existing MSI project does not include a wastewater discharge. The proposed ESMM project will employ a re-use/recycle water management strategy that eliminates any need to consider a possible wastewater discharge.

Groundwater seepage from the tailings impoundment to Swan Lake has been identified as a potential source of release of mine impacted water. Current estimates are for a seepage rate of 199 gpm (see Chapter 4.1 and Section 4.4.1.4 for more detailed information). Risks would only be associated with this seepage if the potential exists for consistent, long-term direct human contact. The potential for exposure and risk would be greatly diminished if seepage occurs directly into subsurface water in Swan Lake. However, detailed knowledge of the groundwater to surface water interaction and the rate of mixing is unknown.

4.3.1.3 Pollutant Transport Assessment

Pollutants emitted into the air are transported by wind. The concentration of the pollutants in the air decreases with distance from the source of the emission. This decrease is generally due to mixing and dispersion in the air and because the pollutants may deposit on the land. Some chemical transformation or degradation of the pollutant may occur during dispersion. Deposition may occur by settling of pollutants contained in particulate matter or by the air cleansing effect of rain and snow. These processes can transfer pollutants from air to soil and water. Illustration 4.3-1 provides a conceptual model of these processes of pollutant release, transport, and exposure.

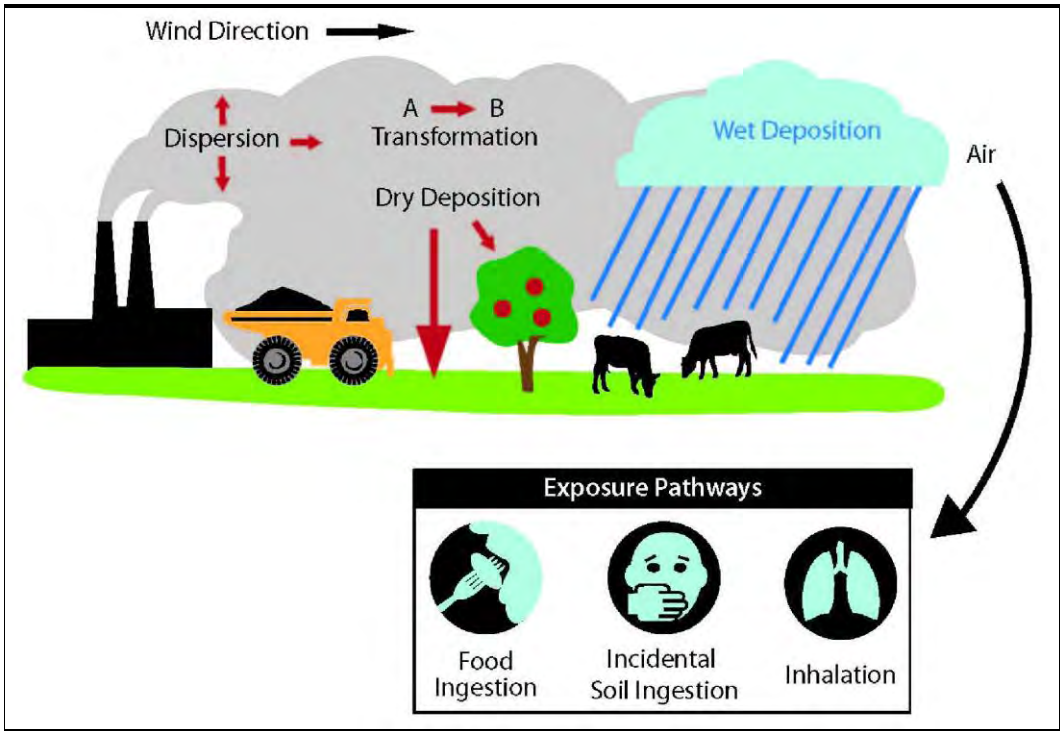


Illustration 4.3-1. Conceptual Model of Air Pollutant Transport and Exposure

The potential risk associated with exposure to a pollutant is a function of both the magnitude of exposure, i.e. the concentration, and the duration of exposure. Short-term exposure to relatively high pollutant concentrations can lead to different toxic effects than long-term exposure to relatively low levels of exposure. To evaluate the range of possible adverse effects under different conditions, MPCA (2007) guidance requires that both acute (i.e. short term) and chronic (i.e. long term) exposures be evaluated. Accordingly, hourly (representing a short term acute) and annual (representing a long term chronic) average emission rates are estimated in the emission inventory. Five years of meteorological data are used in the analysis to estimate the worst case one-hour and annual average pollutant air concentrations. This approach seeks to provide modeled concentrations that do not under predict actual future air concentrations.

In general accordance with MPCA (2007) guidance, the risk assessment modeled the transport of pollutants from the source of emissions to the points of potential exposure using the AERMOD dispersion model. The grid used to conduct the chronic risk modeling is shown in Figure 4.3-1. The acute risk modeling was conducted using the Class II receptor grid (i.e. the criteria pollutant receptor grid). This grid, which is not shown in Figure 4.3-1, was denser on and near the property boundary and did not include any receptors within the property boundary.

The AERMOD dispersion model was used to assess vapor, particulate, and particle-bound phase deposition of emitted pollutants. For the worst-case annual average condition, the dispersion model considered depletion of pollutants in air with distance from the point of emission that would be expected from particulate deposition; however, such depletion was not applied for the one-hour condition. These model simplifications are consistent with a screening level assessment by providing an upper limit estimate of the future potential concentrations of pollutants in air at points of exposure.

Multichem software was used to determine the worst case one-hour air concentrations to assess acute exposure and risk. This commercially available software combines the AERMOD information with emission rate data to produce maximum one-hour concentrations for each chemical at selected locations on the grid. To meet the minimal needs of a simplified, screening level risk assessment, the maximum predicted concentration of a chemical at any location was combined to create one single hypothetical exposure scenario. It was conservatively assumed that 75 percent of emitted nitrous oxide (NO) was instantaneously converted to nitrogen dioxide (NO_2) upon release into the atmosphere; however, the conversion may take hours or days to complete (Barr, 2011a). Otherwise, chemical transformation or degradation was not considered for other pollutants.

To determine worst-case annual average concentrations in support of chronic exposure and risk, the results of the dispersion model were input into a more comprehensive risk assessment model called the Industrial Risk Assessment Program (IRAP). IRAP is commercial software that incorporates risk assessment equations and model input parameters established by U.S. EPA. The model was used to calculate pollutant deposition and concentration in soil, surface water, sediment, vegetables and animal products (meat, milk, eggs, and fish). As described for AERMOD dispersion modeling above, pollutant decreases over time due to physical, chemical and biological processes are accounted for in the model. Calculated chemical concentrations in soil, produce and animal products were based upon the maximum achievable concentration at the end of a 30-year period of deposition (which exceeds the 15-year life of the proposed ESMM project). Barr (2011a) added additional model input parameters where necessary to support the list of pollutants included in the assessment, which were reviewed by MPCA. Unlike the one-hour scenario, which used the maximum modeled air concentrations observed at any location to create a single hypothetical scenario, the worst-case annual average scenario produced different air concentration for each location selected for analysis as shown on Figure 4.3-1.

Mercury Transport

An additional pollutant transport and exposure pathway is relevant for mercury. In comparison to other pollutants, mercury has a much greater tendency to bioaccumulate in aquatic life at levels of potential concern to humans upon consumption. Once mercury enters a surface water body, it is likely to bioaccumulate in fish and other aquatic life that may be consumed by humans. This pathway is illustrated in Illustration 4.3-2. The MPCA approved methodology used to assess cumulative mercury exposure and risk is described in Chapter 5.3.

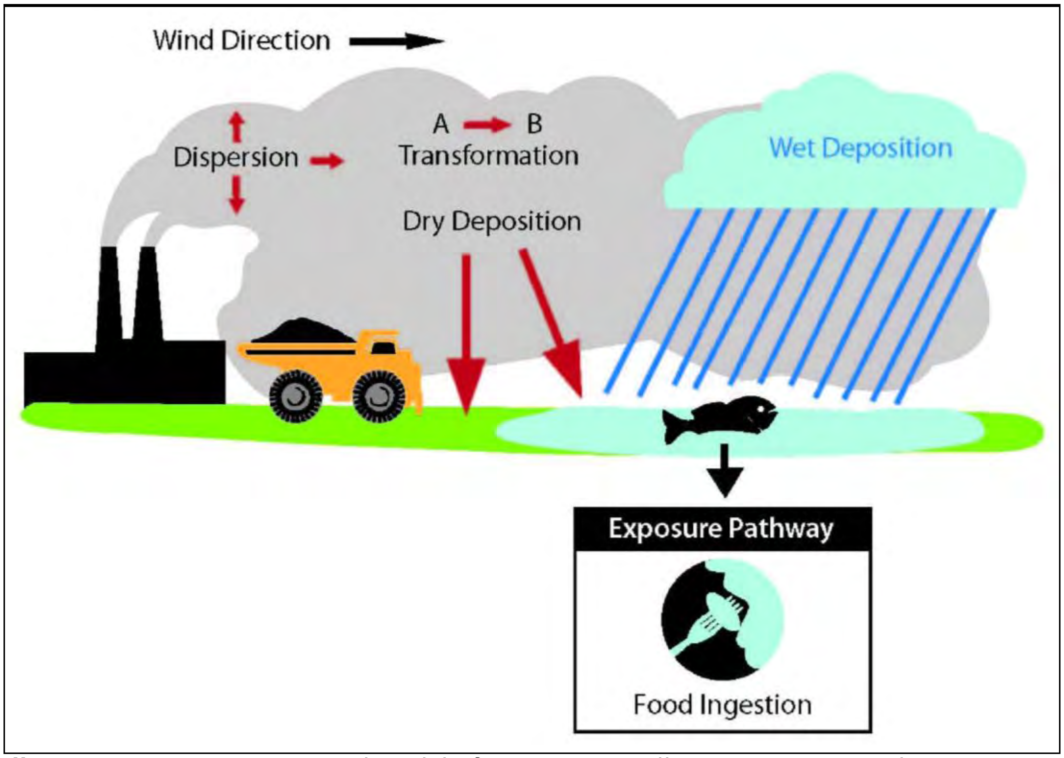


Illustration 4.3-2. Conceptual Model of Mercury Air Pollutant Transport and Exposure via Fish

4.3.1.4 Land Use and Exposure Scenarios Determinations

Knowledge about sources of pollutant emissions, patterns of pollutant dispersion, and existing and future potential land uses was used to select specific locations and exposure scenarios for assessing risk. The facility boundary on the prevailing downwind direction from sources of air emission or the facility boundary in the down gradient direction of surface water or groundwater flow is generally the worst case location. Exceptions may occur for very high stack heights, mountainous or canyon type terrain, and certain property boundary configurations. None of these exceptions were determined through modeling work to be a factor for the proposed ESMM project.

Three types of land uses or receptor types were identified as plausible at or near locations of maximum potential impact:

- Future potential resident. Someone who lives and works close to the mine site boundary.
- Subsistence fisher. Someone who consumes large quantities of locally harvested fish.
- Subsistence farmer. Someone who consumes large quantities of homegrown or locally harvested meat, fish and produce.

The locations selected for assessing the above described exposure scenarios are shown on Figure 4.3-1. The locations selected are a subset of the locations defined by the chronic risk modeling grid. The figure shows multiple locations around the facility boundaries and in the vicinity of the cities where potential worst case exposure may occur. Multiple locations of maximum potential exposure were selected because pollutant emissions change by emission source. Moreover, the emission rate for each pollutant varies at each emission source. Therefore, the location of maximum exposure for one pollutant may be different than another pollutant.

Nine of the selected locations were the location of highest estimated risk from the February 2007 MSI HHSLRA. Two additional receptors were selected for the ESMM HHSLRA. One was selected in Nashwauk to assess potential overlap in air concentrations and risk with the Keetac Expansion Project. The second was selected northwest of the concentrator on the property boundary that was included based on PM_{10} increment modeling results (Barr, 2011a).

Impacts are not assessed within the property boundary. This is consistent with risk assessment methodology as Essar is assumed to have control over the activities within the facility boundary. This is assumed to prevent, for instance, a resident or subsistence farmer locating within the property boundary. Similarly, as an example for acute exposure, the facility boundary is assumed to prevent trespass exposure.

Consistent with the objectives for a simplified, screening level assessment, the exposure assessment applied worst case assumptions that are generally consistent with standard professional practice and MPCA (2007) guidance. The exposure assumptions applied to this project are as follows:

- Residents. Risk assessment calculations assumed residents were exposed to the annual average concentration of pollutants in air for 24 hours per day, 365 days per year, for 30 years. Residents were also assumed to be exposed to pollutants through incidental soil ingestion and consumption of homegrown vegetables and locally caught fish. Exposure to homegrown vegetables includes both leafy and root vegetables.

- Subsistence farmers. No subsistence farmers are currently known to work/live within 10 km of the proposed facility (Barr, 2011a). Risk assessment calculations assumed that subsistence farmers are exposed via inhalation to the annual average concentration of pollutants in air for 24 hours per day, 365 days per year, for 40 years. It was also assumed that the farmer receptor would be exposed to pollutants via consumption of homegrown beef, pork, chicken, eggs, milk, produce, locally caught fish, and incidental soil ingestion. Consumption rates are based on surveys that determine national average food consumption rates for farmers as reported in EPA’s Exposure Factors Handbook.

- Subsistence fishers. Humans who consume locally caught fish were assumed to be exposed to facility emissions via daily consumption of locally caught fish (0.28 pounds/day for adults and 0.06 pounds/day for children as cooked and trimmed fish), consumption of homegrown produce, and incidental ingestion of soil, in addition to direct inhalation of vapors and particulates in air. To support the assessment of pollutant concentrations in fish, water body and watershed parameters were determined for five lakes near the facility (Swan Lake, Snowball Lake, Oxhide Lake, O’Brien Lake, and Big Sucker Lake) where fishing is known to occur.

Some other routes of exposure are ***not*** considered as they are expected to have little effect on results, relative to other routes of exposure. These are:

- Incidental ingestion of surface water or sediments (during swimming for instance),

- Dermal (i.e., skin) exposure to air concentrations of chemicals, to chemicals in soil, to chemicals in surface water and chemicals in sediments, and

- Groundwater exposure – i.e., the potential for groundwater contamination from air emissions (via deposition movement of chemicals through soil) or groundwater seepage from mine facilities.

Mercury Exposure

The following exposure assumptions were used to quantify a range of exposures and risks from mercury exposure (see Chapter 5.3 for more details):

- Subsistence fisher: 224 grams per day (or 0.5 pounds/day). This value is higher than the MMREM default value of 142 grams per day and is preferred by representatives of several northern Minnesota Tribes (Vogt, 2008).
- Recreational angler: 30 grams (0.066 pounds) per day.

Lead Exposure

The EPA has developed a unique methodology for assessing lead exposure that responds to its widespread distribution and sources of exposure. Lead is a naturally occurring nonnutrient metal that follows environmental pathways similar to those of nutrient metals such as calcium. In the human environment, these pathways or routes of exposure transfer lead from sources such as food, drinking water, air, soil, and dust, to the human body by means of ingestion or inhalation. Children have been identified as particularly sensitive to the adverse effects of lead exposure. Concentrations of lead in blood have become recognized as a good indicator of recent exposure to lead. Health effects of concern have been determined to be associated with childhood blood lead concentrations at or below 10 ug/dL (micrograms per deciliter). The Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children was developed by EPA to predict the risk of elevated blood lead (PbB) levels in children (under the age of seven) that are exposed to environmental lead from many sources. Table 4.3-2 shows input values for the IEUBK model.

Table 4.3-2. Input Concentrations for Estimating Potential Lead Exposure with the USEPA Integrated Exposure Uptake Biokinetic (IEUBK) Model [1]

Medium	Concentration	Units
Air – outdoor [1]	0.00091	µg/m³
Air – indoor [2]	0.000273	µg/m³
Soil [1]	0.00032	µg/g
House dust [3]	0.09132	µg/g
Diet [4]	1.95-2.26	µg/day
Drinking water [4]	4	µg/L
Maternal blood [4]	1	µg/dL

[1] Maximum modeled lead concentrations from the IRAP Model at IRAP Receptor 14 located on the northwest portion of the property boundary to the north/northwest of the plant area.

[2] Indoor air: The indoor air concentration of lead is assumed to be 30% of the outdoor concentration, following USEPA (1994) recommendations.

[3] Indoor dust concentration (mg/kg) = (0.7 x soil concentration) + (outdoor air lead contribution at rate of 100 ug/g per 1 µg/m³ air lead).

[4] IEUBK default values for dietary intake, drinking water and maternal blood are used in this analysis. Dietary intake and drinking water intake are age dependent.

4.3.1.5 Toxicity Assessment

Numerical expressions of pollutant toxicity are used to quantify potential risks at a given level of pollutant exposure. Since the toxicity of a chemical is a function of both the magnitude of exposure and the duration of exposure, different benchmark values are used to assess acute (short term) and chronic (long term) exposure. Also, pollutants may cause one or more types of toxic effects. Accordingly, unit risk factors are used to assess cancer risk and reference concentrations are used to assess non-cancer hazards.

With respect to the type of potential impacts, carcinogenic and non-carcinogenic impacts are assessed. For non-carcinogenic health endpoints, the most sensitive endpoint was used for the analysis. These include such things as the potential for developmental effects, systemic effects, neurotoxicity, etc. To be used in a HHSLRA, toxicity data must meet certain criteria for validity. Inhalation toxicity values from the following sources in the following hierarchy (best to least) were used:

- Minnesota Department of Health (MDH) promulgated Health Risk Values (HRVs) and MDH guidance,
- Data published in USEPA's Integrated Risk Information System (IRIS).
- Data developed by the State of California EPA Office of Environmental Health Hazard Assessment (OEHHA),
- Data from USEPA's Health Effects Assessment Summary Tables (HEAST), and
- Minimal Risk Levels developed by the Agency for Toxic Substances & Desease Registry (ATSDR).

For oral toxicity (i.e., from ingestion of chemicals), no standard MPCA or MDH database exists. The MPCA provided Essar with oral toxicity values for use in this assessment.

Except for lead in the IEUBK analysis, all chemicals are assumed to be 100 percent bioavailable in this analysis. For example, if a metal is ingested, it is assumed that 100 percent of it could be used in the body in the mechanism that would result in the toxic endpoint.

The dioxin/furan family of chemicals consists of many individual chemicals that share some common characteristics. The toxicity of those individual chemicals varies. Emissions can be estimated for each individual chemical, or estimates can be made for the total group based on the relative toxicity. When the relative toxicity basis is used, this is referred to as a 'toxic equivalent factor.' Dioxin/furan emissions were treated as toxic equivalents in this HHSLRA.

4.3.2 ENVIRONMENTAL CONSEQUENCES

Proposed mining operations will emit pollutants into the air, and these pollutants may migrate off site. The pollutants may deposit onto soil or into water. Humans may be exposed to the pollutants in air, soil and water. The degree of risk associated with this exposure is dependent upon the magnitude and duration of the exposure and the toxic characteristics of each pollutant. This subsection presents both the quantitative and qualitative estimates of risk from potential exposure to the emitted pollutants.

4.3.2.1 Quantitative Risk Estimates

The quantitative risk results are provided in Table 4.3-3. Note that the values are presented using only one significant figure (only one number other than zeros) to reflect the inherent limits to the accuracy of the risk assessment. Also note that cancer risk values are presented using scientific notation, as is customary in risk assessment to make very low numeric values more readable. A risk value in scientific notation of 1E-5 is numerically equal to 0.00001 or 1 excess cancer in 100,000 exposed humans. There are other natural and man-made causes of cancer that are not addressed by this assessment.

The risk of getting cancer in one's lifetime for people living in Minnesota is 1 in 2 (MDH, 2001).

Also note that this is the incremental increased cancer risk from exposure to pollutants emitted from mining activities under the exposure assumptions used in the risk assessment. These risk values do not consider the type and severity of the cancer and whether it might be treatable. Consistent with the level of detail generally applied in a screening level risk assessment, the exposure assumptions are biased to the high end of likely true values where uncertainties exist or mathematical simplification is desired. For this assessment, it is unlikely that anyone would be exposed at the facility boundaries at the exposure frequencies and durations applied in this assessment.

Results for noncancer toxicity are expressed as a hazard quotient. The hazard quotient is the ratio of the estimated exposure divided by the toxicity factor. Values below 1.0 indicate that exposure is expected to be less than the level that might cause an adverse impact in some people.

Table 4.3-3. Incremental Increased Human Health Risks

Receptor/ Location	Location	Proposed ESMM Project			Original MSI Project		
		Cancer (multi-pathway; adult) [1]	Noncancer Chronic (multi-pathway; child) [2]	Noncancer Acute Inhalation (maximum) [3]	Cancer (multi-pathway; adult) [1]	Noncancer Chronic (multi-pathway; child) [2]	Noncancer Acute Inhalation (maximum) [3]
Resident				0.4			0.9
07	Snowball Lake	1E-06	0.4		2E-06	0.3	
13	Northwest of pellet plant	2E-06	0.2		1E-05	0.3	
14	Northwest of pellet plant	2E-06	0.2		6E-06	0.2	
17	Nashwauk	6E-07	0.08		2E-06	0.1	
25	Snowball Lake	1E-06	0.5		2E-06	0.3	
26	Oxhide Lake	1E-06	0.3		3E-06	0.3	
27	East of Tailings Basin	8E-07	0.4		3E-06	0.4	
28	East of mine area and north of Tailings Basin	7E-07	0.09		2E-06	0.2	
29	West/north-west of concentrator	8E-07	0.3		NE	NE	
Fisher							
07	Snowball Lake	4E-06	0.4		4E-06	0.3	
13	Northwest of pellet plant	3E-06	0.2		1E-05	0.4	
14	Northwest of pellet plant	3E-06	0.2		8E-06	0.3	

Receptor/ Location	Location	Proposed ESMM Project			Original MSI Project		
		Cancer (multi-pathway; adult) [1]	Noncancer Chronic (multi-pathway; child) [2]	Noncancer Acute Inhalation (maximum) [3]	Cancer (multi-pathway; adult) [1]	Noncancer Chronic (multi-pathway; child) [2]	Noncancer Acute Inhalation (maximum) [3]
25	Snowball Lake	4E-06	0.5		4E-06	0.4	
26	Oxhide Lake	3E-06	0.3		5E-06	0.3	
27	East of Tailings Basin	1E-06	0.4		3E-06	0.4	
28	East of mine area and north of Tailings Basin	1E-06	0.09		3E-06	0.2	
Farmer							
14	Northwest of pellet plant	5E-06	0.2		1E-05	0.4	
18	North of McCarthy Lake	2E-06	0.07		5E-06	0.2	
19	East of McCarthy Lake	3E-06	0.09		1E-06	0.09	
27	East of Tailings Basin	2E-06	0.5		6E-06	0.8	
28	East of mine area and north of Tailings Basin	2E-06	0.1		6E-06	0.3	

NE = not evaluated; Receptor 29 added specifically for the proposed ESMM Project.

[1] Highest estimated potential incremental cancer risk from IRAP model is for an adult; incremental facility risk guideline value = 1E-05

[2] Highest estimated potential incremental noncancer chronic risk from IRAP model is for a child; incremental guideline value = 1.0

[3] Highest estimated potential incremental noncancer acute inhalation risk, summed for all chemicals = 0.4 at the property boundary for the proposed ESMM project and 0.9 for the original MSI project; incremental guideline value = 1.0

Essar Project, individual chemical risk: acetaldehyde, HQ = 4.6E-06; arsenic, HQ = 0.05; NO2, HQ = 0.35.

MN Steel Project, individual chemical risk: arsenic, HQ = 0.5; NO2, HQ = 0.35

While default exposure assumptions used in screening level assessment tend to overestimate potential risks in comparison to more likely risks, the application of a consistent methodology for evaluating risk provides reliably consistent risk estimates to decision-makers. MPCA (2007, p. 50) provides the following guidance for evaluating risk results:

> "If quantitative analysis indicates that the sum of the individual chemical screening level cancer risks is less than 1E-05 and the sum of the individual chemical screening level hazard quotients (i.e., screening hazard index) is less than 1, *and* qualitative factors do not appear to depreciate this, then, generally, the project should not need further analysis and a project proposer can complete the environmental review and/or permitting process.
>
> Sometimes after using the refinements to the quantitative analysis described by this guide, the sum of the individual chemical screening level cancer risks may be greater than 1E-05 or the sum of the individual chemical screening level hazard quotients (i.e., screening hazard index) may be greater than 1. Alternatively, the quantitative analysis may show risk estimates below these values, but qualitative factors may suggest that environmental or human health issues remain. In those cases, the MPCA will discuss the analysis with the project proposer to consider appropriate courses of action. The risk summary memorandum will be prepared for this discussion, so that issues identified can be described as:
>
> - Issues that might be further clarified or resolved using a more refined, focused risk analysis, or
> - Issues exist for which a refined analysis would not provide more useful information for decision-making."

For all three receptor types (resident, fisher, farmer), individual risks and summed risks for all chemicals at all locations did not exceed the guideline values of 1E-05 for cancer or 0.1 for non-cancer. For cancer and noncancer acute toxicity, the risks for the proposed ESMM project are below risks for the original MSI project. Acute toxicity results are listed only once in Table 4.3-3 because the maximum predicted chemical concentrations across all locations are compiled to produce a single hypothetical exposure scenario. However, NO_x (evaluated as NO_2) accounted for 0.35 of the 0.4 summed hazard quotient for all chemicals evaluated (NO_2, arsenic, and acetaldehyde); suggesting limited conservatism resulted from using a single hypothetical exposure. For noncancer chronic toxicity, the reported hazard quotients for the proposed ESMM project are slightly higher for some receptors and locations.

For the proposed ESMM project, the highest estimated cancer risks (summed for all chemicals) were to a farmer assumed to be present to the north/northwest of the pellet plant (summed risk = 5E-06; location 14). For this scenario, the risk driver chemical was arsenic (emitted primarily from the pellet plant) with PAHs from estimated mobile source emissions in the mine pit (mining equipment and haul trucks) also contributing to the estimated risks. The next highest estimated cancer risks were for locations 07 and 25, both involving hypothetical subsistence fishers on Snowball Lake (cancer risk = 4E-06). PAH emissions from mobile sources in the mine pit (equipment and haul trucks) were the primary contributors to the estimated risks.

Hydrogen Fluoride Risks

The scope of work for this risk assessment identified a short list of chemicals to be evaluated based on knowledge gained in assessing risk for the original MSI project. Revisions to the emission inventory after the scope of work for the HHSLRA was completed resulting in certain changes in emissions for some chemicals, as presented in Table 4.3-1. Hydrogen fluoride emissions increased the most, with a projected increase of 9495 percent. A screening level assessment of risks for chemicals that are projected to increase by more than 10 percent was performed (Barr, 2011a). Of the 33 chemicals included in this additional assessment, hydrogen fluoride is only chemical where an increase in risk is noteworthy. The initial assessment described above was based on a ratio scaling from the original MSI project risk assessment. During the review process of the risk assessment, Barr Engineering specifically modeled hydrogen fluoride using refined modeling (i.e. specific meteorological data in the same manner that other chronic risk estimates were made). The results of this exercise showed that, through refined modeling, hydrogen fluoride is not a risk driver (IRAP modeled chronic non-cancer hazard quotient was 0.01, compared to a risk driver level of 0.1). The non-cancer acute hazard quotient for hydrogen fluoride was 0.003, indicating that the acute exposure is also not a risk driver (Stegink, 2011).

Lead Risks

Risks from potential exposure to lead are not included in the results presented in Table 4.3-3. EPA's IEUBK lead model was applied to a hypothetical child, aged 6 months to 7 years of age, who might be exposed to lead at the point of maximum modeled annual lead levels air and soil (location 14). The IEUBK model estimated the potential incremental blood lead level in children potentially exposed to lead in air, soil, and house dust, drinking water, diet and maternal lead associated with potential facility lead emissions. The predicted incremental increase in blood lead concentration ranged from 0.6-0.8 μg/dl, depending on the child's age. Children under age 4 were predicted to receive the highest blood lead levels. All results were far below the Centers for Disease Control (CDC) levels of concern of 10 ug/dL.

Mercury Risks

Project related impacts of mercury on area lakes were evaluated for different assumptions about the degree of mercury control that would be achieved (Barr 2011a). As discussed in Chapter 5.3.1.1 and in Chapter 3.0 in greater detail, the proposed ESMM project adds an activated carbon injection step to the indurating furnace air pollution control system to reduce mercury emissions. Use of activated carbon injection on a taconite pellet furnace is a new technology, so there is uncertainty about the degree of control that can be achieved. While assessment of similar technologies used in power plants indicates removal efficiencies may be as high as 80 percent, a likely worst case removal efficiency of 30 percent was used to assess cumulative risk associated with mercury in background air, other nearby facilities and the proposed ESMM project (Chapter 5.3).

Results of the screening mercury deposition analysis for the 30 percent control scenario are contained in Table 4.3-4. The estimated potential incremental increase in fish mercury concentration for the 30 percent control scenario is small for all five lakes, ranging from 0.004 to 0.007 mg/kg. Also for the 30 percent control scenario, the estimated project related increase in hazard quotients to a subsistence fisher ranges from 0.1 to 0.2. This potential incremental change is small when compared to the existing background risk that ranges from 10 to 21 for these lakes.

The impacts presented in Table 4.3-4 would be less should higher levels of mercury control be achieved. For the 50 percent and 80 percent control scenarios, estimates of potential incremental change in fish mercury concentrations ranged from 0.002 to 0.006 mg/kg, depending on the lake and the control level.

Table 4.3-4. Project Related Risks from Mercury Deposition in Area Lakes

Lake	Fish Tissue Concentrations			Hazard Quotients***			
				Subsistence/Tribal Angler		Recreational Angler	
	Existing* (mg/kg)	Predicted Increase** (mg/kg)	Predicted Increase (%)	Existing	Predicted Increase**	Existing	Predicted Increase**
Big Sucker Lake	0.47	0.007	1%	16	0.2	2	0.03
O'Brian Lake	0.59	0.007	1%	20	0.2	3	0.03
Swan Lake	0.42	0.004	1%	14	0.1	2	0.02
Snowball Lake	0.6	0.004	1%	21	0.1	3	0.02
Oxhide Lake	0.3	0.005	2%	10	0.2	1	0.02

*The 95% upper confidence limit of the mean of measured fish tissue data available since 1980.

**Predicted increase associated with the proposed ESMM project only assuming 30 emission control for mercury at the pellet plant. See Table 5.3-1 for a presentation of cumulative risk associated with additional mercury in background air and from other major nearby facilities. The cumulative assessment also evaluates Coons Lake, Horsehead Lake, and Kelly Lake.

***Unitless ratio value. Values below 1.0 indicate little to no potential for adverse effects.

Criteria Pollutant Risks

In addition to the assessment for toxic air pollutants, emissions from criteria pollutants were modeled and compared against ambient air quality standards. Criteria pollutants are a list of six common air pollutants regulated by the federal Clean Air Act that are harmful to health and the environment or cause property damage and for which national standards have been established.

The Clean Air Act established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against visibility impairment, damage to animals, crops, vegetation, and buildings.

The results of the criteria pollutant assessment are presented in Chapter 4.2, Table 4.2-6, Class II Air Dispersion Modeling Results Summary. This assessment indicates that criteria pollutant levels would not exceed the standards.

Cumulative Air Emission Risk Analysis

The cumulative analysis addresses risks associated with exposure to pollutants in air from the proposed ESMM project in combination with other existing sources. Both hazardous air pollutants and some criteria pollutants were included in the cumulative analysis. Ambient air monitoring data for the Virginia, Hibbing and Cloquet areas were considered along with emissions from the U.S. Steel Keewatin Taconite facility and the Keetac Expansion Project to estimate exposure from other existing sources, as previously described.

Three locations were included in the final analysis: two locations on Essar's Property Boundary that would produce the highest estimated cancer inhalation risk (Location 13) and noncancer chronic inhalation risk (Location 25).; and a location in the City of Nashwauk (Location 17). The City of Nashwauk locations were selected to capture the overlap in air emissions from the proposed ESMM project and Keetac facility.

Table 4.3-5 presents the results of the cumulative risk analysis for three risk scenarios (chronic cancer, chronic non-cancer, acute non-cancer).

Table 4.3-5. Cumulative Human Health Risks from Pollutants in Air

	Total Background*	Proposed ESMM	Proposed Keetac Expansion	Total	Percent Due to ESMM
Property Boundary (Location 13 for cancer and Location 25 for non-cancer)					
Chronic Cancer risk	3E-5	4E-7	Not applicable	3E-5	1%
Chronic Non-cancer hazard index	0.9	0.4	Not applicable	1.3	31%
Acute Non-cancer hazard index	0.5	0.4	Not applicable	0.9	44%
City of Nashwauk (Location 17)					
Chronic Cancer risk	3E-5	1E-7	8E-9	3E-5	0.3%
Chronic Non-cancer hazard index	0.9	0.06	0.001	1.0	6%
Acute Non-cancer hazard index	0.8	0.07	0.05	0.9	8%

*Includes monitoring data only for property boundary locations, and from both monitoring data and the existing Keetac facility for City of Nashwauk. To the extent that monitoring data is influenced by Keetac emission, this would lead to an overestimate of risk and hazard index.

Total background concentrations are similar across different risk scenarios and locations, except that the acute (i.e. 1-hour exposure) non-cancer hazard index is higher at 0.8 for the City of Nashwauk than the property boundary. Where ambient monitoring stations located in Virginia, Hibbing and Cloquet are influenced by Keetac emissions, the acute risks for City of Nashwauk may be overstated. Some "double counting" of emissions may occur if modeled concentrations predicted from Keetac emissions are added to measured emissions at ambient monitoring stations that are also derived from Keetac. Since the Virginia, Hibbing and Cloquet monitoring stations are further away from Keetac than the City Nashwauk, the potential for double counting is likely limited.

The total background chronic (i.e. long term exposure) non-cancer hazard index in both locations is 0.9, just below the MPCA facility risk guideline of 1.0. The total background chronic cancer risk is 3E-5 (i.e. 3 additional cancers per 100,000 humans exposed for 70 years), which exceeds the MPCA facility risk guideline of 1E-5. However, the MPCA (2007) guideline applies to facility specific risks, not cumulative risks. No guidance or standard for decision-making regarding cumulative risk levels has been established by MPCA. As a source for more general guidance, the EPA often uses the range of 1E-6 to 1E-4 to guide decisions about levels of potential concern. Various state and federal programs addressing risks from chemical exposure generally adopt risk levels of concern from within this range, where such specific guidance is provided.

The proposed ESMM project provides a higher amount of risk than the proposed Keetac Expansion project at the City of Nashwauk location; although the contribution from both projects is relatively small in comparison to total background levels. Contributions to total risk are highest for the chronic non-cancer hazard index and the acute non-cancer hazard index at the property boundary locations. Total chronic cancer risk and non-cancer hazard quotients at both locations exceed MPCA guidelines, and the acute hazard index is just below the value of 1.0 at both locations, indicating that adverse impacts are not likely. Again, no state or federal guidance or standard specific for decision-making regarding cumulative risk levels has been established.

The acute risks are largely influenced by nitrogen oxide (NO_x) emissions. Modeling assumed that 75 percent of the nitrogen oxide (NO) converts to nitrogen dioxide (NO_2) upon emission to air; however, the conversion may take hours or days to complete (Barr, 2011a referencing Finlayson-Pitts and Pitts, 1986). This assumption may therefore overstate risk.

4.3.2.2 Qualitative Assessment of Uncertainty and Variability

Uncertainty and variability is an inherent aspect of any risk assessment. Uncertainty derives from the limits of scientific knowledge and the necessity of some finite level of site-specific inquiry. Variability derives from natural variability in the amount of exposure that different humans may receive, and different levels of sensitivity that humans may have. However, risk assessments can inform an understanding of the risk by minimizing uncertainty where possible and clarifying the nature of remaining uncertainty and variability. Moreover, the application of a structured and consistent methodology for assessing risk can ensure that current scientific knowledge is applied in accordance with generally accepted best practices, that the level of effort is appropriate to the complexity of a decision, and that the understanding of risk is consistent across multiple projects. In accordance with generally accepted risk assessment practice (e.g. MPCA, 2007; MPCA, 2008), this section of the risk assessment further informs the understanding of risk results presented in this chapter by identifying areas of uncertainty and describing the potential influence of the uncertainty on the quantitative risk estimates presented.

The risk assessment prepared by Barr (2011a) provides an extensive qualitative description of uncertainty and variability inherent in the quantitative assessment of risks. MPCA expanded upon the qualitative assessment provided by Barr. The major components of uncertainty and variability identified are presented here.

Air Dispersion Modeling: Modeling used to estimate ambient impacts has uncertainties. The uncertainties include the choice of meteorological data, ability to represent complex building and stack arrangements, and assumptions regarding dispersion in the model itself. The overall impact of these uncertainties may result in an over or under prediction of air concentrations. The highest annual average of five years of meteorological data were used in an attempt to address some of these uncertainties. The chronic impacts analyses then assume this concentration during the full exposure period, which overestimates risk.

Bioavailability: This risk assessment is based on exposure to the total concentration of pollutants at selected locations. Pollutants vary in terms of their ability to enter into the body and cause toxicity in particular parts of the body. Consistent with general practice for screening level risk assessments, this assessment assumed that 100 percent of the exposed concentration was absorbed into the body. This assumption over-estimates risk for many chemicals.

Chronic (cancer and non-cancer) Exposure: Humans are assumed to be continuously exposed to maximum annual average air concentrations. For example, cancer inhalation impacts assume continuous exposure for 30 years for a resident and 40 years for a farmer at a single outdoor, location. Highest risks are for locations of maximum modeled air concentrations. Moreover, these data account for such things as inhalation and ingestion rates, deposition rates, soil transport, plant uptake, foraging by animals, etc. Numerous site specific conditions can influence how these processes work, and the default values used seek to be protective by providing conservative estimates of these variables. Where multiple variables in a risk equation are based on conservative estimates, it can lead to a condition called “compounding conservatism” that can overestimate exposure and risk. Conversely, if insufficient data were available for a particular chemical, those exposures were not assessed. This underestimates risk.

Acute Exposure and Hazard: The hazard quotient for noncancer acute inhalation exposure is conservatively based on the highest predicted concentration for a chemical at any location. NO_x (evaluated as NO_2) accounted for 0.35 of the 0.4 summed hazard quotient for all chemicals evaluated. The hazard quotient for NO_x assumes that 75 percent of NO instantly converts to NO_2, which conservatively over predicts the hazard quotient. The location of maximum predicted air concentrations for NO_x, hydrogen fluoride and other chemicals assessed for acute risk are not indicated since hourly modeled pollutant concentrations do not localize with wind direction to the degree that annual concentrations would localize. In general modeled hourly air concentrations may be predicted with distance from a facility boundary (i.e. radius from a facility boundary), but are much more variable with respect to directional location around a facility boundary. To the extent that maximum concentrations occur at different locations, the hazard would be less than the summed value of 0.4. Conversely, additional hazard may be derived from the criteria pollutants SO_2 and PM10. Emissions of SO_2 are predicted to be within 93 percent of the standard, while PM10 emissions are predicted to be within 84 percent of the standard. Since standards for criteria pollutants are derived differently than toxicity factors used to determine hazard quotients, it is not possible to sum hazards across the various chemicals. However, combined exposure to SO_2 and PM_{10} may contribute to the total hazard by an unknown amount.

Pathways not addressed: As identified at the end of Section 4.3.1.4, some pathways of exposure were not assessed. Exposure from these pathways is thought to be limited or non-existent, and therefore would not be expected to have a large effect on risk.

The uncertainty and variability associated with the above mentioned and other parts of the risk assessment are the norm for a screening level assessment. Overall, a screening level assessment is intended to provide a conservative estimate of quantitative risk. Accordingly, taken as a whole, the quantitative estimates of risk are more likely to be overestimated than underestimated.

4.3.3 MITIGATION

Human health risks associated with the proposed ESMM project are below facility risk guidelines (MPCA, 2007). The proposed ESMM project will contribute relatively small amounts of additional risk to that associated with background levels of pollutants in air and mercury in fish.

No mitigation measures are proposed in the risk assessment (Barr, 2011a). Emissions controls that were approved by MPCA and incorporated into an air permit would be applied to all equipment and processes that are common to the original MSI project and the proposed ESMM project. Essar would be required to monitor air emission rates as required in its air quality permit. Essar is also proposing to add emissions controls to the new indurating furnace for the pellet plant: including 1) an advanced burner design to lower NO_x emissions per unit of pellet production, and 2) installation and operation of an activated carbon injection system to reduce furnace mercury emissions. In addition, Essar is evaluating alternative control technologies that would potentially reduce indurating furnace particulate and SO2 emissions below the levels assumed for this SEIS.

4.4 Ecological Risk Assessment

Chapter Summary

The Preparation Notice for the SEIS identified the potential need for additional ecological risk assessment. Upon comparison of the MSI FEIS and underlying changes in emissions and discharges of risk driver chemicals from the proposed ESMM project, it was determined that there is a potential for increase in risk. Accordingly, a screening level ecological risk analysis data submittal was provided by the project proposer to assess the potential for ecological impacts from the proposed ESMM project.

The term "screening-level" refers to the relatively simple, yet health protective approach used to assess risk. A definition provided by EPA (2001, p. 1) is:

> "Screening-Level Ecological Risk Assessments (SLERAs) are conservative assessments in that they provide a high level of confidence in determining a low probability of adverse risk, and they incorporate uncertainty in a precautionary manner. It must be stressed that SLERAs are not designed nor intended to provide definitive estimates of actual risk, generate cleanup goals and, in general, are not based upon site-specific assumptions."

For this assessment (Chapter 4.4), the estimates of risk are based on predicted concentrations of chemicals in soil, sediment and surface water in areas outside the permit boundary of the proposed ESMM project. These predicted concentrations are compared to available criteria that have been demonstrated through scientific studies to result in little or no harm to certain organisms in the environment. A more detailed ecological risk assessment would generally determine actual exposure to specific species of organisms in the environment through inhalation, food ingestion and other pathways of exposure and compare these levels of exposure to measures of toxicity in order to determine levels of risk (similar to the approach used for human health risk assessment described in Chapter 4.3). A screening level ecological risk assessment reduces the risk assessment complexity by focusing on concentrations of chemicals in soil, sediment and surface water and eliminating the need to directly evaluate exposure to multiple organisms.

This assessment is informed by several prior assessments. The principal assessment that establishes the screening level approach used to assess risk was completed by Barr Engineering in 2006 in support of the original MSI project (Barr, 2006a; Barr, 2006b). This work was applied to support a cumulative assessment of ecological risk for the nearby Keetac project (risk analysis also conducted by Barr (2009)). The proposed ESMM project involves certain changes in air emissions and tailings basin seepages. A technical memorandum was prepared that identified these changes, reassessed risks in a streamlined manner, and referenced the prior risk work for details on the methodological approach and supporting information (Barr, 2010a). The technical memorandum was reviewed by preparers of the SEIS (Chapter 7.0) assigned to the SLERA. This review produced a response to comments (MNDNR, 2010) and a second technical memorandum (Barr, 2010b) to further inform this assessment. In January 2011 Barr released a human health risk assessment for the proposed ESMM project (Barr, 2011a). This assessment presented some revised estimates of air emissions that resulted from a review by MPCA of the emission inventory. The SLERA evaluated in this chapter of the SEIS considers the January 2011 updated air emissions.

The evaluation of ecological risk presented in this chapter is organized into three principal parts.

- Section 4.4.1, Affected Environment, provides the information necessary to support the assessment of risk. Included are the identification and description of:
    - habitat types and species of potential concern,
    - sources of air emissions and water releases,
    - chemicals of potential interest (COPI),
    - air dispersion modeling used to estimate exposure concentrations, and
    - the approach used to assess cumulative risk from the proposed project and other sources of potential exposure to chemicals.

- Section 4.4.2, Environmental Consequences, presents the findings of the screening level risk assessment and how the risks identified from the proposed ESMM project differ from the original MSI project. As an overall summary, ecological risk from the predicted increased concentrations of chemicals in surface soils and sediments would be low, while moderate to high risks due to iron, manganese, and magnesium would be possible for Snowball Lake and other lakes along the south boundary of the mine. Additionally, cumulative risk to Swan Lake from Keetac emissions would be moderate to high due to boron and copper. While the screening level assessment has achieved a measure of focus on chemicals of greatest potential concern, uncertainty persists regarding the overall conclusions. This uncertainty is characterized by describing the quality of the criteria used to assess risk and describing the components of the screening level process that contribute most to uncertainty.
- Section 4.4.3, Mitigation Measures, identifies actions that can be taken to reduce uncertainty in the risk assessment, assesses whether future risks are consistent with current predictions, and identifies the types of practices that might be used to reduce ecological risk where warranted.

Regulatory Framework and Assessment Approach

As an overall regulatory tool, this risk assessment may accompany the facility's air or water discharge permit application. A full description of the applicable regulatory framework, permits, and approvals for air permitting is provided in Chapter 4.2. Water permitting is addressed in Chapter 4.1. This chapter of the SEIS provides recommendations regarding the kinds of actions that might be included in a permit to reduce ecological exposure and generally assure ecosystem protection. These recommendations are provided in the Mitigation section that concludes Chapter 4.4.

Documentation to Prepare Chapter 4.4:

Barr, 2011. Supplemental Human Health Screening-Level Risk Analysis, Version 1. Prepared for Minnesota Steel Industries, LLC. January, 2011.

Barr, 2010a. Essar Steel Expansion Project: Screening Ecological Risk Analysis, Data Submittal, Technical Memorandum to Bill Johnson, MNDNR, July 14, 2010.

Barr, 2010b. Response to Ecological Data Submittal Comments Dated October 14, 2010, Technical Memorandum to Bill Johnson, MNDNR and Lisa Fay, MNDNR, November 2, 2010.

Barr, 2009. Screening-Level Ecological Risk Assessment for Chemicals Potentially Emitted to Air and Their Estimated Deposition to Nearby Ecological Receptors, Keetac Expansion Project, Prepared for U. S. Steel, May 2009.

Barr, 2006a. Screening-Level Ecological Risk Assessment for Chemicals Potentially Emitted to Air and Their Estimated Deposition to Nearby Receptors. Prepared for Minnesota Steel Industries, LLC. August 2006.

Barr, 2006b. Supplemental Information to the August 2006 Ecological Screening-Level Risk Assessment. Prepared for Minnesota Steel Industries, LLC. November 2006.

Bureau of Land Management (BLM), 2004. Risk Management Criteria for Metals at BLM Mining Sites. Technical Note 390 rev., October 2004. U.S. Dept. of Interior, Bureau of Land Management.

MNDNR, 2010. Comments, Response to Comments, Review of Responses, and Proposed Treatment for Essar Steel Expansion Project: Screening Ecological Risk Analysis, Data Submittal, Technical Memorandum to Bill Johnson, MNDNR, July 14, 2010. October 14, 2010.

4.4.1 AFFECTED ENVIRONMENT

4.4.1.1 Habitat Types and Species of Special Concern

Knowledge of the different habitat types and species occurring within areas potentially impacted by the proposed ESMM project is important for determining the kinds of potential impacts that should be assessed. In particular, highly valued species should be identified. Examples include fish species sought for sport fishing and food or threatened and endangered species that are important for preserving ecological diversity and ecosystem health.

According to Barr (2006a), approximately one-half of the area within a 10 km radius of the proposed facility is in a forested cover type (mostly aspen-birch), one-third is in shrub lands, and most of the remainder is in open water and grassland cover. Urban areas, cropland and developed areas account for just over 5 percent of the 94,711 acres within the 10-km radius of the proposed facility.

Wetlands cover 24 percent of the 10-km radius risk assessment area. Nearly two-thirds of the wetland types found in this area are characterized by relatively dense, woody vegetation. The major wetland types are bogs, shrub swamps and forested wetlands.

The entire 10-km risk assessment area lies within the Upper Mississippi River Watershed. Fourteen minor watersheds containing 275 naturally occurring and constructed bodies of water are within the risk assessment area.

Swan Lake is located approximately one mile south of the proposed mine site (Figure 4.4-1). The town of Pengilly is located on the northern-most tip of Swan Lake. The lake encompasses approximately 2,500 acres, with an average depth of about 10.7 meters (35 feet) and a maximum depth of about 20 meters (65 feet). Swan Lake southwest bay is a shallower area somewhat distinct from the main lake basin (see Figure 4.1-3). Swan River originates on the western end of Swan lake.

Downstream of the proposed ESMM project wild rice has been identified in the Swan River and the Swan Lake southwest bay. Wild rice is a highly valued resource. Toxicity to wild rice involves some specific chemicals and mechanisms that are different from those addressed in the ecological risk assessment. Accordingly, potential impacts to wild rice are addressed in detail in a Chapter 4.1. However, this assessment does address potential toxicity to aquatic plants as a more general endpoint of potential concern.

As reported by Barr (2006a), the USFWS lists three federally threatened species as potentially occurring in Itasca County, which includes the project area: the Canada lynx (*Lynx canadensis*), the bald eagle (*Haliaeetus leucocephalus*) and the gray wolf (*Canis lupus*). Areas within the mine permit boundary are not considered to be critical habitat for these species. Areas within 10 kilometers radius of the mine site are considered to be marginal habitat for the lynx (Barr, 2010b). Under the Endangered Species Act, critical habitat is an area essential to the conservation of a listed species, though the area need not actually be occupied by the species at the time it is designated.

The Minnesota Natural Heritage and Nongame Research Program maintains the Natural Heritage Information System containing information on Minnesota's rare plants, animals, native plant communities, and other rare features. The database lists 14 species known to occur within a 10-km radius of the proposed facility location. Of these 14 species,

- three vascular plants are identified as endangered,
- four vascular plants and the bald eagle are identified as threatened, and
- six vascular plants are identified as special concern.

The above description of habitat types and species of special concern surrounding the proposed ESMM project indicates that most of the land surrounding the mine site supports ecological resources. Terrestrial and aquatic habitats both comprise a significant portion of the land. Efforts to predict the transport and fate of chemical migration in the environment should consider the large amount of wetlands and lakes in the study area. The bald eagle and presumably other predators exist in the area that could be exposed to chemicals in air, soil, water, and through the food chain, such as through the ingestion of fish or other small mammals that have themselves been exposed to chemicals in air, soil or water. Similarly, a diversity of mammals, reptiles and smaller birds are expected to live within the forested, shrub, and wetland areas that may be exposed to chemicals in air, soil, water, and food sources. Several plant species are identified as either endangered, threatened, or of special concern. The MSI FEIS provides a detailed account of these resources.

4.4.1.2 Air Emission Affects on Environmental Quality

Mine site operations would emit chemicals into the air. Once emitted into the air, chemicals can be transported by wind and dispersion mechanisms as depicted in Illustration 4.3-1. Chemicals that are associated with particulate matter can settle onto surface soil or surface water. Chemicals in soil can be further transported via erosion processes into surface water bodies. Once in the water body, the chemicals can dissolve or become suspended in the water and some chemicals can break down in the environment, while others can persist.

Environmental impacts from air emissions were determined by modeling the overall process by which chemicals are released and dispersed into the environment. This subsection begins by describing the air emission inventory and dispersion modeling work that supported the MSI FEIS and then describes how this information was applied using a "ratio approach" to meet the ecological risk assessment needs of the proposed ESMM project.

Air emissions from mine site operations as defined by the original MSI project can generally be divided into mining sources (excavating, hauling and crushing of mined rock) and processing sources (concentrator, pelletizer, DRI, steel mill, and slag processing). As described in Chapter 3.0, the proposed ESMM project involves operational changes to only a portion of these sources of emissions. To prevent redoing much work in areas that did not involve any changes, the ecological risk assessment for the proposed ESMM project made extensive use of work completed in support of the MSI FEIS.

As a first step, an emission inventory was conducted to determine the types and amounts of chemicals that would be emitted from each proposed operation. The emission estimates were based on the maximum potential to emit when operating at expected operational capacity plus a 10% safety factor, excluding consideration of infrequent events such as startup/shutdown conditions or upset/equipment malfunction conditions (Barr, 2006a). By applying emission factors contained in a number of commonly used references to specific operations, 113 Chemicals of Potential Interest (COPI) for risk assessment use were identified. This list was refined to include only those chemicals for which applicable toxicological data were available to support risk evaluation. This resulted in the identification of 51 chemicals that could be evaluated quantitatively (Barr, 2006a). Dioxin/furan emissions resulting from the Electric Arc Furnace were quantified (Barr, 2006b). For some chemicals, additional input data needed to conduct the dispersion modeling were input, as further explained below. Table 4.4-1 presents the results of this chemical identification process.

Table 4.4-1. Chemicals of Potential Interest (COPI)

Chemicals Emitted [1]	Toxicity Value Available			IRAP Data	
	Water	Soil	Sediment	Existing	Added
5-Chloro-2-methyl-4-isothiazolin-3-one [2]					
Acenaphthene [3]	X	X	X	X	
Acenaphthylene [3]		X			X
Acetaldehyde [3]					
Acetic Acid [2]					
Acrolein [3]	X	X	X		
Aluminum Compounds [2]	X	X			X
Aluminum Oxide [2]					
Anthracene [3]	X	X	X	X	
Antimony Compounds [2]	X	X	X	X	
Arsenic Compounds [2] [3]	X	X	X	X	
Barium Compounds [2] [3]	X	X	X	X	
Benz(a)anthracene [3]					
Benzene [3]	X	X	X	X	
Benz(a)anthracene [3]	X	X	X	X	
Benzo(a)pyrene [3]	X	X	X	X	
Benzo(b)fluoranthene [3]	X	X	X	X	
Benzo(g,h,i)perylene [3]	[8]	[8]	[8]		
Benzo(k)fluoranthene [3]	X	X	X	X	
Beryllium Compounds [2] [3]	X	X		X	
Bismuth [2]					
Boron Compounds [2]	X	X			X
Butadiene, 1,3- [3]					
Butane [3]					
Cadmium Compounds [2] [3]	X	X	X	X	
Calcium Carbonate [2]					
Calcium Compounds [2]	[9]				
Calcium oxide [2]					
Carbon Monoxide [2] [3]					
Chloride salts [2]					
Chlorine, Chlorides [2]	X			X	
Chromium (VI) [2] [3]	X	X		X	
Chromium Compounds [2] [3]					
Chromium total [2] [3] [4]					
Chrysene [3]	X	X	X	X	
Cobalt Compounds [2] [3]	X	X			X
Copper Compounds [2] [3]	X	X			X
Dibenzo(a,h)anthracene [3]	X	X	X	X	
Dichlorobenzenes [3]	X	X	X	X	
Dichlorotolyltriazole [2]					
Dimethylbenz(a)anthracene, 7,12- [3]	X	X	X	X	X
Dioxin/Furan (TCDD) [2]	X	X	X	X	
Ethane [3]					
Ferro chromium [2]					
Ferro manganese [2]					
Ferro niobium [2]					

Chemicals Emitted [1]	Toxicity Value Available			IRAP Data	
	Water	Soil	Sediment	Existing	Added
Ferro vanadium [2]					
Flourine, Flourides [2]					
Fluoranthene [3]	X	X	X	X	
Fluorene [3]	X	X	X	X	
Fluoride Salts [2]	[10]	X			X
Formaldehyde [3]	X	X		X	
Gallium [2]					
Hexane [3]	X				X
Hydrogen Chloride (as Cl) [2]					
Hydrogen Fluoride (as F) [2]	[10]				
Hydrogen sulfide [2]					
Indeno(1,2,3-cd)pyrene [3]	X	X	X	X	
Iron Compounds [2] [5]	X	X	[8]		X
Iron II Oxide [2]					
Iron III Oxide [2]					
Isododecyloxypropal-1,3-diaminopropane [2]					
Isoparafinic petroleum distillate [2]					
Lead Compounds [2]	X	X	X	X	
Limestone/Dolomite [2]					
Lithium Compounds [2]	X	X			X
Magnesium Compounds [2]	[8]				
Magnesium nitrate [2]					
Magnesium oxide [2]					
Manganese Compounds [2] [3] [6]	X	X	[8]		X
Manganese Dioxide [2]					
Mercury Compounds [2] [3]	X	X	[9]	X	
Methyl Amyl Alcohol [2]					
Methyl isobutyl alcohol [2]					
Methyl isobutyl carbinol [2]					
Methylcholanthrene, 3- [3]	X	X	X		X
Molybdenum Compounds [2] [3]	X	X			X
Naphthalene, 2-Methyl [3]	X	X			X
Naphthalene [3]	X		X	X	
Nickel Compounds [2] [3]	X	X	X	X	
Nitrogen dioxide (1-hour) [2] [3]					
Pentane [3]					
Phenanthrene [3]					
Phosphorous Compounds [2]	[8]				
Phosphorous Total [2]					
Polycyclic Organic Material (total PAH) [3]		[9]			
Potassium Compounds [2]	[8]				
Potassium Oxide [2]					
Propane [3]					
Propanediamine, 1,3- [2]					
Propylene [3]					
Pyrene [3]	X	X	X	X	
Selenium Compounds [2] [3]	X	X	X	X	

Chemicals Emitted [1]	Toxicity Value Available			IRAP Data	
	Water	Soil	Sediment	Existing	Added
Silicon Compounds [2]					
Silicon Dioxide [2]					
Silver Compounds [2]	X	X	X	X	
Sodium acrylate and acrylamide copolymer [2]					
Sodium Carbonate [2]					
Sodium Compounds [2]	[9]				
Sodium Molybdate [2]					
Sodium Nitrate [2]					
Sodium Oxide [2]					
Sodium Tolytriazole [2]					
Strontium Compounds [2]	X				X
Sulfur Compounds [2]		[9]			
Sulfur Dioxide [2] [3]					
Sulfuric Acid [2]					
Thallium [2]	[10]	[9]			
Tin Compounds [2]	X	X			X
Titanium Compounds [2] [7]		X		X	
Titanium Dioxide [2]					
Toluene [3]	X	X	X	X	
Vanadium Compounds [2] [3]	X	X			X
Xylene [3]	X	X			X
Zinc Compounds [2] [3]	X	X	X	X	

[1] Chemicals identified in emission factors for one or more sources in the MSI SLERA (Barr, 2006a) or the human health risk assessment (Barr, 2011). [2] Chemicals from process emissions. [3] Chemicals from combustion - natural gas (processes) and diesel fuel (engines). [4] Chromium compounds are included and evaluated as Chromium total. [5] Iron II oxide and Iron III oxide are included and evaluated as Iron compounds. [6] Manganese dioxide are included and evaluated as Manganese compounds. [7] Emissions of COPI Titanium dioxide are included and evaluated as Titanium compounds. [8] Chemicals potentially emitted and having toxicity values assessed using a similar chemical to estimate media concentrations (Barr, 2010b). [9] Chemicals identified as emitted and having toxicity values but addressed qualitatively in Section 4.4.2.3, Uncertainties in Predicted Risk. [10] Chemicals assessed quantitatively by preparers of the SEIS as part of the risk assessment review and SEIS text development process.

The emission inventory represented by Table 4.4-1 was developed in support of the original MSI project, which was approved with the MSI FEIS. Accordingly, for the proposed ESMM project, a comprehensive third-party review was not repeated for this previously approved assessment. However, a few chemicals identified during the application of the tables to the proposed ESMM project assessment were subjected to additional assessment by preparers of this SEIS. Similarly, updates for a few chemicals in the emission inventory presented in the Supplemental Human Health Screening-Level Risk Analysis (Barr, 2011) also lead to additional assessment by preparers of this SEIS. These changes are identified by footnotes 8 through 10 in Table 4.4-1. Updates are addressed where appropriate throughout this assessment, and the possible implications of the omissions are discussed in Section 4.4.2.2, Qualitative Assessment of Variability and Uncertainty.

Chemicals emitted into the air would be transported in response to prevailing wind directions and become increasingly dispersed with distance from the point of emission. AERMOD, EPA's preferred air dispersion model for addressing short-range concentration impacts, was used to predict annual average air concentrations at points on a grid on and around the mine permit boundary. Modeling to support the SLERA is based on the assessment conducted for the orginal MSI project. This prior assessment used a different grid than that used for Class II modeling for the proposed ESMM project (refer to Chapter 4.2 for details), but was identical to that used for the Supplemental Human Health Screening Level Risk Analysis (Barr, 2011) for the proposed ESMM project. For the original MSI project, air concentrations were predicted for 1,050 points within a 35 km north-south by 30 km east-west grid centered over the mid-point of the project site. AERMOD receptor nodes were placed at 500 meter intervals on the mine's air permit boundary out to a distance of 2 km. At distances greater than 2 km, receptors were placed with a spacing of 1 km.

Each emission source associated with a mine operation was modeled separately to predict air concentrations at each point of the grid. Approximately 200 emission sources were modeled with four years of meteorological data (2001-2004) in accordance with MPCA approved methodology. The output from AERMOD provided three plotfiles, one for chemicals released as gases (vapor phase), one for chemicals released in the form of minute particles (particle phase), and one for chemicals that are adhered to particles (particle-bound phase). A total of 2,400 plotfiles were generated from this modeling (200 sources x 4 years of meteorological data x 3 types of files = 2,400). Predicted air concentrations for each plotfile were summed to determine a total air concentration at each point on the grid (Barr, 2006a).

Once transported down wind, chemicals in the air can deposit onto soil, surface water and sediment in predictable ways based on the chemical and physical characteristics of the chemical and any particles that the chemical may be associated with. The Industrial Risk Assessment Program (IRAP-*h* View), by Lakes Environmental, was used to predict future concentrations of chemicals in air, soil, surface water and sediment from air concentrations at selected grid locations contained in the plotfiles generated by AERMOD.

Twenty eight locations on the original grid generated by AERMOD were selected for calculating chemical concentrations, as shown in Figure 4.4-1. Each selected location required a separate manual effort of inputting the plotfiles, running the IRAP-h View model, and capturing the model output. The locations were chosen to encompass the the area surrounding the air permit boundary with an emphasis on identifying potential worst case locations for both human health and ecological risk applications. Location selection considered proximity to sources of emissions, prevailing wind directions, and the location of water bodies.

In this case, the IRAP-h software modeled the amounts of chemicals in the particle phase and particle-bound phase that settled onto soil or surface water at each point of the grid. Results were projected based on a 20-year period of accumulation, consistent with the proposed life of the original MSI project. The modeled chemical concentration in surface water also considered inputs from eroded soil throughout various delineated watersheds, run-off from impervious and pervious surfaces, the rate at which chemicals are diluted by water turnover within a water body, the rate at which chemicals are lost to deep sediment in a water body, and the rate at which some chemicals evaporate from surface water.

The result is an estimate of the concentrations of the chemicals in surface soil, sediment and surface water that is attributable to the original MSI project at the end of a 20-year period of operations. Any naturally occurring levels of the chemicals in soil or water are not reflected in this modeling concentration. The IRAP-h software contained the information necessary to conduct this modeling and compare the media concentrations to toxicity criteria for thirty-two of the chemicals. For the remaining chemicals, Barr retrieved and entered the additional necessary information (Barr, 2006a; Barr, 2006b), as indicated in the far right column in Table 4.4-1. All of the above described work was reviewed by MNDNR in support of the preparation of the MSI FEIS (MNDNR, 2007).

Since different sources of emissions in different locations may emit differing amounts of a specific chemical, it is possible that each chemical may have a different location among the 28 locations shown on Figure 4.4-1 where maximum concentrations are predicted to occur. However, a review of the model output (provided in Barr 2006a, Appendix B) for soil concentrations indicates that adjacent locations 7 and 25, by Snowball Lake as shown on Figure 4.4-1, have the same and highest overall concentrations of chemicals. Location 13, located on the northeastern corner of the mine air permit boundary, has higher predicted chemical concentrations for certain trace metals (e.g. cadmium, copper), some chemicals included in a class known as poly aromatic hydrocarbons (PAHs; e.g. anthracene), dioxin/furans (also called TCDD), and certain other chemicals. Location 14 has the highest predicted concentrations of strontium and zinc. Location 22 was selected to represent Swan Lake and the Swan Lake watershed.

The above described process for determining emissions and predicting chemical concentrations in air, soil, water and sediment was conducted to support the assessment for the original MSI project. To efficiently apply this work to the proposed ESMM project, a "ratio approach" was used to adjust the predicted concentrations in air, soil and water for the original MSI project so that the results would reflect the proposed project design modifications (Barr, 2010a). The results of this assessment were used to identify a short list of chemicals associated with the proposed ESMM project that should be evaluated in greater detail in a screening level risk assessment for the proposed ESMM project. Using the ratio approach to essentially scope the screening level risk assessment eliminated the need to manually rerun all of the models while producing approximately the same results. This was achieved by revising the predicted chemical concentrations in air, soil and water based on the change in production proposed for certain operations. Operational changes used in applying the ratio approach were as follows:

- Pellet Plant: For the screening level ecological risk, the operational change used was a 60% increase in emission based on a proposed 60% increase in maximum permitted production rates on an annual basis (see Chapter 3.0 for actual rates) . A new primary grinding mill, secondary crushing and screening, and ore storage and handling equipment would be needed to support this increase. Also, the size of the indurating furnace and related equipment would be increased to meet increased production.
- Mining Area: A higher volume of mining activity would occur to meet annual production increases, including increased mine vehicle usage. However, the "ratio approach" over-predicts emissions from the mining area because the proposed ESMM project proposes a more efficient haul road layout with fewer but heavier vehicles, which would reduce total emissions. Also, the duration of mining would be reduced by the proposed plan from 20 years to 15 years, which does not itself change annual emissions during mining but it does reduce the cumulative impact to soil and water that would have occurred over an additional 5-year period. Recall that the predicted soil and water concentrations were determined based on 20 years of emissions. Therefore, the simplified "ratio approach" is likely to have over-predicted concentrations in soil and water compared with the approach of re-running all the models and calculations.

Since the pellet plant and mining area are the primary sources of air emissions, increasing predicted concentrations for all chemicals associated with air related emissions provides a generally conservative approximation of concentrations in air, surface soil, and most surface water. Swan Lake is an exception, since it is also potentially affected by chemicals released from the tailings basin via a subsurface groundwater flow pathway (deep seepage), as described in Section 4.4.1.3.

The revisions to the emission modeling that supported the human health risk assessment involved newly available emission factors and other changes that affected emission rates for some chemicals (see Table 4.3-1). A revised emission inventory dated January 14, 2011 was used for the human health risk assessment. These revisions led to deviations from the assumptions described above that supported the ratio approach, essentially providing more detailed understanding of the changes in predicted concentrations. These updated emission rates were reviewed by MNDNR to identify chemicals with changes in predicted emissions that differ from the assumptions used in the ratio approach to the degree that it might substantially effect estimates of risk (e.g. cause a risk to shift from "moderate" to "low", or vice versa, according to definitions provided later in this chapter). Specifically, the following changes in emission rates were incorporated into this risk assessment through independent assessment by preparers of this chapter of the SEIS:

- Dioxin, decreased 97%
- Fluorine, Fluorides, increased 877%
- Hydrogen Fluoride, increased 9495%
- PAHs, decreased 98%
- Phosphorus, decreased 33%
- Potassium, increased 112%
- Thallium, increased 99%
- Tin, increased 174%

The updated January 14, 2011 emission rates were also used by preparers of this chapter of the SEIS to refine the predicted concentrations in soil and water that support this assessment.

4.4.1.3 Groundwater Seepage Affects on Swan Lake Water Quality

The tailings impoundment is the only identified source of potentially significant release of chemicals to groundwater outside the mine permit boundary. Once in groundwater, it is possible that chemicals may be transported via groundwater flow into Swan Lake.

Tailings are the materials left over after the initial process of grinding the ore and separating the valuable fraction to be subject to additional processing from the uneconomic fraction of the originally mined ore. This initial processing and separation produces slurry, a mixture of fine mineral particles and water, which is placed into the tailings impoundment. The particles in the water eventually settle out as sediment.

Accumulated sediments left exposed above the water surface may be dispersed by wind, although this transport mechanism is minor relative to the other pathways described in Section 4.4.1.1 due to the inherent characteristics of the sediments. While the height of the impoundment would grow as mining continues, the footprint of the impoundment would not change (see Chapter 3.2, Proposed Action). Accordingly, the amount of exposed sediments is not expected to change with the proposed ESMM project. This means that risks associated with any exposure to windblown dust from the tailings impoundment also do not change with the proposed ESMM project.

Conversely, changes in how water within the tailings impoundment would be used for the proposed ESMM project do require changes in how emissions from the tailings impoundment are predicted. The water in the impoundment is proposed for reuse in ore processing (see Chapter 4.1). This eliminates the previously planned (but not utilized) need for a surface water discharge from the impoundment to Swan Lake that was proposed in the original MSI project but was never constructed. The proposed ESMM project would eliminate this planned discharge by reusing the water in plant operations.

New information pertaining to subsurface flow also changes how emissions from the tailings impoundment are predicted. The impoundment does not contain a liner to prevent groundwater flow because the seepage rate is estimated at less than the 500 gallon/acre/day rate in the MPCA guidelines for a newly constructed pond system in the State Disposal System (SDS) permit. However, the dikes used to convey water around the impoundment are lined. Certain chemicals may therefore be transported by deep seepage flow of water into subsurface soils and ultimately groundwater. The rate of transport through subsurface soil is dependent on factors like the degree to which a chemical is soluble in water, how well it binds to or is contained within particles, and the degree to which particles themselves can move through subsurface pore spaces. Once in groundwater, it is assumed that groundwater flows in the general downhill direction into Swan Lake. A potential seepage rate of 230 gpm was determined for use in the prior SLERA (Barr, 2006a).[1]

New data have been used to apply a more complex deep seepage model and refine the estimated seepage rate for the proposed ESMM project. The updated seepage estimate is considered more accurate because it uses measured rather than estimated model input values, takes advantage of detailed dam cross sections developed from borings performed since the MSI FEIS was completed, and uses a more realistic conceptual model that also considers horizontal flow in addition to previously assumed vertical flow through the bottom of the basin. The assessment also included a sensitivity analysis to determine a range of likely seepage rates. See Chapter 4.1 for a more detailed explanation of the modeling. The sensitivity analysis resulted in a range in anticipated deep seepage flows in year 15 between 65 and 199 gpm. The uppermost value of 199 gpm was selected for use with the water balance.

To determine the potential environmental quality impacts to Swan Lake for the proposed ESMM project, the "ratio approach" used for air was similarly used to adjust predicted water concentrations. The planned direct discharge from the tailings basin to Swan Lake was eliminated. Also, revised estimates of groundwater flow rates reduce flow from the tailings basin to Swan Lake from 230 gpm, the value used in the SLERA for the original MSI project, to 199 gpm. Therefore, only 16% of the water contribution and related chemicals that were assessed in the prior SLERA (Barr, 2006a, MNDNR, 2007) is applicable to the proposed ESMM project. Note that Barr (2006a) initially used a ratio of 1.3% based on a lower seepage rate proposed at the time the original MSI project SLERA document was submitted.

The influence of groundwater flow is combined with estimated inputs from air emissions to determine total impact to Swan Lake. Air impacts to Swan Lake are estimated using location 22 shown on Figure 4.4-1.

4.4.1.4 Approach for Assessing Cumulative Risk

A cumulative assessment of ecological risk from both the original MSI project and the nearby Keetac project was performed (Barr, 2009). The assessment focused on potential risk to Swan Lake because both projects involved air emissions and direct discharge from tailings basins that could affect water quality in Swan Lake, and the original MSI project involved groundwater seepage from the tailings impoundment that could impact water quality in Swan Lake. The Keetac Project proposed tailings basin discharge/seeps to O'Brien Creek, which flows into Swan Lake (Barr, 2009). The 2009 assessment was updated to include revised estimates of potential impacts to water quality from the

[1] The 230 gpm value was revised based upon further assessment completed after the 2006 SLERA. Seepage rates presented in the 2006 EIS were 570 gpm on average over 20 years, with a maximum seepage rate of 758 gpm estimated during years 11 to 20 of operations for the original MSI project. A complete description of this deep seepage is provided in Chapter 4.1.

proposed ESMM project. These updates address the elimination of the discharge and reduced seepage estimates for the proposed ESMM project as described in Section 4.4.1.3.

4.4.2 Environmental Consequences

Environmental consequences from exposure to chemicals emitted during mining operations are expressed in terms of the risk (or likelihood) of adverse impacts to organisms in the environment. The magnitude of the risk is determined by comparing predicted concentrations in the environment to Toxicity Reference Values (TRVs). Since there are many different kinds of adverse effects that can be used to derive a TRV, the basis for the TRVs used in this assessment is described in Section 4.4.2.1. Knowledge about the basis of the TRVs is important for understanding the kinds of adverse effects associated with the predicted risks. Accordingly, the description of the TRVs supports the presentation and interpretation of the quantitative risk estimates presented in Section 4.4.2.2. The interpretation of the risk estimates are further supported by a qualitative assessment of uncertainty in Section 4.4.2.3.

4.4.2.1 Toxicity Assessment

Concentrations of chemicals in soil, surface water and sediment must be compared to applicable toxicity criteria in order to determine if there is a potential for risk. The SLERA for the original MSI project (Barr, 2006a) identified the criterion selected to quantify the potential toxicity for each chemical. The criteria are referred to as TRVs. TRVs are expressed on a concentration basis (e.g. milligrams of chemical per kilogram of soil). Separate criteria are applicable to air, soil, surface water, and sediment. Chemical concentrations in air, soil, surface water, and sediment that are equal to or less than the TRVs are expected to exhibit little to no ecological risk.

The TRVs were obtained from The Risk Information System.[2] This database is sponsored by the U.S. Department of Energy, Office of Environmental Management, Oak Ridge Operations Office through a contract between Bechtel Jacobs Company LLC and the University of Tennessee. The database is updated upon request or when notified of a change. Various states and regions within EPA maintain standards or criteria that support programs involving ecological risk. When these programs get new toxicological information and update their standards or criteria, they may request that these values be included in The Risk Information System.

EPA also maintains an extensive database of ecological toxicology studies. However, this database focuses on experimental study results that would support more detailed ecological risk assessment. It does not provide TRVs expressed on a concentration basis.

TRV values are not available for all COPIs identified for this assessment. Table 4.4-1 identifies those chemicals for which TRVs were available. As a general rule, toxicology studies and TRVs are available for those chemicals that are known to be more toxic or released into the environment in large amounts. A larger number of studies are generally performed on the most toxic and commonly released chemicals. Several chemicals that emerge in this assessment as potentially relevant to understanding risk are supported by relatively few or recent toxicological studies. More detailed explanations are provided for these chemicals to ensure that the uncertainty associated with this more limited knowledge is recognized within the context of the amounts projected to be released by the proposed ESMM project.

For the chemicals included in this investigation, The Risk Information System provided 17 different types of TRVs for surface water, with different chemicals varying widely in

[2] See http://rais.ornl.gov/tools/eco_search.php

terms of how many different types of TRVs were available. These TRVs address a wide range of toxicological endpoints of potential concern, such as TRVs for short-term exposure, TRVs specific to aquatic invertebrates, and a range of TRVs applicable to protection of ecological resources more generally. While the definitions of protectiveness vary across the criteria, those of a general nature are intended to be protective of most species most of the time. The TRVs are often based on more sensitive species or more sensitive aquatic environments. They may also be based on more bioavailable forms of the chemical. In other words, forms of the chemical that are more readily taken into the body can render it more available to produce a toxic effect. Accordingly, the criteria are often considered to be conservative (i.e. health protective) estimates of significant potential risk to organisms that live in water.

The Risk Information System does not track water quality standards developed by all states. Water quality standards promulgated by the State of Minnesota would only be included to the degree that the standards are the same as U.S. National Ambient Water Quality Criteria.

For soils, The Risk Information System provides 13 different kinds of TRVs. The TRVs identify the concentrations at which toxicity is observed or predicted based on risk assessment models to soil invertebrates, soil microbes, earthworms, plants, birds, and mammals. Different chemicals vary widely in terms of how many different types of TRVs are available. TRVs for certain kinds of organisms like plants, birds, and mammals are available for only a short list of metals (arsenic, cadmium, chromium, cobalt, lead and vanadium). As for water, the TRVs for soil tend to be based on more bioavailable forms of chemicals and are derived using the most sensitive tested species. Accordingly, they are generally considered to be conservative estimates of potential risk to organisms that may be exposed to chemicals in soil through incidental soil ingestion and direct contact pathways.

The Risk Information System provided 14 different kinds of TRVs for sediment, with different chemicals varying widely in terms of how many different types of TRVs were available. The toxicity of chemicals in sediments is complicated by a diverse range of chemical and physical factors that influence the bioavailability of the chemical in sediments. Few toxicology studies are done directly using sediments. Rather, the TRVs are often derived using assumptions about how a chemical might equilibrate between sediment and water in the environment. Hence, there can be considerable uncertainty in the application of the TRV to any specific sediment. None of the TRVs are identified as specific to a type of organism. Rather, the various TRVs are generally intended to support the functioning of healthy ecosystems using protective assumptions that allow the TRVs to apply to most organisms and most sediments.

Consistent with the screening level assessment objectives of this study, the lowest available TRVs for each chemical in surface water, soil and sediment were selected for assessing risk. Predicted chemical concentrations in surface water, soil and sediment at the end of a 20-year period of mining operations were compared to the TRVs to determine if there is potential for ecological risk. Note that the ratio approach is based on the modeling work completed for the original MSI project, which had a 20-year mining period rather than a 15-year mining period for the ESMM project.

The risk assessment conducted for the original MSI project was updated to reflect changes in emissions associated with the proposed ESMM project (Barr, 2010a). Also, a review of The Risk Assessment Information database was conducted to identify updates in toxicity values (Barr, 2010b; MNDNR, 2010). Further review by preparers of this chapter of the SEIS identified that new Eco-SSL updates to The Risk Assessment Information web site were made in September 2006, one month after the SLERA (Barr, 2006a) was completed. The Eco-SSLs are the source of information used to develop TRVs for soil protective of food ingestion pathways. Specifically reviewed were the new database information for mercury and methyl mercury, and the Eco-SSLs that were published in 2007 for lead, manganese, nickel, selenium, zinc, and PAH's.[3] This review identified a number of new TRVs, including much lower TRVs for mercury and methyl mercury in soils, sediment and surface water. However, when compared to predicted concentrations at location 7, the worst case location, it was determined that the new TRV information would not change the risk assessment conclusions.

4.4.2.1.1 Consequences of Food Web Bioaccumulation

The TRVs for surface water, soil and sediment address toxicity to organisms that have direct contact with a chemical. However, few of the standards specifically address the potential for chemicals to bioaccumulate in the food web. The TRVs rarely consider exposure how higher trophic level organisms, such as carnivorous birds and mammals for example, might be exposure to chemicals that accumulate in the tissues of lower trophic level organisms, such as rodents or earthworms. Chemicals that have the potential to bioaccumulate at toxic levels are known as persistent, bioaccumulative and toxic (PBT).

A review of potential PBT issues was conducted by prepares of this SEIS and is provided in Appendix D. Chemicals identified as emitted for the proposed ESMM project, considered to be PBTs, but do not have TRVs that consider the potential for exposure via bioaccumulation are: chromium, copper, dioxin, mercury, PCBs, and thallium. Limited available information from the screening level assessment provided by Barr (2010a, 2010b) suggests an overall low level of potential concern for bioaccumulation for the proposed ESMM project; however, considerable uncertainty remains due to the many variables that would be involved in a more thorogh site-specific assessment. Predators identified as threatened species may be particularly susceptible to exposure via this pathway.

4.4.2.1.2 Alternative TRVs

For either the project related impacts or cumulative impacts, a simple application of the lowest available TRVs resulted in ESQs exceeding 1.0 for several chemicals: boron, copper, iron, magnesium, manganese and phosphorus. For these chemicals, additional inquiry into the basis of the TRVs was conducted and "alternative" TRVs were proposed by Barr (2006a) that were deemed to be more applicable to the site-specific conditions and needs of this risk assessment. Review of this information led to additional assessments that were conducted by preparers of this SEIS, as presented in Appendix D. Accordingly, Appendix D provides the more detailed toxicological information supporting the derviation and selection of alternative TRVs used to derive the quantative risk estimates presented in Section 4.4.2.2.

4.4.2.2 Quantitative Risk Estimates

An Ecological Screening Quotient (ESQ) is calculated for those COPIs where sufficient information is available to predict a concentration in the environment and to develop a TRV. The ESQ is calculated for each chemical in surface soil, surface water, and sediment as:

$$ESQ = \frac{Predicted\ Concentration}{TRV}$$

[3] A current list of available documents is available at http://www.epa.gov/ecotox/ecossl/. Note that not all documents listed provide criteria for food web pathways.

For soil, surface water and/or sediment, the ESQ was calculated using the maximum Predicted Concentration at any location. For Swan Lake, location 22 on Figure 4.4-1 was used to predict concentrations. These predicted concentrations were generally compared to the lowest available TRV for the specific media. Additional description and explanation is provided in cases where alternative TRVs are applied.

When the Predicted Concentration exceeds the TRV, the ESQ would be greater than 1, indicating the potential for adverse toxicological impacts (i.e. risk). Importantly, an ESQ greater than 1 does not necessarily mean that readily observable adverse ecological impacts would occur or that any adverse impacts would necessarily occur. Moreover, the ESQ is not a statistical measure of the probability that an adverse effect would occur. In other words, an ESQ of 2 does not imply twice as much risk as an ESQ of 1. Different organisms can have vastly different susceptibility to a particular chemical and as exposure levels increase many different types of adverse impacts may result.

Discerning the potential risk requires careful attention to the quality of the information used to derive the TRV (addressed in Section 4.4.2.1) and the kinds of ecological risk it is intended to be protective of (addressed in Section 4.4.1). In most cases, TRVs are not set at levels protective of all individual organisms in the way that hazard quotients are designed in human health risk assessment. Rather, they are generally intended to ensure sustainability of viable populations and habitats. The studies are generally conducted using species that are more sensitive to adverse effects and using more bioavailable forms of the chemical. The natural environment has many chemical, physical and biological stresses on population health. Also, there are many variables that can reduce the extent to which a chemical would be bioavailable. In short, there are many variables that can influence exposure at a particular site and many variables other than chemical toxicity that can influence ecosystem health.

As stated at the outset, the goal of a screening level ecological risk assessment is to use a relatively simple methodology to provide a high level of confidence in determining a low probability of adverse risk. The State of Minnesota does not have established criteria for interpreting an ESQ. Ecological risk assessment guidance developed by the BLM (2004) for metals suggests that ESQ values be interpreted as follows:

- less than TRV: low risk
- 1-10 times the TRV: moderate risk
- 10-100 times the TRV: high risk
- >100 times the TRV: extremely high risk

An appropriate response to the determined ESQ values as defined by BLM (2004, p. 11) in the context of historic waste cleanup is as follows:

> "Given the uncertainties associated with the [ESQ] and the values inherent in ecosystem management, moderate risk may be addressed by management and or institutional controls, whereas high risk may require remediation."

The quantitative results of the proposed project risk assessment are provided in Table 4.4-2. Table results are restricted to only those chemicals that were identified in the SLERA for the original MSI project to have an ESQ greater than 0.1. In preparing Table 4.4-2, the predicted concentrations of chemicals in soil and water were calculated using the January 14, 2011 emission inventory as presented in Table 4.3-1 of the human health risk assessment. The bases for these calculations are provided in the notes to Table 4.4-2.

Table 4.4-2. Ecological Screening Quotients for Chemicals with Greatest Risks

		Predicted Concentration				TRV		ESQ (MSI, ESMM)	
Location [1]	**Chemical**	**MSI [2]**		**ESMM [3]**		**Lowest**	**Alter-native [4]**	**Lowest**	**Alter-native**
Soil	Aluminum	15.8	mg/kg	17.4	mg/kg	50	--	0.3, 0.3	--
	Iron	739	mg/kg	754	mg/kg	200	0	3.7, 3.8	0, 0
	Manganese	12.7	mg/kg	11.7	mg/kg	100	--	0.1, 0.1	--
Surface Water	Aluminum	0.023	mg/L	0.0025	mg/L	0.08	--	0.3, 0.3	--
	Boron	0.00017	mg/L	0.00014	mg/L	0.0016	--	0.1, 0.09	--
	Iron	10.7	mg/L	10.9	mg/L	1	40	10.7, 10.9	0.3, 0.3
	Manganese	0.08	mg/L	0.07	mg/L	0.08	0.12	1, 0.9	0.7, 0.6
	Hydrogen Fluoride	evaluated qualitatively							
Sediment	No chemicals with an ESQ greater than 0.1								
Swan Lake	Barium	0.00084	mg/L	0.00013	mg/L	0.0039	--	0.0	--
	Boron	0.00234	mg/L	0.000374	mg/L	0.0016	--	1.5, 0.2	--
	Cadmium	0.0000022	mg/L	0.00000035	mg/L	0.000013	--	0.0	--
	Iron	0.361	mg/L	0.368	mg/L	1	--	0.4, 0.4	--
	Magnesium	5.14	mg/L	0.822	mg/L	0.647	82	7.9, 1.3	0.1, 0.01
	Phosphorus	0.00066	mg/L	0.00044	mg/L	evaluated qualitatively			

[1] For soil, surface water and sediment, location 7 shown on Figure 4.4-1 has the maximum predicted concentration. Swan Lake is represented by location 22.

[2] The maximum predicted increase over existing background concentration after 20 years of operation for the original MSI project. Dissolved concentrations are used for surface water.

[3] ESMM predicted concentration in soil and surface water is based on the MSI Predicted Concentration multiplied by the change in emissions identified in Table 4.3-1: Aluminum, 10%; Iron, 2%; Manganese, -8%; Boron, -17%. For Swan Lake, iron is the only chemical to be primarily from atmospheric depositon and is therefore increased by 2%. For other chemicals in Swan Lake, predicted concentrations are based on groundwater seepage from the tailings basin. MSI concentrations are multiplied by 0.16 (i.e. reduced by 16%) to reflect a reduction in water flow from about 230 gpm estimated for the MSI project (direct discharge and seepage) to 199 gpm for the ESMM project (seepage only). Phosphorus levels are adjusted down by 33% rather than increased by the 1.6 multiplier to reflect revised emission rate estimates (Barr, 2011, Table 4-1).

[4] Alternative toxicity values only evaluated and applied when the Lowest ESQ exceeded 1.0. Boron also evaluated because the ESQ in Swan Lake for the original MSI project exceeded 1.0 due to potential tailings basin contributions. Manganese is evaluated because the ESQ is very close to 1.0 for the lowest TRV.

Comparison of the ESQ for the MSI and ESMM projects is comma-separated in the final two columns of Table 4.4-2. Overall, levels of ecological risk for the proposed ESMM project are similar to the risks for the original MSI project. A comparison of risk levels between the two projects can be understood by comparing predicted concentrations for chemicals of greatest potential concern, recognizing that risk is proportional to predicted concentration, and interpreting the degree of risk change within the context of the BLM interpretive criteria. Predicted concentrations in soil, surface water and sediment for those chemicals identified in the scoping process to be of greatest potential concern are similar or lower for the proposed ESMM project than for the original MSI project, as shown in Table 4.4-2. For example, the predicted concentration for iron in soil for the original MSI project was 739 mg/kg, while the predicted concentration for the proposed ESMM project is 754 mg/kg. This increase in predicted soil concentration increases the TRV from 3.7 to 3.8 . Since risk assessment calculations are widely regarded as accurate to only one significant figure, the risks for both projects can be understood to be essentially the same, or an ESQ of 4. Since an ESQ in the range of 1-10 is considered moderate by BLM criteria, a much larger change in predicted concentrations would be needed to make a substantial difference in the overall interpretation of risk.

Sections 4.4.2.2.1 through 4.4.2.2.5 further discuss the bases for the lowest and alternative ESQ results for the proposed ESMM project.

4.4.2.2.1 Potential Risks from Air Emissions that Deposit on Soil

Air emissions of certain chemicals would lead to increased concentrations in surface soil. However, ecological risks from future exposure to the increased concentrations are considered to be low, with one possible exception. An ESQ of 3.8 is noted for iron based on a predicted concentration in soil of 754 mg/kg and a TRV of 200 mg/kg (see Table 4.4-2). This would be considered a moderate risk by strict interpretation of BLM criteria; however, an understanding of the basis for the TRV for iron and existing background concentrations of iron in soil suggest more limited potential for risk.

The TRV for iron is based on effects to soil microbes. Adverse impacts to soil microbes may or may not have significant influence on other higher level life forms or valued species. No other TRVs are identified.

Barr (2006a) notes that iron is an essential micronutrient. Many chemicals, such as iron, can be essential nutrients at lower levels of exposure yet toxic at higher levels of exposure. The concentration at which a chemical is a nutrient or toxin can vary between species.

Normally, TRVs are not set at levels below naturally occurring background concentrations. Background soil concentrations in open areas in Minnesota range from 226 – 5,163 mg/kg. In comparing predicted concentrations to background values, recall that the predicted concentrations are only the increased concentration at the end of the proposed life of project. The sum of the existing plus predicted concentrations should be considered to assess total risk rather than only the incremental risk associated with the proposed project. Also, it is not known to what extent existing concentrations are influenced by historic mining operations. Accordingly, it is difficult to confidently interpret the implications of existing background concentrations on risk without further assessment. Using the information available, the predicted concentrations (754 mg/kg) are within the range of existing iron concentrations reported for the Minnesota range (226 – 5,163 mg/kg). If iron toxicity in soil has not been observed to occur in response to past mining projects, it is unlikely to result from the predicted increases for the proposed ESMM project.

Finally, any impacts from iron would be limited in geographical extent. Location 7 (see Figure 4.4-1) is the location predicted to have the maximum impact. Predicted increases in soil concentrations in areas adjacent to location 7 are at least half that predicted for location 7.

4.4.2.2.2 Potential Risks from Air Emissions that Deposit on Surface Water

Generally consistent with the BLM (2004) criteria, ecological risks from exposure to chemicals in surface water are considered moderate based on ESQs close to the 1.0 to 10 range for iron and manganese. The maximum location of impact is location 7, adjacent to Snowball Lake, with similar but lower predicted increases at locations 8 and 9. This finding suggests that predicted risks would apply to lakes along the south boundary of the mine site; however, the risks do not extend to Swan Lake to the south or to Little Sucker Lake to the north were model results indicate concentrations would be much lower. The increased concentrations of iron and manganese are associated with dust emissions originating from the mining area. The interpretations of impacts to surface water are highly uncertain due to uncertainty in TRVs and the geochemistry of iron.

For iron, the lowest TRV reported by Barr is the National Ambient Water Quality Criteria of 1.0 mg/L, and Barr (2006a) proposed an alternative TRV of 40 mg/L based on a study demonstrating no effects to mayflies. The degree to which iron would occur in area lakes at levels above 1.0 mg/L is dependent upon several site-specfic factors, and the selection of a site-specific TRV depends upon a detailed understanding of species occurring in area lakes. Appendix D provides a review of the toxicological data supporting the selection of TRVs for iron and manganese, and it describes the complex geochemistry of iron.

An ESQ of 10.9 is derived when using a TRV of 1.0 mg/L, while the ESQ reduces to 0.3 when the alternative TRV of 40 mg/L proposed by Barr is used. Applying the BLM interpretive criteria to these ESQs indicates risks in the range of moderate (or borderline high) to low. As was explained for soils, the predicted concentrations are the incremental increase over existing background levels that would be due to future mining. Existing background levels of iron may increase the potential for adverse effects. Efforts to reduce uncertainty about potential iron toxicity to aquatic resources would need to further evaluate or measure the complex geochemistry of iron in areas of potential concern. Efforts would also need to consider the degree to which the aquatic ecosystem in the area is naturally adapted to the iron enriched geology of the region.

For manganese, the ESQs range from 0.9 to 0.6, depending on the choice of the TRV. According to the BLM criteria, an ESQ of this magnitude is indicative of a boarderline moderate to low level of risk. Barr (2006a) selects a value of 0.12 mg/L as an alternate TRV, which is only slightly higher than the lowest published TRV value of 0.08 mg/L. The alternative TRV for manganese appears to be based on toxicity to both fish and invertebrates. The difference is not significant when considering the inherent level of precision involved in risk assessment. Again, the ESQs consider only the incremental increased concentration and do not consider existing background concentrations.

Also, the predicted concentrations are based on dissolved concentrations. However, many TRVs such as the National Ambient Water Quality Criteria are intended for comparison to total concentrations. Water containing high amounts of particulate matter or organic content can have much higher levels of total versus dissolved concentrations. In this case, the predicted total and dissolved concentrations for iron and manganese are the same. The degree to which this prediction is correct is unknown. Actual measurements of dissolved and total concentrations in area lakes would reduce this uncertainty.

4.4.2.2.3 Potential Risk from Air Emissions that Deposit on Sediments

Risks from exposure to chemicals in sediments are predicted to be low. All ESQs are less than 1.0.

Notably absent is an assessment of mercury compounds in sediment, as indicated in Table 4.4-1. However, predicted concentrations reported at location 7 for mercuric chloride and methyl mercury both appear to be below TRVs provided by The Risk Information System. It is unknown to what extent the various sediment standards provided by The Risk Information System consider exposure through the food web and bioaccumulation concerns.

4.4.2.2.4 Potential Risk in Swan Lake from Air Emissions and Groundwater Seepage

Swan Lake is evaluated separately from other surface water impacts because of the potential for impact by both air emissions from mining and pellet plant processes and water emissions from the tailings impoundment. The elimination of the direct discharge from the tailings impoundment and the reduced deep seepage groundwater flows from the tailings impoundment to Swan Lake reduced risk levels from that identified for the original MSI project. While boron also had an ESQ greater than 1.0 for the original MSI project, only magnesium is identified as a potential risk concern under the proposed ESMM project. Additional potential concern related to phosphorus is also addressed.

For magnesium, the lowest TRV is 0.647 mg/L. This TRV produces an ESQ of 1.3. While technically greater than the 1.0 decision criteria, estimates of risk are generally considered accurate to only one significant figure, which means that the ESQ of 1.3 is not meaningfully different from 1.0. Moreover, there is considerable uncertainty about magnesium toxicity, as described in Appendix D. In summary however, the proposed ESMM project is not predicted to substantially increase magnesium levels above reported background concentrations. Accordingly, risks for magnesium exposure are considered to be low. For phosphorus, the only TRV provided in The Risk Information System is a TRV applicable only to salt water (Barr, 2006a). Further assessment of possible TRVs based on state standards and potential risks from phosphorus are provided in Appendix D, where it is concluded that the proposed ESMM project will not result in increased phosphorus concentrations that exceed state standards or degrade designated beneficial uses.

4.4.2.2.5 Cumulative Risk

The assessment of cumulative risks considered the combined influence of both the Keetac and MSI operations. Barr used the same 2009 assessment to assess cumulative risk from both the Keetac and proposed ESMM projects (Barr, 2010a). Due to the large size and complexity of the table containing the results of the assessment for all COPIs, the table is provided in Appendix C, and interpretive text is provided in Appendix D.

The results of the cumulative assessment indicate varied sources of influence to Swan Lake water quality for chemicals contributing at least 0.1 to the ESQ:

- Keetac predominant influences: Cadmium, copper and silver have predicted concentrations in Swan Lake at least 10 times higher for Keetac related sources than for the original MSI project.
- Nearly equal influences: Aluminum, barium, boron, lead, magnesium and manganese, have nearly equal predicted influences to Swan Lake water quality from both the Keetac and MSI operations. Since only aluminum is influenced by air emissions, when MSI inputs are adjusted for lower water related emissions for the proposed ESMM project, Keetac would have greater influence for barium, boron, lead, magnesium and manganese.

- Original MSI project predominant influences: The original MSI project is a larger source of iron than the Keetac project. Given the increased air emissions associated with the proposed ESMM project, if chemical concentrations in Swan Lake for aluminum, iron and manganese were to increase by 60%, the proposed ESMM project would be the larger source for all three of these metals. However, increasing the concentrations and ESQ values for these chemicals would not result in a cumulative ESQ of greater than 1.0 for any of these chemicals. Moreover, Table 4.3-1, which compares projected emissions for the original MSI project and the proposed ESMM project, indicates that increased emissions for these three chemicals would be substantially less than 60%.

The total ESQ for all chemicals from both facilities ranges from 24.2 for the lowest TRV to 4.4 when using an alternative TRV. These totals suggest an overall high to moderate level of risk when applying the BLM interpretative criteria defined above. However, risks from exposure to multiple chemicals are not likely to be cumulative, particularly where risk to different species or different kinds of toxic effects are represented by the chemical-specific TRVs. Accordingly, a more detailed assessment of the findings is presented in Appendix D for chemicals having ESQs greater than 1.0 (boron, copper and magnesium).

For Boron, cumulative ESQs range from 5.5 to 0.29, depending on the choice of TRV. Using the lowest TRV, the ESQ is 3.9 for Keetac and 1.5 for MSI. Under conditions for the proposed ESMM project (higher air emission and lower water related emissions), influences to Swan Lake by Keetac are about ten times higher than the proposed ESMM project for water related emissions. As described in Appendix D, the toxicity of Boron appears to vary widely among species and under different water quality conditions. Available data suggest that some species may be adversely affected at the concentrations predicted. Given that this assessment is at the screening level, which is to identify uncertainty of conservative analysis, on-site monitoring of biota would be necessary if reducing this uncertainty is warranted.

For copper, cumulative ESQs range from 1.5 to 0.17, depending on the choice of TRV. Only 0.07% of the cumulative ESQ is associated with the proposed ESMM project when the results are adjusted to reflect reduced water related emissions (deep seepage). The selection of the National Ambient Water Quality Criteria as an alternative TRV for copper applies a generally accepted hierarchy. This supports emphasis on the alternative ESQ in interpreting risk. However, National Ambient Water Quality Criteria are not intended to ensure protection of all species all the time and available data suggest that some species may be impacted at lower levels. Application of the Biotic Ligand Model for copper (see Appendix D) might support the development of a more site-specific TRV. For magnesium, cumulative ESQs range from 13.2 to 0.1, depending on the choice of TRV. About 24% of the cumulative ESQ is associated with the proposed ESMM project when the results are adjusted to reflect reduced water related emissions. While limited available toxicology data suggest that this increase and the total concentration might be toxic to some populations of organisms, the potential effects to Swan Lake are uncertain but likely limited. An initial assessment of natural background concentrations of magnesium in Swan Lake (see Appendix D) suggests that Swan Lake may support species with more tolerance to magnesium.

When considering the cumulative risk to Swan Lake from the Keetac and proposed ESMM projects, iron is the only chemical identified to have a larger potential contribution from the proposed ESMM project. Aluminum, barium, boron, lead, magnesium and manganese, have nearly equal predicted influences to Swan Lake water quality. Iron impacts are mostly due to airborne emissions from mining operations. Predicted concentrations in Swan Lake from the airborne pathway are 0.361 mg/L for the original MSI project versus 0.368 for the proposed ESMM project (Table 4.4-2). Both predicted concentrations result in the same level of risk when expressed to one significant figure, which is an ESQ of 0.4. Results are similar for other airborne related chemicals, while risks are lower for the proposed ESMM project for risks to Swan Lake from chemicals derived principally from the tailings basin. For example, predicted concentrations of magnesium in Swan Lake are 5.14 mg/L for the original MSI project and 0.822 for the proposed ESMM project (Table 4.4.-2). Accordingly, the ESQ for magnesium is reduced from 7.9 to 1.3 when using the lowest available TRV. While ecological risks from magnesium are considered highly uncertain due to naturally elevated concentrations in the area, when considered within strict application of the BLM interpretive criteria the risk level is reduced from moderate to borderline low.

4.4.2.3 Uncertainties in Predicted Risk

Uncertainty is an inherent aspect of any risk assessment. Uncertainty derives from the limits of scientific knowledge, the necessity of some finite level of site-specific inquiry, natural variability in the amount of exposure that different organisms may receive, and different sensitivity to toxic effects that exist between different ecological species and even between individuals within a single species. However, risk assessments can inform an understanding of the risk by minimizing uncertainty where possible and clarifying the nature of remaining uncertainty. Moreover, the application of a structured and consistent methodology for assessing risk can ensure that current scientific knowledge is applied in accordance with generally accepted best practices, that the level of effort is appropriate to the complexity of a decision, and that the understanding of risk is consistent across multiple projects. In accordance with generally accepted risk assessment practice (e.g. EPA, 2005; Ohio EPA, 2003), this section of the risk assessment further informs the understanding of risk by identifying areas of uncertainty and describing the potential influence of the uncertainty on the quantitative risk estimates presented.

As previously discussed and shown in Table 4.4-1, many chemicals identified in the air emission inventory could not be assessed numerically because the data necessary for modeling distributions in the environment or assessing toxicity are not available. Many of these chemicals are considered to have little or no toxicity to aquatic life. Also, some chemicals are identified by different forms (e.g. iron oxide versus iron compounds), and are therefore addressed by one of the forms. Chemicals identified by footnotes 9 and 10 in Table 4.4-1 were not assessed by Barr (2010a; 2010b); however, review by MPCA indicated that toxicity factors were available to support assessment. Elemental mercury in sediment, total PAH in soil, and fluorides and sodium compounds in water are chemicals identified by footnotes 9 and 10 in Table 4.4-1 that are most likely to cause significant levels of risk if further assessed using current toxicology data. As such a review by MNDNR was undertaken of likely predicted concentrations and comparison to TRVs that showed further analysis would not identify significant ecological risks.

In addition to its direct toxic effects, hydrogen fluoride was considered through MPCA review in terms of aquatic acidification potential. Changes in the process emissions for the proposed ESMM project are projected to increase emissions of hydrogen fluoride by 9495 percent (Bar, 2011, Table 4-1). Hydrogen fluoride is less dense than air, and therefore, if released as gas would not be expected to deposit locally at a high rate. It can however form acid mist in humid air. While known as a strong acid when used in concentrated form for certain industrial applications, hydrogen fluoride has a unique property of behaving as a weak acid in dilute concentrations. Accordingly, dilute concentrations of hydrogen fluoride in surface water would not be expected to have a large influence on pH levels of surface water.

For the chemicals that were assessed quantitatively by Barr, several factors influence the degree to which results may be conservatively low or high.

- **Modeled concentrations.** The predicted concentrations in the environment are based on conservative assumptions that would tend to moderately over-predict concentrations. Also, the predicted concentrations apply at the end of 20 years of mining, according to the original MSI project assessment, not the 15 year duration of the proposed ESMM project. Infrequent, short-term conditions that can result in higher emissions for some sources like upset events affecting emission control equipment and shutdown/startup events are not considered, but are likely minor in terms of additional releases. There is considerable uncertainty regarding the modeling of chemical transport from the tailings impoundment through groundwater as applied specifically to Swan Lake water quality (see Section 4.4.1.3 and Chapter 4.1).

- **Incrementally increased concentrations.** Predicted concentrations in the environment provide the incremental increased concentration associated with mining emissions. To assess total toxicity, existing background concentrations should be added to these increased levels as was done in select cases of special concern described above.

- **Bioavailability in soil and sediment.** As is standard, this screening level assessment does not consider the extent to which chemicals are sufficiently bound onto or within particles in soil and sediment such that they do not contribute to toxicity. Accordingly, results predicted by this risk assessment may be biased moderately high (i.e. real risk is lower than predicted).

- **Bioavailability in water.** The predicted concentrations in water are presented as dissolved rather than total basis. Chemicals in dissolved water are generally more bioavailable than chemicals on suspended solids that are included in total measurements. Since many TRVs are designed for comparison to total concentrations, results by this risk assessment may be biased slightly low.

- **Bioaccumulation.** Bioaccumulation is only considered in the development of TRVs for a few metals, as previously discussed in Section 4.4.2. Where it was included, elevated risks to organisms higher in the food chain are not identified. This suggests low overall concern; however, there are many chemical specific factors involved in this assessment and it is unknown if further assessment would result in identifying additional risks. Specific chemicals emitted by the proposed ESMM project and having the potential to bioaccumulate but not having criteria that consider bioaccumulation exposure pathways are chromium, copper, dioxin, mercury, PCBs, and thallium. Predators identified as threatened species may be particularly susceptible to exposure via this pathway.

- **Impacts to plants.** Fourteen species of rare plants are known to occur in the area. TRVs specific to plants used in this assessment are limited to a short list of metals. Recognizing the large area of wetlands in the study area, few if any TRVs in sediment, soil or water specifically consider wetland vegetation in their formulation. Also, none of the TRVs applied in this assessment are specific to wild rice; however, wild rice is addressed in Chapter 4.1. No risks to plants were identified where applicable TRVs were available. Moreover, concentrations for metals reduce rapidly with distance from the mine permit boundary. This suggests there is low overall concern for toxicity to plants, particularly on a broader geographical and ecosystem impact basis.

4.4.3 Summary

Predicted concentrations of chemicals in soil, surface water, and sediment that are equal to or less than the TRVs are expected to exhibit little to no ecological risk. When the predicted concentration exceeds the TRV, the ESQ would be greater than 1, indicating a potential for adverse toxicological impacts (i.e. risk).

Quantitative estimates of risk must be understood and interpreted based on the quality of the information used to derive the TRV, the kinds of toxic effects associated with the TRV, and other qualitative considerations that define the overall level of uncertainty associated with the assessment. All risk assessment involves some level of uncertainty.

Accordingly, this assessment (inclusive of Appendices C and D) has presented a range of TRVs that can be applied to assess risk, explain the underlying basis for the TRVs, and identify other variables that affect levels of uncertainty in the risk assessments. These details are provided to inform decision-making, particularly for chemicals where a modest level of risk is implicated and multiple variables contribute to uncertainty.

Ecological risk associated with increased concentrations of chemicals in surface soils is predicted to be low. While the predicted increase in iron concentrations in soil exceeds the TRV for iron in soil, suggesting a moderate level of risk, several lines of evidence suggest that risks are lower than that indicated by quantitative assessment alone: the TRV is based on limited toxicological data, the TRV is based only on impacts to soil microbes, predicted concentrations are within the range of existing background concentrations, and any impacts would be restricted to a limited area immediately adjacent to the mine site.

Ecological risk to surface water, specifically Snowball Lake and other lakes located along the south boundary of the mine site, is considered moderate when applying all of the default assumptions of the screening level risk assessment process. Iron is the chemical of principal concern in surface water. However, the interpretation of risks to surface water is highly uncertain due to the wide range of potentially applicable TRVs and the complex geochemistry of iron. Different species have wide ranging variability in their sensitivity to iron, and the toxicity of iron in natural water systems varies substantially depending upon a wide range of water quality characteristics. Given the health protective conservatism inherent in a screening level risk assessment, actual risks may be significantly lower.

Risks from exposure to chemicals in sediments are predicted to be low. All ESQs are less than 1.0. However, this assessment does not assess mercury compounds in sediment. Moreover, the potential for mercury in sediments to bioaccumulate in the food chain is not assessed.

Ecological risks in Swan Lake due to projected emissions from the proposed ESMM project are predicted to be low. Swan Lake is potentially impacted by both atmospheric emissions from mining areas and deep seepage releases to groundwater from the tailings impoundment. An ESQ of 1.3 for magnesium is derived using the lowest available TRV. However, the basis of the TRV is not clear from a review of the available literature, and the TRV is well below naturally occurring background concentrations in Swan Lake. Mining related increases in magnesium concentrations to Swan Lake are minor when compared to existing background concentrations. ESQs for all other chemicals are below 1.0.

An assessment was completed of the cumulative risk to Swan Lake from emissions for the Keetac and original MSI project. The total ESQ for all chemicals from both facilities ranges from 24.2 when using the lowest TRVs to 4.4 when using alternative TRVs. These totals suggest an overall moderate to high level of risk when applying the BLM interpretative criteria. However, risks from exposure to multiple chemicals are not likely to be cumulative, particularly where risk to different species or different kinds of toxic effects are represented by the chemical-specific TRVs. More detailed assessment for chemicals with ESQs greater than 1.0 was provided to improve the understanding of cumulative risk. For the chemicals identified in the following bullets, the Keetac facility is predicted to contribute higher concentrations of chemicals to Swan Lake.

- Cumulative ESQs for boron range from 5.5 to 0.29, depending on the choice of TRV. Available data suggests that some species may be adversely affected at the concentrations predicted. On-site monitoring of biota would be necessary to reduce uncertainty.
- Cumulative ESQs for copper range from 1.5 to 0.17, depending on the choice of TRV. The toxicity of copper to aquatic organisms decreases as water hardness increases. This screening level assessment did not advance to the level of calculating a site-specific, hardness-based TRV.
- Cumulative ESQs for magnesium range from 13.2 to 0.1, depending on the choice of TRV. Ecological risk for magnesium exposure is likely to be in the lower portion of this range because the incremental increase in magnesium concentration in Swan Lake from the cumulative emissions from Keetac and ESMM are predicted to be about 20% of existing background concentrations.

Overall, levels of ecological risk for the proposed ESMM project are similar to the risks for the original MSI project. The predicted concentrations of chemicals in soil, surface water, sediment, and Swan Lake are sufficiently similar such that the ESQs for specific chemicals are generally within the same order of magnitude used by BLM to interpret risk levels. With minor exception in boarderline cases, as shown in Table 4.4-2, chemicals under both the proposed ESMM project and the original MSI project lead to estimates of risk that are low for most chemicals and in the moderate range for a few chemicals.

4.4.4 Mitigation

Applying BLM interpretive criteria, whereby an ESQ in the range of 1-10 is interpreted as a moderate level of risk, the principal sources of risk identified in this SLERA are as follows:

- Moderate risk for iron in soil. Risk is reduced to low when considering the basis for the TRV, background concentrations, and the likely geographic extent of any impacts.
- Overall moderate risk in surface water along the south boundary of the mine site due to iron and manganese in surface water. Risk for iron is barely in the low range for the lowest TRV and more confidently considered low when applying the alternative TRV; however, there is limited toxicological and regulatory support for the alternative TRV.
- Moderate risk in Swan Lake based on limited toxicological information for magnesium. Risk is low when compared to existing background concentrations.
- Moderate risk for boron and copper and high risk for magnesium in Swan Lake when considering cumulative effects involving the Keetac facility. Risk for copper may be reduced when evaluated based on site-specific hardness. Risk for magnesium is reduced to low when background concentrations are considered.

Uncertainty in this risk assessment can be generally understood to derive from the lack of complete toxicological information for all chemicals and the inability of current screening level risk assessment to assess all pathways of chemical migration and potential exposure.

The screening level methodology seeks to overcome these limitations by employing conservative assumptions where uncertainty exists in quantifying exposure and toxicity.

Two categories of mitigation options exist: 1) additional site-specific assessments can be performed to reduce uncertainty in risk estimates and ensure that actual exposure is at or below levels predicted, and 2) actions can be taken to reduce emissions from current predicted amounts.

4.4.4.1 Additional Site-Specific Assessment Options

Considerable uncertainty surrounds the quantitative risk estimates for chemicals that emerge as potential concerns from this screening level risk assessment. Several actions may be taken to reduce uncertainty if deemed warranted in future permitting. As is planned, during mine operations, monitoring of air and water related emissions can be used to determine consistency with the assumptions of this risk assessment. Monitoring of background concentrations of select chemicals in surface soil, surface water and sediment can be used to ensure concentrations do not increase significantly over time. More detailed risk assessment evaluations in the following areas could be conducted to reduce uncertainty:

- Evaluate risk via food web pathways for PBT chemicals in a more detailed risk assessment.
- Conduct site-specific studies to assess any iron (and possibly boron) related impacts to surface water or sediment.
- Establish a hardness dependent criterion for copper.

However, more detailed risk assessment is not likely to reduce uncertainty in other areas of this risk assessment. The assessment is constrained by the availability of appropriate toxicological data. Additional reduction in uncertainty might be derived from site-specific studies of the physical, chemical and biological character of the area. Any such monitoring could be limited to soils and water bodies along the south side of the mine permit boundary that are identified in this assessment to involve higher risks. However, the moderate levels of risks identified by this assessment can be difficult to discern in field studies at high levels of confidence.

4.4.4.2 Emission Reduction Measures

Mitigation measures to reduce air emissions are addressed in Section 4.2.3. Actions for mitigating air emissions that are already part of the proposed ESMM project and that are applicable to the chemicals potentially posing moderate levels of risk are:

- Best Available Control Technology (BACT) for stack emissions
- Indurating furnace air emission control technologies:
    - Clean fuels (natural gas) for SO_2, NOx, particulate and HAPs
    - Good combustion practices for CO, VOC, particulate and HAPs
    - Enclosures with fabric filters or wet scrubbers for particulate and HAPs
    - Low NOx, ultra low NOx, and oxy fuel burners for NOx
    - Absorber / wet scrubber for SO_2, fluorides, and sulfuric acid mist
    - Lead, fluoride and sulfuric acid mist control performance monitored via SO_2 and PM emissions limits
    - Best practices for fugitive dust control via a fugitive dust control plan
- Using larger trucks to reduce miles driven, dust levels, and vehicle emissions
- Dust control plan to reduce fugitive dust emissions

- Plant emissions air monitoring would be conducted as required in its air quality permit
- Energy efficiency (Appendix B)

Mitigation measures to reduce water emissions are addressed in Section 4.1.3. Actions for mitigating water emission that are already part of the proposed ESMM project are:

- NPDES/SDS permit limits that establish numeric water quality requirements for any discharges, ambient water quality monitoring requirements, and an adaptive management system for ensuring that desired outcomes are achieved.

4.5 Socioeconomics

Chapter Summary

This chapter addresses how the proposed production increase and shortened initial mine plan time period would modify the workforce needs and the potential effects on economic and public services in Itasca and St. Louis Counties as compared to the original MSI project. Socioeconomic analysis for the original and proposed projects relies on economic forecast modeling (IMPLAN) used by the University of Minnesota Duluth (UMD) Labovitz School of Business and Economics. Updates to the model run in 2006 were made in order to report employment and tax demands for the proposed ESMM project.

Value added totals for all direct, indirect, and induced dollars generated for the original MSI project estimated $83 million to $456 million per year from years 2-5, whereas the proposed ESMM project would be between $107 million and $215 million per year over the first five years. During construction, a range of $162 million to $325 million per year is estimated for the first five years for the original MSI project, in contrast to a range of $197 million to $263 million per year for the first five years in the proposed ESMM project.

Output effects for all direct, indirect, and induced dollars generated are construction related ($2.63 billion over the first five years of the original MSI and $2.7 billion over five years in the proposed ESMM project); and operations related (the original MSI project generating an estimated $246 million to $1.3 billion per year over the first four years versus $431 million to $863 billion per year in the first four years of the proposed ESMM project).

For all direct, indirect, and induced employment in Itasca and St. Louis Counties combined, the original MSI project estimated just over 3,600 jobs during the first two years of construction, whereas the proposed ESMM project is reduced to just over 3,200 jobs. During operations, by the fifth year the original MSI project estimated just over 2,200 jobs (Itasca and St. Louis), whereas the proposed ESMM project downgrades this to just over 1,900 jobs (Itasca and St. Louis). Actual direct operational jobs change from 420 – 700 jobs for the original MSI project, depending on year of operation, to 250 – 500 jobs for the proposed ESMM project. During the construction phase, the original and proposed direct jobs stay the same. The lower employment numbers display an influence of factors including updated data input for the IMPLAN 3.0 model that reflects actual operating requirements based on more detailed design, increased worker productivity, and the shortened initial mine plan time period (from 20 to 15 years).

Housing effects were reported in the MSI FEIS and mitigation was prescribed. No changes between the original MSI project and the proposed ESMM project are anticipated.

Demand for public services is projected based upon proposed employment figures. Based upon the reduced employment figures it is anticipated that the demand for public services as a result of the proposed ESMM project would be less than the original MSI project.

Property acquisition would be undertaken for mitigation purposes. In accordance with the MSI FEIS, Essar is following through with acquisition of six properties within the Permit to Mine and Air Permit ambient air quality boundary.

Cumulative impacts would not be expected to change in the SEIS and were not identified in the Preparation Notice for this SEIS.

Background information on Socioeconomics issues not identified as being affected by the modifications, is reported in the MSI FEIS, Section 6.14, starting on page 6-53.

Project Alternatives Relevant to this Issue:

The No Action and Proposed Project Alternatives are relevant for evaluation of potential effects on socioeconomic issues.

Documentation to Prepare Chapter 4.5

Labovitz School of Business and Economics, 2010. UPDATE: Essar Steel Minnesota LLC Economic Impact 2010, June 2010.University of Minnesota Duluth.

Labovitz School of Economics and Business, 2006. The Economic Impact of Constructing and Operating Minnesota Steel Industries LLC in Itasca County, Minnesota.

Minnesota Department of Administration, 2010. Annual Estimates of City and Township Population, Households, and Persons per Household, 2000 to 2009. August 2, 2010.

Minnesota Department of Natural Resources, 2010. Essar Steel SEIS Preparation Notice and Scoping Response to Public Comments.

Minnesota Department of Natural Resources and U.S. Army Corp of Engineers. 2007. Minnesota Steel Project Final EIS, June 2007.

4.5.1 AFFECTED ENVIRONMENT

4.5.1.1 Population Trends

Populations and trends were reported in the MSI FEIS using the 2000 census broken out according to counties and cities on the Iron Range. The 2000 census data (reported in the MSI FEIS) compared to the most recent available population data show both increases and decreases depending on Iron Range location. The 2010 census data were not available for the SEIS. Over the period shown, there is no overall trend increase or decrease when evaluating Iron Range cities shown below.

Table 4.5-1. Regional Population Differences from 2000 to 2009

Northeast MN and Iron Range Locations	2000 Population	2009 Population	Change in Population: 2000-2009
Grand Rapids	7,764	10,576	+2812
Hibbing	17,071	16,106	-965
Keewatin	1,164	1,156	-8
Nashwauk	935	1,684	+749
Itasca County	43,992	44,663	+671
St. Louis County	200,528	196,036	-4492

4.5.1.2 Employment Trends

Any measurable trends in employment which occurred in the region since the MSI FEIS were taken into account in the updated economic analysis model. The trends reflect changing economic conditions but also software updated in the economic forecast IMPLAN model. Since then, the IMPLAN software utilized by UMD has been updated from version 2.1 to version 3.0. Additionally, assumptions for the updated model were based on revised output and employment direct inputs, project timing and years, and deflators. All of these variables were different than in the 2006 MSI study and reflect current employment trends. One variable highlighted is the increase in labor productivity that has occurred in the marketplace and is reflected in the updated model. More productive workers decreased the number of estimated jobs that would be created by the proposed ESMM project. However, many of the remaining jobs would have increased salary levels.

4.5.2 ENVIRONMENTAL CONSEQUENCES

Potential effects of the proposed ESMM project are presented in this section. A detailed breakout is provided separately for the construction and operations stages of the proposed ESMM project. These two stages were then combined and used to evaluate in comparison to the No Action Alternative (original MSI project). The two technology alternatives for air emissions would not be expected to change the number of employees or demand for services compared to the proposed ESMM project.

4.5.2.1 Potential Effects on Housing

Housing effects were reported in the MSI FEIS and mitigation was prescribed. It was determined that six properties would be acquired for the project, and that this would not represent a significant loss in regional housing stock. The status of property acquisition is provided in Section 4.5.3. With lower employment figures (see Section 4.5.2.2), housing stock pressure for the proposed ESMM project would be expected to be less than in the original MSI project. No changes between the original and proposed projects are anticipated.

4.5.2.2 Potential Effects on Local Economy and Jobs

The updated 2010 IMPLAN model predicts potential economic effects for Itasca and St. Louis counties. The base year for analysis uses 2010 values, and future effects are modeled for five years after that, regardless of construction or operation. Subsequent effects would need to be based upon new base year values after year five.

Three types of effects, value added, output, and employment, were described in both the 2006 and the 2010 IMPLAN studies as follows (Labovitz School of Economics and Business 2006):

- **value added effects** are *a measure of the effecting industry's contribution to the local community; it includes wages, rents, interest, and profits*,
- **output effects** include *the value of local production required to sustain activities*, and
- **employment effects** are *estimates in terms of jobs, not in terms of full-time equivalent employees. Jobs may be temporary, part time, or short term jobs*.

Each can be broken out in terms of direct, indirect, and induced effects. Direct effects reflect direct Essar jobs. Indirect effects address the *changes in spending, income, or levels of employment by businesses that supply goods and services to the mining sector* (Labovitz School of Economics and Business 2006). Induced effects *reflect the spending of income earned by employees who work for local businesses that directly or indirectly serve the mining sector* (Labovitz School of Economics and Business 2006).

In evaluating all forms of employment (direct, indirect, induced) that could potentially be generated, construction is expected to generate a similar number of jobs as full operations employment, when considering Itasca County alone (Tables 4.5-2 and 4.5-3). St. Louis County is predicted to benefit less overall compared to Itasca County.

Table 4.5-2. Proposed Essar Project Construction Effects on Employment for Itasca, and Itasca and St. Louis Counties, MN, 2011-2015

Years	*Value Added Totals*	*Output Totals*	*Employment Totals*
Itasca County:			
2011	$216,523,392	$529,350,784	2,896
2012	$216,523,392	$529,350,784	2,896
2013	$216,523,392	$529,350,784	1,448
2014	$162,392,512	$397,012,352	1,738
2015	$162,392,512	$397,012,352	1,738
Total	$974,355,200	$2,382,077,056	*
Itasca and St. Louis Counties:			
2011	$263,418,752	$606,328,832	3,286
2012	$263,418,752	$606,328,832	3,286
2013	$263,418,752	$606,328,832	1,643
2014	$197,564,160	$454,745,856	1,972
2015	$197,564,160	$454,745,856	1,972
Total	$1,185,384,576	$2,728,478,208	*

Source: IMPLAN

*Note, employment should not be summed. Although the construction investment adds up over time, employment does not; consider, for instance, that a construction project truck driver employed during 2011 may be continuing in the same job in 2012.

Table 4.5-3. Proposed Essar Project Operations Effects on Employment in Itasca, and Itasca and St. Louis Counties, MN, 2012 (start-up) and 2015 (full)

Years	*Value Added Totals*	*Output Totals*	*Employment Totals*
Itasca County:			
2012	$94,246,144	$393,950,592	844
2015	$188,492,288	$787,901,184	1,688
Itasca and St. Louis Counties:			
2012	$107,668,064	$431,963,008	967
2015	$215,336,128	$863,926,016	1,935

Source: IMPLAN

A further breakdown of construction employment predictions shows direct jobs to dominate over indirect and induced jobs provided by professional technical and food services (Tables 4.5-4 and 4.5-5).

Further analysis of operations employment shows a considerably smaller number of direct jobs and relatively higher direct and induced jobs provided by a broader sector of industries (Tables 4.5-6 and 4.5-7). Lower operations employment is expected to be a function of several factors including updated data input for the IMPLAN 3.0 model that reflects actual operating requirements based on more detailed design, increased worker productivity, and the shortened initial mine plan time period (from 20 to 15 years).

Table 4.5-4. Proposed Essar Project Construction Effects on Employment in Itasca, and Itasca and St. Louis Counties, MN, 2011-2015

Years	*Direct*	*Indirect*	*Induced*	*Total*
Itasca County:				
2011	2,000	370	526	2,896
2012	2,000	370	526	2,896
2013	1,000	185	263	1,448
2014	1,200	222	316	1,738
2015	1,200	222	316	1,738
				*
Itasca and St. Louis Counties:				
2011	2,000	586	700	3,286
2012	2,000	586	700	3,286
2013	1,000	293	350	1,643
2014	1,200	352	420	1,972
2015	1,200	352	420	1,972
				*

Source: IMPLAN
*Note, employment should not be summed. Although the construction investment adds up over time, employment does not; consider, for instance that a construction project truck driver employed during 2011 may be continuing in the same job in 2012.

Table 4.5-5. Proposed Essar Project Construction Effects on Employment in Itasca and St. Louis Counties, MN, Peak Year 2012, Top 25 Indirect Jobs by Industry Sector

Source: IMPLAN	Projected Employment Impacts			
IMPLAN Sector	*Direct*	*Indirect*	*Induced*	*Total*
Itasca and St. Louis Counties:				
Construction of other new nonresidential structures	2,000	0	0	2,000
Architectural, engineering, and related services	0	176	2	178
Food services and drinking places	0	24	91	115
Private hospitals	0	0	48	48
Wholesale trade businesses	0	27	15	42
Retail Stores - General merchandise	0	13	28	41
Retail Nonstores - Direct and electronic sales	0	17	23	39
Retail Stores - Food and beverage	0	12	27	39
Offices of physicians, dentists, and other health practitioners	0	0	38	38
Retail Stores - Motor vehicle and parts	0	15	20	34
Nursing and residential care facilities	0	0	34	34
Monetary authorities and depository credit intermediation activities	0	16	14	30
Civic, social, professional, and similar organizations	0	13	14	27
Employment services	0	20	6	26
Automotive repair and maintenance, except car washes	0	15	10	26
Retail Stores - Miscellaneous	0	8	16	24
Real estate establishments	0	6	13	20
Retail Stores - Building material and garden supply	0	6	13	19
Services to buildings and dwellings	0	13	6	19
Retail Stores - Clothing and clothing accessories	0	5	13	18
Insurance carriers	0	3	15	18
Legal services	0	12	5	17
Commercial and industrial machinery equipment repair maintenance	0	17	1	17
Individual and family services	0	0	17	17
Retail Stores - Gasoline stations	0	5	11	16
				2,903
As well as additional full and part-time jobs in another 125 various sectors of the economy . . .				383
Total	2,000	586	700	3,286

Table 4.5-6. Proposed Essar Project Operations Effects on Employment in Itasca, and Itasca and St. Louis Counties, MN, 2012 and 2015

Years	*Direct*	*Indirect*	*Induced*	*Total*
Itasca County:				
2012	250	374	220	844
2015	500	747	440	1,687
Itasca and St. Louis Counties:				
2012	250	458	259	967
2015	500	916	518	1,934

Source: IMPLAN

Table 4.5-7. Proposed Essar Project Operations Effects on Employment in Itasca and St. Louis Counties, MN, Peak Year 2015, Top 25 Indirect Jobs by Industry Sector

Source: IMPLAN	Projected Employment Impacts			
IMPLAN Sector	*Direct*	*Indirect*	*Induced*	*Total*
Itasca and St. Louis Counties:				
Iron and steel mills and ferroalloy manufacturing	500	6	0	506
Wholesale trade businesses	0	172	11	183
Food services and drinking places	0	34	68	102
Services to buildings and dwellings	0	58	4	62
Electric power generation, transmission, and distribution	0	54	3	57
Maintenance and repair construction of nonresidential structures	0	47	2	49
Business support services	0	45	3	48
Transport by rail	0	46	0	46
Employment services	0	35	4	39
Transport by truck	0	38	1	39
Private hospitals	0	0	36	36
Architectural, engineering, and related services	0	32	1	33
Management of companies and enterprises	0	29	1	30
Automotive repair and maintenance, except car washes	0	21	8	29
Offices of physicians, dentists, and other health practitioners	0	0	28	28
Monetary authorities and depository credit intermediation activities	0	16	10	26
Nursing and residential care facilities	0	0	25	25
Mining iron ore	0	24	0	24
Commercial and industrial machinery equipment repair maintenance	0	22	1	23
Retail Stores - General merchandise	0	1	21	22
Retail Stores - Food and beverage	0	1	20	21
Investigation and security services	0	17	2	19
Civic, social, professional, and similar organizations	0	8	10	18
Retail Nonstores - Direct and electronic sales	0	1	17	18
Other state and local government enterprises	0	14	3	17
				1,500
As well as additional full and part-time jobs in another 130 various sectors of the economy . . .				435
Total	500	916	518	1,935

Value added dollars are predicted to be higher for the early construction years, principally through direct jobs, and greater overall compared to full operations. As with employment figures, Itasca County is a much higher beneficiary compared to St. Louis (Tables 4.5-8 and 4.5-9).

Table 4.5-8. Proposed Essar Project Construction Effects on Value Added Dollars for Itasca, and Itasca and St. Louis Counties, MN, 2011-2015

Years	*Direct*	*Indirect*	*Induced*	*Total*
Itasca County:				
2011	$141,087,232	$32,260,864	$43,175,296	$216,523,392
2012	$141,087,232	$32,260,864	$43,175,296	$216,523,392
2013	$141,087,232	$32,260,864	$43,175,296	$216,523,392
2014	$105,815,296	$24,195,648	$32,381,568	$162,392,512
2015	$105,815,296	$24,195,648	$32,381,568	$162,392,512
Total	$634,892,288	$145,173,888	$194,289,024	$974,355,200
Itasca and St. Louis Counties:				
2011	$149,302,784	$54,443,392	$59,672,576	$263,418,752
2012	$149,302,784	$54,443,392	$59,672,576	$263,418,752
2013	$149,302,784	$54,443,392	$59,672,576	$263,418,752
2014	$111,977,216	$40,832,512	$44,754,432	$197,564,160
2015	$111,977,216	$40,832,512	$44,754,432	$197,564,160
Total	$671,862,784	$244,995,200	$268,526,592	$1,185,384,576

Source: IMPLAN

Table 4.5-9. Proposed Essar Project Operations Effects on Value Added Dollars in Itasca, and Itasca and St. Louis Counties, MN, 2012 (start-up) and 2015 (full)

Years	*Direct*	*Indirect*	*Induced*	*Total*
Itasca County:				
2012	$45,753,984	$35,934,336	$12,557,824	$94,246,144
2015	$91,507,968	$71,868,672	$25,115,648	$188,492,288
Itasca and St. Louis Counties:				
2012	$42,353,408	$49,268,608	$16,046,048	$107,668,064
2015	$84,706,816	$98,537,216	$32,092,096	$215,336,128

Source: IMPLAN

As expected, an evaluation of output dollars (Tables 4.5-10 and 4.5-11) mirrors the trends observed in the above data.

Table 4.5-10. Proposed Essar Project Construction Effects on Output Dollars for Itasca, and Itasca and St. Louis Counties, MN, 2011-2015

Years	*Direct*	*Indirect*	*Induced*	*Total*
Itasca County:				
2011	$400,000,000	$56,890,240	$72,460,544	$529,350,784
2012	$400,000,000	$56,890,240	$72,460,544	$529,350,784
2013	$400,000,000	$56,890,240	$72,460,544	$529,350,784
2014	$299,999,232	$42,667,648	$54,345,472	$397,012,352
2015	$299,999,232	$42,667,648	$54,345,472	$397,012,352
Total	$1,799,998,464	$256,006,016	$326,072,576	$2,382,077,056
Itasca and St. Louis Counties:				
2011	$400,000,000	$103,627,776	$102,701,056	$606,328,832
2012	$400,000,000	$103,627,776	$102,701,056	$606,328,832
2013	$400,000,000	$103,627,776	$102,701,056	$606,328,832
2014	$299,999,232	$77,720,832	$77,025,792	$454,745,856
2015	$299,999,232	$77,720,832	$77,025,792	$454,745,856
Total	$1,799,998,464	$466,324,992	$462,154,752	$2,728,478,208

Source: IMPLAN

Table 4.5-11. Proposed Essar Project Operations Effects on Output Dollars in Itasca, and Itasca and St. Louis Counties, MN, 2012 and 2015

Years	*Direct*	*Indirect*	*Induced*	*Total*
Itasca County:				
2012	$313,091,072	$59,773,184	$21,086,336	$393,950,592
2015	$626,182,144	$119,546,368	$42,172,672	$787,901,184
Itasca and St. Louis Counties:				
2012	$313,138,176	$91,209,472	$27,615,360	$431,963,008
2015	$626,276,352	$182,418,944	$55,230,720	$863,926,016

Source: IMPLAN

Potential tax effects were also evaluated in the updated 2010 model. The results predict that Itasca County would be by far the largest beneficiary of tax receipts compared to St. Louis County. Construction activities and full (peak year) operations would have similar effects.

Table 4.5-12. Proposed Essar Project Construction Effects on Taxes in Itasca, and Itasca and St. Louis Counties, MN, 2011-2015

	Source: IMPLAN	*Employee Compensation*	*Proprietor Income*	*Indirect Business Taxes*	*Households*	*Corporations*
CONSTRUCTION						
Itasca:						
2011	Federal Government Non-Defense	$11,839,030	$2,736,889	$844,942	$5,314,461	$969,726
	State/Local Non-Education	$400,216	$0	$5,939,364	$3,042,698	$657,933
Peak year 2012	Federal Government Non-Defense	$11,839,030	$2,736,889	$844,942	$5,314,461	$969,726
	State/Local Non-Education	$400,216	$0	$5,939,364	$3,042,698	$657,933
2013	Federal Government Non-Defense	$5,919,517	$1,368,445	$422,471	$2,657,231	$484,863
	State/Local Non-Education	$200,108	$0	$2,969,682	$1,521,349	$328,966
2014	Federal Government Non-Defense	$7,103,420	$1,642,134	$506,965	$3,188,677	$581,836
	State/Local Non-Education	$240,130	$0	$3,563,619	$1,825,618	$394,760
2015	Federal Government Non-Defense	$7,103,420	$1,642,134	$506,965	$3,188,677	$581,836
	State/Local Non-Education	$240,130	$0	$3,563,619	$1,825,618	$394,760
	Federal Sub-Total	$43,804,417	$10,126,491	$3,126,285	$19,663,507	$3,587,987
	State/Local Sub-Total	$1,480,800	$0	$21,975,648	$11,257,981	$2,434,352
	Grand Total	$45,285,217	$10,126,491	$25,101,933	$30,921,488	$6,022,339
Itasca and St. Louis:						
2011	Federal Government Non-Defense	$15,458,790	$2,366,265	$1,224,786	$6,694,416	$1,283,117
	State/Local Non-Education	$449,653	$0	$7,429,419	$3,721,916	$870,560
Peak year 2012	Federal Government Non-Defense	$15,458,790	$2,366,265	$1,224,786	$6,694,416	$1,283,117
	State/Local Non-Education	$449,653	$0	$7,429,419	$3,721,916	$870,560
2013	Federal Government Non-Defense	$7,729,393	$1,183,133	$612,393	$3,347,208	$641,559
	State/Local Non-Education	$224,826	$0	$3,714,709	$1,860,958	$435,280
2014	Federal Government Non-Defense	$9,275,271	$1,419,759	$734,872	$4,016,649	$769,870
	State/Local Non-Education	$269,792	$0	$4,457,651	$2,233,149	$522,336
2015	Federal Government Non-Defense	$9,275,271	$1,419,759	$734,872	$4,016,649	$769,870
	State/Local Non-Education	$269,792	$0	$4,457,651	$2,233,149	$522,336
	Federal Sub-Total	$57,197,515	$8,755,181	$4,531,709	$24,769,338	$4,747,533
	State/Local Sub-Total	$1,663,716	$0	$27,488,849	$13,771,088	$3,221,072
	Grand Total	$58,861,231	$8,755,181	$32,020,558	$38,540,426	$7,968,605

Table 4.5-13. Proposed Essar Project Operations Effects on Taxes in Itasca, and Itasca and St. Louis Counties, MN, 2012 and 2015

	Source: IMPLAN	*Employee Compensation*	*Proprietor Income*	*Indirect Business Taxes*	*Households*	*Corporations*
OPERATIONS						
Itasca:						
2012	Federal Gov. Non-Defense	$5,722,603	$635,386	$929,967	$2,229,401	$1,562,807
	State/Local Non-Education	$193,452	$0	$6,537,032	$1,276,403	$1,060,321
Peak year 2015	Federal Gov. Non-Defense	$11,445,210	$1,270,772	$1,859,934	$4,458,803	$3,125,613
	State/Local Non-Education	$386,903	$0	$13,074,060	$2,552,806	$2,120,643
	Federal Sub-Total	$17,167,813	$1,906,158	$2,789,901	$6,688,204	$4,688,420
	State/Local Sub-Total	$580,355	$0	$19,611,092	$3,829,209	$3,180,964
	Grand Total	$17,748,168	$1,906,158	$22,400,993	$10,517,413	$7,869,384
Itasca and St. Louis:						
2012	Federal Gov. Non-Defense	$6,632,411	$327,255	$1,247,360	$2,467,692	$1,855,151
	State/Local Non-Education	$192,918	$0	$7,566,350	$1,371,971	$1,258,669
Peak year 2015	Federal Gov. Non-Defense	$13,264,820	$654,509	$2,494,720	$4,935,385	$3,710,301
	State/Local Non-Education	$385,836	$0	$15,132,700	$2,743,941	$2,517,338
	Federal Sub-Total	$19,897,231	$981,764	$3,742,080	$7,403,077	$5,565,452
	State/Local Sub-Total	$578,754	$0	$22,699,050	$4,115,912	$3,776,007
	Grand Total	$20,475,985	$981,764	$26,441,130	$11,518,989	$9,341,459

4.5.2.2.1 Comparison of original MSI and proposed ESMM project effects on value added and output dollars and employment.

The 2010 model focused on Itasca and St. Louis counties for the proposed ESMM project modifications due to obvious proximity and the estimated range of impact of the proposed ESMM project. The 2006 study and IMPLAN model were part of larger and region-wide studies of proposed Iron Range projects completed by UMD. For comparing the original and proposed projects, the 2006 and 2010 IMPLAN model results were grouped into Construction and Operations. Tables 4.5-14, 4.5-15, and 4.5-16 show the results. UMD compared the data according to BBER Model runs. The 1st run 2006 represents the original MSI project, and the 2nd run 2010 represents the proposed ESMM project.

The most noticeable difference between the 2006 model completed for the original MSI project and the updated 2010 model created for the proposed ESMM project is the lower number of jobs expected in the proposed ESMM project. The lower employment numbers display an influence of factors including updated data input for the IMPLAN 3.0 model that reflects actual operating requirements based on more detailed design, increased worker productivity, and the shortened initial mine plan time period (from 20 to 15 years). Table 4.5-16 summarizes the differences between construction employment information of the two projects.

Value added totals for all direct, indirect, and induced dollars generated for the original MSI project estimated $83 million to $456 million per year from years 2-5, whereas the proposed ESMM project would be between $107 million and $215 million per year over the first five years. During construction, a range of $162 million to $325 million per year is estimated for the first five years for the original MSI project, in contrast to a range of $197 million to $263 million per year for the first five years in the proposed ESMM project (Table 4.5-14).

Output effects, as shown in Table 4.5-15, for all direct, indirect, and induced dollars generated include construction related - $2.63 billion over the first five years of the original MSI project and $2.7 billion over five years in the proposed ESMM project; and operations related - the original MSI project generating an estimated $246 million to $1.3 billion per year over the first four years versus $431 million to $863 billion per year in the first four years of the proposed ESMM project.

Table 4.5-14. Comparison of Original MSI and Proposed Essar Project Construction and Operations Effects on Value Added Dollars in Itasca, and Itasca and St. Louis Counties, MN

IMPLAN version 2.1; 3.0

CONSTRUCTION IMPACTS

				Value Added			
	BBER Model and Assumptions	*IMPLAN Dollar Year*	*Impact Year*	*Direct*	*Indirect*	*Induced*	*Total*
Itasca:	1st run 2006	2005	2007	$162,781,440	$43,590,729	$56,921,758	$263,293,927
		2005	2008	$162,781,440	$43,590,729	$56,921,758	$263,293,927
		2005	2009	$81,390,720	$21,795,365	$28,460,879	$131,646,964
		2005	2010	$122,086,080	$32,693,049	$42,691,320	$197,470,449
		2005	2011	$122,086,080	$32,693,049	$42,691,320	$197,470,449
	1st run totals			$651,125,760	$174,362,921	$227,687,035	$1,053,175,716
	2nd run 2010	2010	2011	$141,087,232	$32,260,864	$43,175,296	$216,523,392
		2010	2012	$141,087,232	$32,260,864	$43,175,296	$216,523,392
		2010	2013	$141,087,232	$32,260,864	$43,175,296	$216,523,392
		2010	2014	$105,815,296	$24,195,648	$32,381,568	$162,392,512
		2010	2015	$105,815,296	$24,195,648	$32,381,568	$162,392,512
	2nd run totals			$634,892,288	$145,173,888	$194,289,024	$974,355,200
Itasca and St. Louis:	1st run 2006	2005	2007	$173,625,328	$68,110,920	$84,078,640	$325,814,888
		2005	2008	$173,625,328	$68,110,920	$84,078,640	$325,814,888
		2005	2009	$86,812,664	$34,055,460	$42,039,320	$162,907,444
		2005	2010	$130,219,008	$51,083,192	$63,058,981	$244,361,181
		2005	2011	$130,219,008	$51,083,192	$63,058,981	$244,361,181
	1st run totals			$694,501,336	$272,443,684	$336,314,562	$1,303,259,582
	2nd run 2010	2010	2011	$149,302,784	$54,443,392	$59,672,576	$263,418,752
		2010	2012	$149,302,784	$54,443,392	$59,672,576	$263,418,752
		2010	2013	$149,302,784	$54,443,392	$59,672,576	$263,418,752
		2010	2014	$111,977,216	$40,832,512	$44,754,432	$197,564,160
		2010	2015	$111,977,216	$40,832,512	$44,754,432	$197,564,160
	2nd run totals			$671,862,784	$244,995,200	$268,526,592	$1,185,384,576
OPERATIONS IMPACTS							
Itasca:	1st run 2006	2005	2009	$34,276,080	$24,746,066	$12,731,898	$71,754,044
		2005	2010	$102,828,232	$74,238,199	$38,195,695	$215,262,126
		2005	2011	$123,921,208	$89,466,555	$46,030,710	$259,418,473
		2005	2012	$187,200,112	$135,151,589	$69,535,749	$391,887,450
	2nd run 2010	2010	2012	$45,753,984	$35,934,336	$12,557,824	$94,246,144
		2010	2015	$91,507,968	$71,868,672	$25,115,648	$188,492,288
Itasca and St. Louis:	1st run 2006	2005	2009	$34,275,852	$31,255,369	$18,098,164	$83,629,385
		2005	2010	$102,827,552	$93,766,108	$54,294,491	$250,888,151
		2005	2011	$123,920,392	$113,000,183	$65,431,823	$302,352,398
		2005	2012	$187,198,880	$170,702,391	$98,843,812	$456,745,083
	2nd run 2010	2010	2012	$42,353,408	$49,268,608	$16,046,048	$107,668,064
		2010	2015	$84,706,816	$98,537,216	$32,092,096	$215,336,128

Table 4.5-15. Comparison of Original MSI and Proposed Essar Project Construction and Operations Effects on Output Dollars in Itasca, and Itasca and St. Louis Counties, MN

IMPLAN version 2.1; 3.0

CONSTRUCTION IMPACTS

	BBER Model and Assumptions	IMPLAN Dollar Year	Impact Year	Output: Direct	Output: Indirect	Output: Induced	Output: Total
Itasca:	1st run 2006	2005	2007	$399,999,872	$76,208,570	$89,983,888	$566,192,330
		2005	2008	$399,999,872	$76,208,570	$89,983,888	$566,192,330
		2005	2009	$199,999,936	$38,104,285	$44,991,944	$283,096,165
		2005	2010	$299,999,904	$57,156,430	$67,487,917	$424,644,251
		2005	2011	$299,999,904	$57,156,430	$67,487,917	$424,644,251
	1st run totals			$1,599,999,488	$304,834,285	$359,935,554	$2,264,769,327
	2nd run 2010	2010	2011	$400,000,000	$56,890,240	$72,460,544	$529,350,784
		2010	2012	$400,000,000	$56,890,240	$72,460,544	$529,350,784
		2010	2013	$400,000,000	$56,890,240	$72,460,544	$529,350,784
		2010	2014	$299,999,232	$42,667,648	$54,345,472	$397,012,352
		2010	2015	$299,999,232	$42,667,648	$54,345,472	$397,012,352
	2nd run totals			$1,799,998,464	$256,006,016	$326,072,576	$2,382,077,056
Itasca and St. Louis:	1st run 2006	2005	2007	$399,999,872	$121,529,464	$136,825,688	$658,355,024
		2005	2008	$399,999,872	$121,529,464	$136,825,688	$658,355,024
		2005	2009	$199,999,936	$60,764,732	$68,412,844	$329,177,512
		2005	2010	$299,999,904	$91,147,099	$102,619,270	$493,766,273
		2005	2011	$299,999,904	$91,147,099	$102,619,270	$493,766,273
	1st run totals			$1,599,999,488	$486,117,858	$547,302,760	$2,633,420,106
	2nd run 2010	2010	2011	$400,000,000	$103,627,776	$102,701,056	$606,328,832
		2010	2012	$400,000,000	$103,627,776	$102,701,056	$606,328,832
		2010	2013	$400,000,000	$103,627,776	$102,701,056	$606,328,832
		2010	2014	$299,999,232	$77,720,832	$77,025,792	$454,745,856
		2010	2015	$299,999,232	$77,720,832	$77,025,792	$454,745,856
	2nd run totals			$1,799,998,464	$466,324,992	$462,154,752	$2,728,478,208
OPERATIONS IMPACTS							
Itasca:	1st run 2006	2005	2009	$162,500,064	$42,531,449	$20,128,029	$225,159,542
		2005	2010	$487,500,192	$127,594,347	$60,384,086	$675,478,625
		2005	2011	$587,500,224	$153,767,579	$72,770,567	$814,038,370
		2005	2012	$887,500,288	$232,287,126	$109,930,001	$1,229,717,415
	2nd run 2010	2010	2012	$313,091,072	$59,773,184	$21,086,336	$393,950,592
		2010	2015	$626,182,144	$119,546,368	$42,172,672	$787,901,184
Itasca and St. Louis:	1st run 2006	2005	2009	$162,500,064	$54,793,488	$29,452,218	$246,745,770
		2005	2010	$487,500,192	$164,380,463	$88,356,655	$740,237,310
		2005	2011	$587,500,224	$198,099,520	$106,481,099	$892,080,843
		2005	2012	$887,500,288	$299,256,692	$160,854,418	$1,347,611,398
	2nd run 2010	2010	2012	$313,138,176	$91,209,472	$27,615,360	$431,963,008
		2010	2015	$626,276,352	$182,418,944	$55,230,720	$863,926,016

Table 4.5-16. Comparison of Original MSI and Proposed Essar Project Construction and Operations Effects on Employment in Itasca, and Itasca and St. Louis Counties, MN

IMPLAN version 2.1; 3.0

	BBER Model and Assumptions	*IMPLAN Dollar Year*	*Impact Year*	Employment *Direct*	*Indirect*	*Induced*	*Total*
CONSTRUCTION IMPACTS							
Itasca:	1st run 2006	2005	2007	2,000	560	642	3,202
		2005	2008	2,000	560	642	3,202
		2005	2009	1,000	280	321	1,601
		2005	2010	1,200	336	385	1,921
		2005	2011	1,200	336	385	1,921
	1st run totals			-	-	-	
	2nd run 2010	2010	2011	2,000	370	526	2,896
		2010	2012	2,000	370	526	2,896
		2010	2013	1,000	185	263	1,448
		2010	2014	1,200	222	316	1,738
		2010	2015	1,200	222	316	1,738
	2nd run totals			-	-	-	
Itasca and St. Louis:	1st run 2006	2005	2007	2,000	726	937	3,663
		2005	2008	2,000	726	937	3,663
		2005	2009	1,000	363	464	1,827
		2005	2010	1,200	436	556	2,192
		2005	2011	1,200	436	556	2,192
	1st run totals			-	-	-	
	2nd run 2010	2010	2011	2,000	586	700	3,286
		2010	2012	2,000	586	700	3,286
		2010	2013	1,000	293	350	1,643
		2010	2014	1,200	352	420	1,972
		2010	2015	1,200	352	420	1,972
	2nd run totals			-	-	-	
OPERATIONS IMPACTS							
Itasca:	1st run 2006	2005	2009	420	454	332	1,206
		2005	2010	420	454	332	1,206
		2005	2011	420	454	332	1,206
		2005	2012	700	757	553	2,010
	2nd run 2010	2010	2012	250	374	220	844
		2010	2015	500	747	440	1,687
Itasca and St. Louis:	1st run 2006	2005	2009	420	495	435	1,350
		2005	2010	420	495	435	1,350
		2005	2011	420	495	435	1,350
		2005	2012	700	824	725	2,249
	2nd run 2010	2010	2012	250	458	259	967
		2010	2015	500	916	518	1,934

4.5.2.3 Potential Effects on Demand for Public Services

Demand for public services is projected based upon proposed employment figures. As shown in Table 4.5-16, for all direct, indirect, and induced employment in Itasca and St. Louis Counties combined, the original MSI project estimated just over 3,600 jobs during the first two years of construction, whereas the proposed ESMM project is reduced to just over 3,200 jobs. During operations, by the fifth year the original MSI project estimated just over 2,200 (Itasca and St. Louis, 1st run, impact year 2010), whereas the proposed ESMM project downgrades this to just over 1,900 jobs (Itasca and St. Louis, 2nd run, impact year 2015). Actual direct operational jobs change from 420 – 700 jobs for the original MSI project, depending on year of operation, to 250 – 500 jobs for the proposed ESMM project. During the construction phase, the original and proposed direct jobs stay the same.

Based upon the reduced employment figures it is anticipated that the demand for public services as a result of the proposed ESMM project would be less than the original MSI project.

4.5.3 MITIGATION

4.5.3.1 Property Acquisition

In accordance with the MSI FEIS, Essar is following through with acquisition of six properties within the Permit to Mine and Air Permit ambient air quality boundary. To date the acquisition process for 3 of 6 properties has been or will be completed by September 2011. A completion date for acquisition of two properties is uncertain at this time. The process and detailed outcomes are summarized below.

From 2005 to present, representatives of MSI and now Essar have had informal discussions with the six private home or property owners within the Permit to Mine and Air Permit ambient air quality boundary. Essar representatives conveyed that the timing for property acquisition will be based upon the expectation that plant commissioning will begin in late 2012.

Early discussions with the private property owners led to more formal acquisition steps in the summer of 2010 when Trask Land Company was retained. Two property transactions were completed in October 2010 and these properties are now owned by Essar. One property owner has an accepted purchase offer scheduled for closing September 2011. The remaining three homes are in active negotiations, and formal appraisals by both owner and seller have been completed recently to move the process forward.

5.1 Cumulative Air Quality Class I Particulates (PSD) and Visibility

Chapter Summary

This chapter describes current conditions and historical and projected future trends in particulate, SO_2, and NO_x emissions and evaluates associated visibility impairment effects at each of Minnesota's two Class I areas: Boundary Waters Canoe Area Wilderness (BWCAW) and Voyageurs National Park (VNP). It considers in a semi-quantitative manner the effect on cumulative visibility degradation that the proposed ESMM project would have in combination with other anticipated emissions and factors.

In 2007, the Minnesota Department of Natural Resources and the United States Army Corps of Engineers issued a Final Environmental Impact Statement (FEIS) (MDNR, 2007) describing impacts from a proposed taconite mine, ore processing operation, and steel mill. The project was proposed by Minnesota Steel Industries (MSI) which has since been purchased by Essar Steel Minnesota LLC. The FEIS included a cumulative impacts analysis of Class I area visibility impacts potentially resulting from the original MSI project. This chapter provides updated data and analyses and specifically addresses effects related to the proposed ESMM project.

The chapter is organized according to the following sections:

Section 5.1.1, Affected Environment, describing regulatory framework, analysis method, and technical background.

Section 5.1.2, Environmental Consequences, presenting historical, existing, and projected future conditions relative to particulate concentrations, visibility impacts, source contributions, emissions, and emission-limiting air quality regulations.

Section 5.1.3, Mitigation, providing a statement that cumulative impacts from proposed ESMM project and reasonably foreseeable developments fit within Minnesota's current plan for Class I area visibility improvements. This section also summarizes measures incorporated into the project design and others that are being evaluated to limit emissions of haze-producing pollutants.

Project Alternatives Relevant to this Issue:

- Proposed Action (proposed ESMM project) and associated Technology Alternatives.
- No Action Alternative (the original MSI project)

Cross-Referenced Materials:

- Proposed Action and Alternatives (Chapter 3.0)
- Air Quality (Chapter 4.2)
- Cumulative Air Quality Class I Acid Deposition & Ecosystem Acidification (Chapter 5.2)

Key Issues:

- Emissions of haze-producing air pollutants.
- Cumulative impacts to visibility at surrounding Class I areas.
- Air emissions control methods and technologies.

Documentation for Preparing Chapter 5.1

Barr Engineering. 2010. Cumulative Impacts Analysis, Assessment of Potential Visibility Cumulative Impacts in Federal Class I Areas in Minnesota, Essar SEIS Project, Version 2. October 2010.

Minnesota Department of Natural Resources and U.S. Army Corps of Engineers 2007. Minnesota Steel Final Environmental Impact Statement. June 2007

Minnesota Pollution Control Agency (MPCA). 2009. Minnesota Regional Haze SIP – December 2009. Document aq-sip2-12.

National Park Service (NPS). 2009. Air Quality in National Parks, 2009 Annual Performance and Progress Report. November 2009.

National Park Service (NPS). 2011. National Park Service, Explore Nature website, Air Quality Glossary. Accessed at *http://www.nature.nps.gov/air/AQBasics/glossary.cfm*. March 9, 2011.

Pitchford, M.L. and Malm, W.C. 1994. Development and Applications of a Standard Visual Index. Atmospheric Environment. Volume 28, Issue 5, pp. 1049-1054. March 1994.

5.1.1 AFFECTED ENVIRONMENT

Haze-related visibility impairment is a widely recognized problem in many areas of the country, especially in areas valued for scenic vistas such as national parks and wilderness areas. The notice of preparation for this SEIS identified this as a topic of concern as follows:

> Cumulative Air Quality Effects – Class I Visibility Impairment. The SEIS will include a cumulative effects analysis assessing the potential visibility effects on Federal Class I areas. The SEIS will use a semi-quantitative approach in the analysis. The SEIS will also describe how the proposed modification project affects the NE Minnesota Regional Haze Plan.

In 2007, the Minnesota Department of Natural Resources and the United States Army Corps of Engineers issued a Final Environmental Impact Statement (FEIS) (MDNR, 2007) describing impacts from a proposed taconite mine, ore processing operation, and steel mill. That FEIS included a cumulative impacts analysis of Class I area visibility impacts potentially resulting from the original MSI project. This chapter provides updated data and analyses and specifically addresses effects related to the proposed ESMM project.

The proposed ESMM project is projected to increase haze-producing pollutant emissions from the original MSI project as follows: 307 tons/yr additional sulfur dioxide (SO_2) emissions, a 73 percent increase; 123 tons/yr additional NO_x emissions, an eight percent increase; and 131 tons/yr additional coarse particulate (PM-C, or PM_{10}) emissions, a ten percent increase. The proposed ESMM project will also emit 895 tons/yr of fine particulate (PM-F, or $PM_{2.5}$); the increase due to the proposed ESMM project was not quantified because PM-F emissions were not required to be reported at the time of the original MSI project.

5.1.1.1 Regulatory Framework

In the 1977 amendment to the Clean Air Act (CAA), Congress recognized the problem of visibility impairment and pronounced this goal:

> *"Congress hereby declares as a national goal the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I Federal areas which impairment results from man-made air pollution."*

The U.S. EPA responded in 1980 with rules to address visibility impairment "reasonably attributed to" individual or small groups of sources. In the years immediately following, several scientific studies were conducted to advance general understanding of regional haze, its causes, and methods to mitigate it.

In 1990, Congress passed a major amendment to the CAA that included specific direction for EPA to study and begin to reduce regional contributions to visibility impairment at Class I areas caused by long-range transport of particulate matter. As a result, EPA proposed in 1997, and finalized in 1999, a Regional Haze Rule (RHR). The RHR includes the following provisions:

- It requires certain existing facilities that meet defined criteria to install "best available retrofit technology" to reduce emissions of NO_x, SO_2, and particulate matter.
- It sets a goal to achieve natural visibility conditions at all Class I areas by 2064. It also requires states and tribes to develop plans, known as state implementation plans, or SIPs, and tribal implementation plans, or TIPs, to satisfy this requirement and to periodically demonstrate "reasonable progress" towards the final goal.

- It directs the establishment of regional planning organizations (RPOs) to coordinate solutions to regional haze reduction.

Minnesota is a member of the Central Regional Air Planning Association (CENRAP) along with Arkansas, Iowa, Kansas, Louisiana, Missouri, Nebraska, Oklahoma, Texas, and all tribal governments within those states. Minnesota has also collaborated extensively with the Midwestern Regional Planning Organization (MRPO) in developing its regional haze plan.

At the end of 2009, the Minnesota Pollution Control Agency (MPCA) submitted a proposed regional haze SIP to EPA (MPCA, 2009). The SIP establishes reasonable progress goals (RPGs) for 2018 visibility at BWCAW and VNP (see Graphs 5.1-2 and 5.1-3) and for a 30 percent combined reduction in NO_x and SO_2 emissions, relative to 2002 emissions, from large northeastern Minnesota emissions sources. These goals are based on the decrease in light extinction from ammonium sulfate and ammonium nitrate controllable by Minnesota needed to meet the uniform rate of progress.

5.1.1.2 Analysis Method

Chapter 4.2 describes dispersion modeling analyses that Essar has conducted to demonstrate the proposed ESMM project's potential impacts to air quality at surrounding Class I areas. Those analyses included a quantitative evaluation of changes to visibility at BWCAW, VNP, and Isle Royale National Park. This chapter will analyze "the impact on the environment that results [or could result] from incremental effects of the project in addition to other past, present, and reasonably foreseeable future projects." The purpose of the analysis is to ensure that "[s]ignificant cumulative potential effects [do not] result from individually minor projects taking place over a period of time."[1]

This cumulative impacts assessment considers potential impacts to visibility at Minnesota's two Class I areas—BWCAW and VNP—resulting from air pollutant emissions from the proposed ESMM project, significant existing regional sources, and reasonably foreseeable developments that are expected to lead to significant emissions increases and decreases. An assessment of cumulative impacts at Isle Royale is not included in this chapter because past studies have demonstrated that impacts there from emissions originating in northeastern Minnesota are insignificant (Barr, 2010).

The assessment described in this chapter considers the following factors:

- Haze and pollutant concentration monitoring data.
- Results of studies identifying proportional source contributions to BWCAW and VNP haze.
- Current and projected emission rates of haze-producing pollutants on regional and national levels.
- Existing and proposed regulations that limit, or would limit, emissions of haze-forming air pollutants.

5.1.1.3 Technical Background

Small particles suspended in the atmosphere tend to absorb and scatter light. When the light is being reflected from an object being viewed by an observer, the perceived clarity, contrast, and coloration of the object are degraded. This phenomenon is referred to as

[1] Quotations are from the definitions of "cumulative impact" and "cumulative potential effects" according to Minnesota Environmental Quality Board environmental review rules at Minnesota Rules, part 4410.0200, Subp. 11 and 11a.

regional haze and is a particular concern when it affects landscapes with significant visual value and when the atmospheric particles cumulate from a large number of sources throughout a large geographical expanse.

Haze-causing particles, or particulate matter (PM), can be categorized as primary or secondary. Primary PM is emitted directly into the atmosphere as a solid or liquid particle. Secondary PM is originally emitted as a gas but transforms into a solid or liquid particle in the atmosphere as it reacts chemically with other atmospheric constituents. PM is further categorized as coarse (PM-C), with a diameter of between 2.5 and 10 microns (10^{-6} meters), or fine (PM-F), with a diameter of 2.5 microns or less. Nearly all secondary PM is fine PM. PM-F is generally the major contributor to regional haze because it can be transported thousands of miles and can accumulate in the atmosphere, whereas larger particles settle out more readily. PM is used throughout this chapter to represent the sum of PM-C and PM-F and the sum of primary and secondary particulate.

There are many sources of atmospheric PM, both natural and anthropogenic. The main constituents of haze-causing PM are organic carbon, compounds of sulfur and ammonia (ammonium sulfates), and compounds of nitrogen and ammonia (ammonium nitrates). Table 5.1-1 shows the major sources, natural and anthropogenic, of these materials.

Table 5.1-1. Major Sources of Atmospheric Fine Particles

	Primary Sources		Secondary Sources	
Atmospheric Pollutant	Natural	Man Made (Anthropogenic)	Natural	Man Made (Anthropogenic)
Sulfate (SO_4)	Sea spray	Fossil fuel combustion	Volcanoes, oceans, wetlands	Fossil fuel combustion
Nitrate (NO_3)	N/A	Motor vehicle exhaust, fossil fuel combustion	Soils, forest fires, lightning	Fossil fuel combustion, vehicle exhaust, prescribed burning
Organic Carbon	Wildfires	Open burning, residential wood heating, prescribed burning, vehicle exhaust, tire wear	Oxidation of hydrocarbons (terpenes and waxes) emitted by vegetation and wildfires	Oxidation of hydrocarbons by vehicles, open burning, residential wood heating, fuel storage, solvent use
Ammonia (NH3)	N/A	Motor vehicle exhaust	N/A	Animal agriculture, sewage, fertilizer

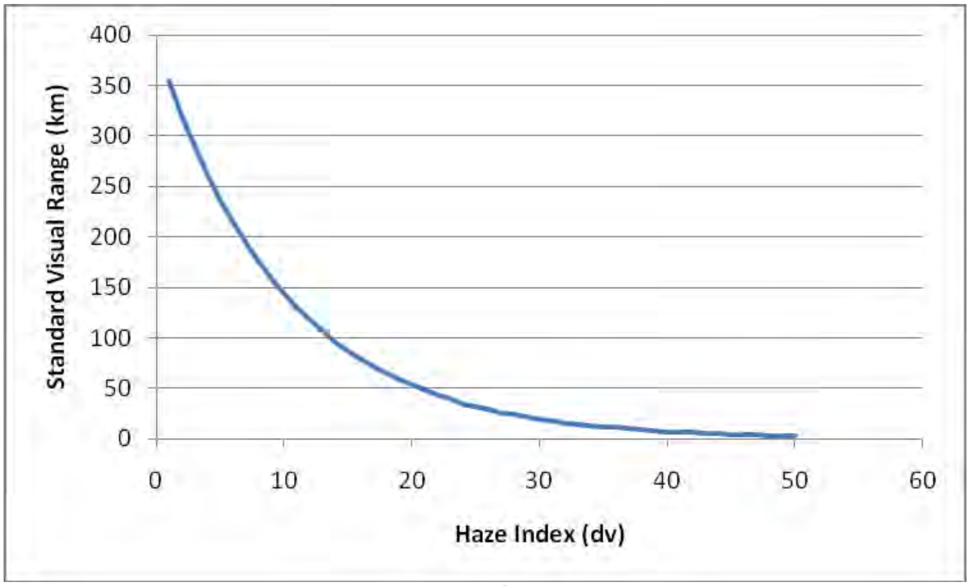
Degree of visibility impairment is generally expressed using one of three measures: light extinction, haze index value, or standard visual range.

Total light extinction, represented as b_{ext}, is a direct function of atmospheric PM concentration. It is calculated by adding PM concentration values that are each first multiplied by a species-specific extinction efficiency coefficient. Concentrations of sulfates and nitrates—and in some cases, sea salt—are also multiplied by a humidity factor because particle size for these types of PM increases with humidity. Light extinction is a measure of light extinction per unit distance and is expressed in units of “inverse megameters” [10^{-6} m^{-1}, or (10^6 m)$^{-1}$].

The haze index (HI) relates light extinction to human perception of visibility. A change in perceived visibility depends on the starting point for the change. For example, a one-unit

b_{ext} change in light extinction may be very noticeable when starting from a clear baseline, but hardly noticeable if the starting point is already hazy. Scientists developed the haze index, which is expressed in units of deciviews (dv), such that one HI unit change is equivalent to the minimum perceptible change in visibility, independent of the starting point for the change.

Standard visual range (SVR) is the distance at which a large black object would just disappear from view (NPS, 2011). Graph 5.1-1 shows the non-linear relationship between HI and SVR.



Graph 5.1-1. HI Relationship to SVR (Pitchford, 1994)

5.1.2 ENVIRONMENTAL CONSEQUENCES

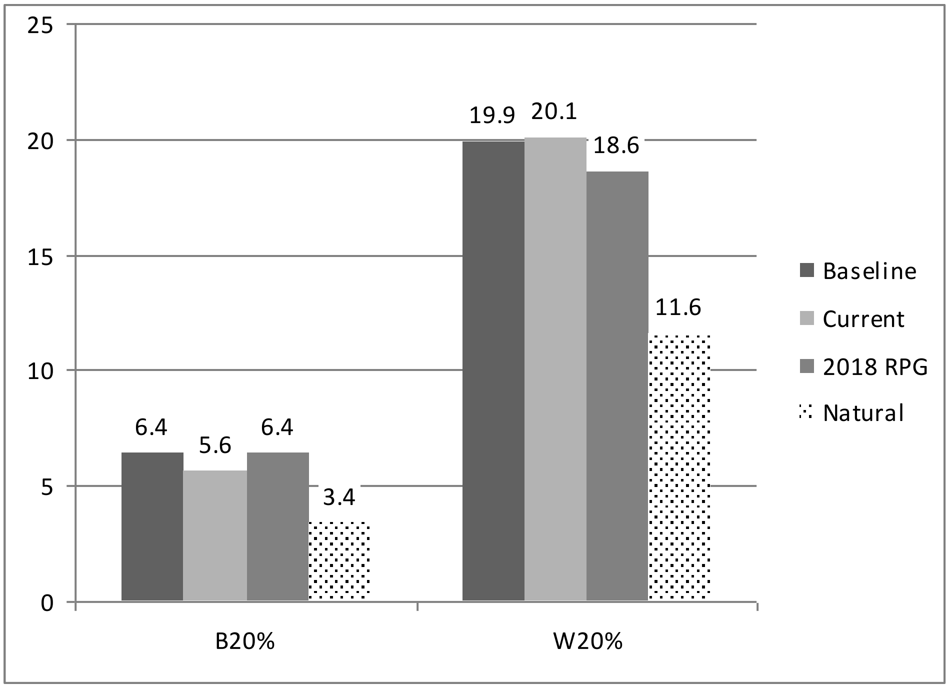
5.1.2.1 PM Concentration and Visibility Trends

A program was established in 1985 to measure and monitor Class I area visibility and visibility parameters to aid in accomplishing CAA visibility goals. This program, known as the Interagency Monitoring of Protected Visual Environments (IMPROVE) program, is administered by a steering committee of federal, state, and regional agency representatives. It currently monitors visibility metrics and haze-producing pollutant concentrations at 110 sites throughout the country. Minnesota hosts an active IMPROVE site at each of its two Class I areas. The BWCAW site was established in 1991. IMPROVE data have been collected at the current VNP site since 2000.

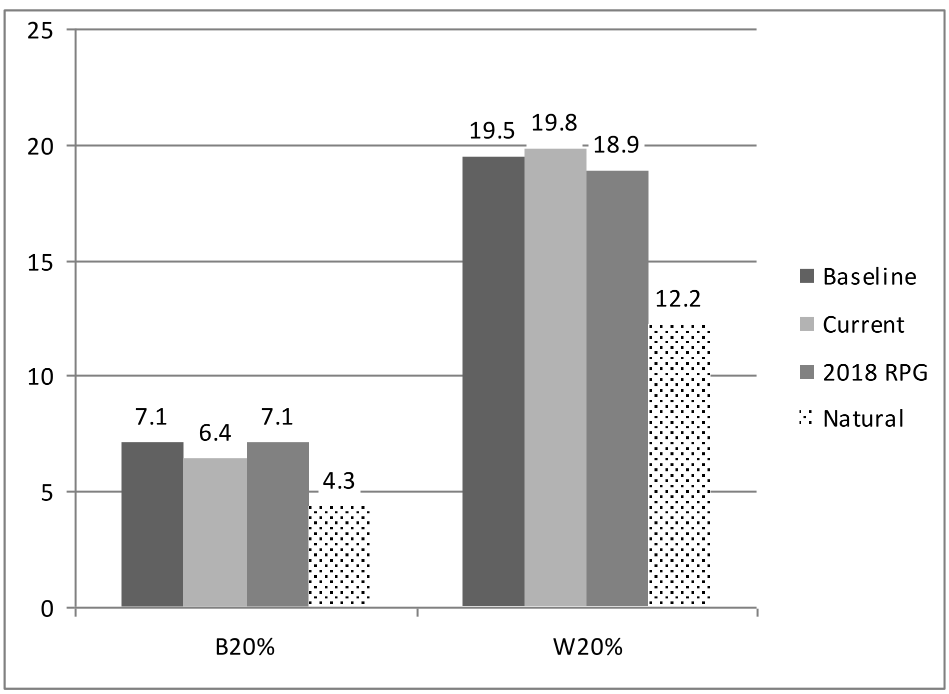
Graph 5.1-2 and Graph 5.1-3 show data for the two Minnesota Class I area indicating baseline, current, and target haze index values. All values are expressed in units of deciviews. Because daily visibility varies significantly throughout the year, the Regional Haze Rule (RHR) applies visibility goals to both clear and hazy conditions. Specifically, it sets goals for improvement of the average of the 20 percent best, or clearest, days (B20%) and of the average of the 20 percent worst, or haziest, days (W20%).

The baseline values shown in the graphs represent the average over the years 2000 through 2004, as prescribed in the RHR. Current values are averages for the periods of

2005 through 2009.[2] Baseline conditions, proposed reasonable progress goals (RPGs) for 2018, and natural conditions are reported in the *Minnesota Regional Haze SIP – December 2009* (MPCA, 2009). Natural conditions represent estimated visibility absent anthropogenic effects.



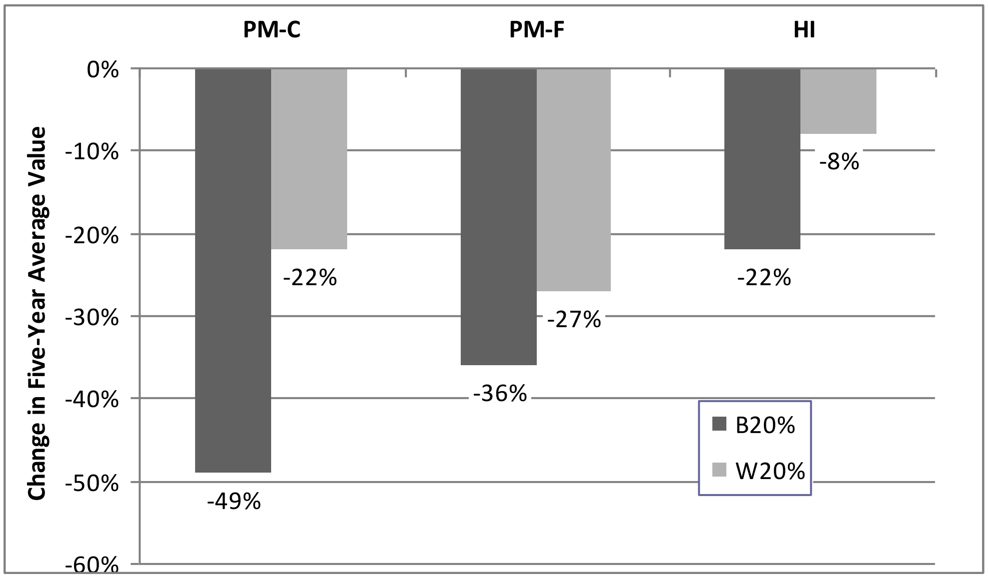
Graph 5.1-2. BWCAW Visibility Conditions and Targets



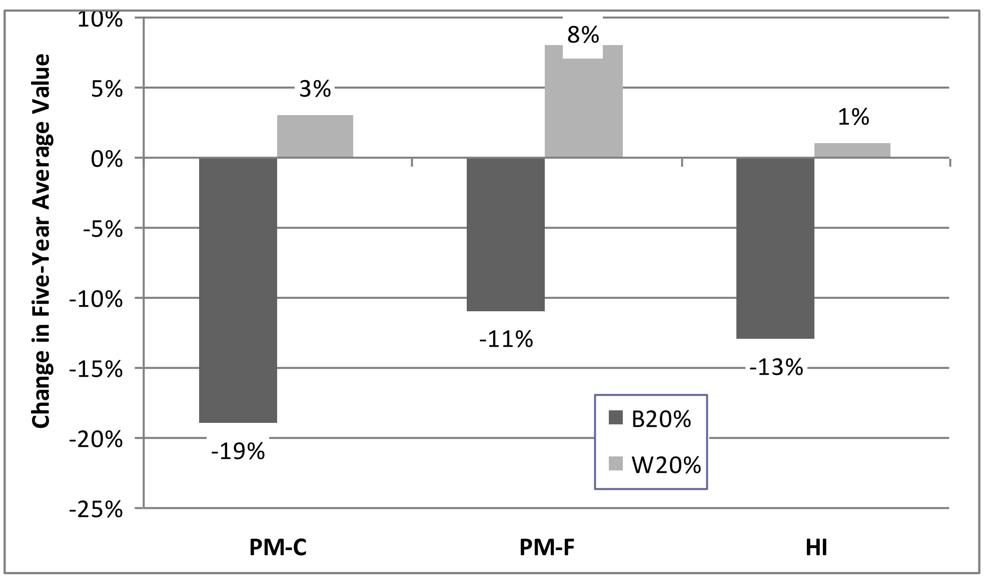
Graph 5.1-3. VNP Visibility Conditions and Targets

[2] Current conditions are calculated using 1988 – 2008 summary data available from the IMPROVE web site (http://vista.cira.colostate.edu/improve/Data/IMPROVE/summary_data.htm) and 2009 data available from the VIEWS2.0 web site (http://views.cira.colostate.edu/web/DataWizard).

Graphs 5.1-4 and 5.1-5 show changes in PM-C and PM-F concentrations and in haze index over the life of the two Class I area IMPROVE monitoring stations. Data for the graphs were reported in in the *Cumulative Impacts Analysis, Assessment of Potential Visibility Cumulative Impacts in Federal Class I Areas in Minnesota, Essar SEIS Project, Version 2* (Barr, 2010). Note that negative values indicate declining concentrations and improving visibility.



Graph 5.1-4. Historical Changes in BWCAW Visibility 1992-2008



Graph 5.1-5. Historical Changes in VNP Visibility 2000-2008

The National Park Service (NPS) routinely evaluates air quality in national parks and performs statistical data analyses to identify trends. In *Air Quality in National Parks, 2009 Annual Performance and Progress Report* (NPS, 2009), NPS reported that the visibility data for VNP do not meet criteria for concluding that values are trending either higher or lower. A similar evaluation is not available from the U.S. Forest Service for BWCAW.

5.1.2.2 Haze Contribution Study Results

In the course of developing its Regional Haze SIP, MPCA conducted long-range transport modeling to evaluate the effect of potential emissions reductions. This modeling analysis also identified contributions from sources within and outside of Minnesota. Table 5.1-2 lists some of the source areas evaluated and their proportional contribution to total light extinction due to ammonium sulfate [$(NH_4)_2(SO_4)$] and ammonium nitrate (NH_4NO_3) concentrations.

Table 5.1-2. Modeled Geographic Area Contributions to Minnesota Class I Area Light Extinction from Ammonium Sulfate [$(NH_4)_2(SO_4)$] and Ammonium Nitrate (NH_4NO_3) for 2018

	Area	BWCAW	VNP
Minnesota	Total Minnesota	26%	32%
	NE Counties	14%	15%
States	Wisconsin	10%	6%
	Iowa	8%	7%
	Illinois	6%	3%
	Missouri	6%	4%
	North Dakota	6%	13%
	Subtotal of states contributing >5%	36%	33%
	All other modeled states	22%	16%
Other	Canada	3%	5%
	Boundary conditions	11%	15%

Explanatory notes:

- Total light extinction to which these source areas contribute is only that attributable to atmospheric concentrations of ammonium sulfate and ammonium nitrate. The values do not include contributions from other PM species, the most active of which is organic carbon from natural sources.
- The models from which these data were generated were based on projected 2018 emission inventories and evaluated impacts to average visibility for the 20% worst days.
- The domain throughout which emissions were considered included the southeastern portion of Canada and the central and eastern portion of the continental United States east of a north-south line tangent to the western tip of Texas.
- Boundary conditions represent atmospheric pollutant concentrations that result from sources outside of the model domain. These include sources around the globe.

5.1.2.3 PM Emissions Trends

Future Class I visibility impairment reductions will result from future reductions of PM and PM precursor emissions. This section examines current and reasonably foreseeable emissions of SO_2, NO_x, and PM from Minnesota sources—local and statewide—and throughout the continental United States.

5.1.2.3.1 Local Emissions

As shown in Table 5.1-2, contributions to sulfate and nitrate light extinction at BWCAW and VNP from sulfate and nitrate sources in northeastern Minnesota counties are expected to equal approximately half the total contributions from statewide sources. This observation corresponds with data indicating that stationary source emissions from northeastern Minnesota account for nearly half of statewide stationary source emissions of SO_2 (40%), NO_x (41%), and PM (48%) (Barr, 2010).

The following counties in the northeast corner of Minnesota surround the two Minnesota Class I areas and were isolated for special consideration by the *Minnesota Regional Haze SIP* (MPCA, 2009).

- Carlton
- Koochiching
- Cook
- Lake
- Itasca
- St. Louis

These counties contain the Minnesota Iron Range, a major source of taconite ore used for steel production and so include several taconite mining and processing operations.

The most recent complete point source emissions inventory for the northeastern Minnesota region is for 2007. Data for that year indicate total actual emissions of:

- 40,386 tons SO_2,
- 53,090 tons NO_x, and
- 14,963 tons PM10.

Since 2007, several new projects have been initiated or completed in the area that would either increase or reduce air pollutant emissions. Table 5.1-3 lists and briefly describes these projects and shows the resulting estimated emissions changes.

Table 5.1-3. Projected Potential SO_2, NO_x, and PM Emissions Changes from Near-Term Projects in Northeastern Minnesota*

Company, Facility, and County	Project Description	Emissions Change
Excelsior Energy, Mesaba Energy Project; Itasca	Proposed IGCC power plant. Minnesota PUC permit issued 2010.	SO_2 .... 1390 tpy NO_x .... 2872 tpy PM......... 532 tpy
Mesabi Nugget Phase I LSDP; St. Louis	Large scale demonstration project. Permitted for construction.	SO_2 .... 417 tpy NO_x .... 954 tpy PM......... 514 tpy
Mesabi Nugget Phase II; St. Louis	Taconite mining and processing expansion. Undergoing EIS and permitting.	SO_2 .... 7 tpy NO_x .... 282 tpy PM......... 955 tpy
Essar Steel Minnesota, LLC (formerly Minnesota Steel Industries) – original MSI project; Itasca	Build mining, ore processing, and steel manufacturing facility. Construction ongoing.	SO_2 .... 421 tpy NO_x .... 1505 tpy PM......... 1354 tpy
Essar Steel Minnesota LLC – proposed ESMM project; Itasca	Modifications to original MSI project. (Emissions represent increases relative to MSI project emissions.)	SO_2 .... 307 tpy NO_x .... 123 tpy PM......... 131 tpy
Northshore Mining Company: Furnace 5 Reactivation; Lake	Reactivate two crushing lines, nine concentrating lines, one pellet furnace. Construction complete.	SO_2 .... 56 tpy NO_x .... 200 tpy PM......... 149 tpy
PolyMet Mining, NorthMet Project; St. Louis	Proposed mining/processing facility.	SO_2 .... 30 tpy NO_x .... 159 tpy PM......... 1175 tpy
SAPPI Cloquet; Carlton	Plant expansion, new paper machine, new boiler. Permitted.	SO_2 .... 48 tpy NO_x .... 87 tpy PM......... 35 tpy

Company, Facility, and County	Project Description	Emissions Change
UPM/Blandin Paper Mill Expansion: Project Thunderhawk; Itasca	Facility expansion. Permitted.	SO_2 .... 213 tpy NO_x .... 169 tpy PM......... -7 tpy
US Steel Keewatin, Keetac Expansion; Itasca and St. Louis	Mine expansion and restart ore processing line. FEIS 11/2010.	SO_2 .... 125 tpy NO_x .... 39 tpy PM......... 1231 tpy
United Taconite Green Production Project	Fuel changes, concentrator line capacity increase. Permitted.	SO_2 .... 35 tpy NO_x .... 35 tpy PM......... -11 tpy
Minnesota Power, Laskin Energy Center; St. Louis	Upgrade coal combustion system to reduce NOx emissions. 2010 completion.	SO_2 .... -143 tpy NO_x .... -1381 tpy PM......... N/A
Minnesota Power, Taconite Harbor Energy Center; Cook	Upgrade coal combustion chambers and add reagent injection system.	SO_2 .... -1549 tpy NO_x .... -1149 tpy PM......... N/A
Minnesota Power, Boswell Energy Center; Itasca	Replace wet scrubber with SCR, fabric filter, and wet FGD. 2010 completion.	SO_2 .... -11,952 tpy NO_x .... -9683 tpy PM......... N/A
United Taconite, Fairlane Plant; St. Louis	Install BART.	SO_2 .... -2240 tpy NO_x .... N/A PM......... N/A
US Steel Minntac; St. Louis	Install NOx BACT. Conducting pilot scale tests to prove technology.	SO_2 .... N/A NO_x .... -7624 tpy PM......... N/A
Hill Wood Products; St. Louis	Major modification to replace old emission units. Draft permit issued 2010.	SO_2 .... 3 tpy NO_x .... -113 tpy PM......... -12 tpy
Northshore Mining Company; Lake	Install BART.	SO_2 .... -583 tpy NO_x .... -1159 tpy PM......... N/A
Total Increases		SO_2 .... 3052 tpy NO_x .... 6425 tpy PM......... 6076 tpy
Total Reductions		SO_2 .... -16,467 tpy NO_x .... -21,109 tpy PM......... -30 tpy
Net Reductions/Increases		SO_2 .... -13,415 tpy NO_x .... -14,684 tpy PM......... +6046 tpy

BART = best available retrofit technology. Required by Regional Haze Rule.
BACT = best available control technology. Required by PSD air quality permitting rules.
IGCC = integrated gasification combined cycle.
* Source: Table 1 of the *Cumulative Impacts Analysis, Assessment of Potential Visibility Cumulative Impacts in Federal Class I Areas in Minnesota, Essar SEIS Project, Version 2* (Barr, 2010). See also Table 5.2-1.

Table 5.1-4 summarizes emissions changes shown in Table 5.1-3 and compares the changes to northeast Minnesota 2002 and 2007 actual emissions. Note that Table 5.1-4 assumes all proposed projects and reductions listed in Table 5.1-3 will be in full operation by the year 2015.

Table 5.1-4. Summary of Past and Present Northeastern Minnesota Emissions Relative to Expected Near-Term Projected Emissions*

Pollutant/Year	Emission Rate (tons/yr)	Change Relative to 2015 (tons/yr)	% Change Relative to 2015
SO_2			
2002	36,548	-9,577[a]	-26%[a]
2007	40,386	-13,415	-33%
2015	26,971	--	--
NO_x			
2002	59,613	-21,807	-37%
2007	52,490	14,684	-28%
2015	37,806	--	--
Total (SO_2 + NO_x)			
2002	96,161	-31,384	-33%
2007	92,876	-28,099	-30%
2015	64,777	--	--

(a) Example: Northeastern Minnesota SO_2 annual emissions are projected to decrease 9,577 tons by 2015, which is a 26 percent reduction.

* Source: Table 6 of the *Cumulative Impacts Analysis, Assessment of Potential Visibility Cumulative Impacts in Federal Class I Areas in Minnesota, Essar SEIS Project, Version 2* (Barr, 2010). Table 6 provides individual years (1990-2007). The year 2015 is provided as a prediction using the average of the period 2003-2007.

According to these estimates, MPCA's Regional Haze SIP goal of reducing northeastern Minnesota total stationary source NO_x and SO_2 emissions relative to 2002 by 30 percent by 2018 will have been met by 2015. Reasonably foreseeable air quality regulations described in Section 5.1.2.3.3 will likely result in further reductions.

5.1.2.3.2 Statewide Emissions

Table 5.1-5 compares reported actual statewide emissions in 2008 with emissions increases that would result from changes associated with the proposed ESMM project and with changes associated with reasonably foreseeable projects in northeastern Minnesota (as reported in Table 5.1-3). The table illustrates that proposed ESMM project emissions would be negligible compared to statewide emissions. Additionally, foreseeable potential decreases in SO_2 and NO_x emissions and increases in PM emissions are significant with respect to statewide stationary source emissions.

Table 5.1-5. 2008 Statewide Actual Emissions Compared with Proposed and Reasonably Foreseeable Emissions

	2008 Actual	Proposed ESMM Project	Reasonably Foreseeable Changes in NE MN
SO_2			
Stationary sources (tons/yr)	102,000	307	-13,000
All sources (tons/yr)	129,000	--	--
% 2008, stationary	--	0.3%	-12.7%
% 2008, total	--	0.2%	-10.1%
NO_x			
Stationary sources (tons/yr)	129,000	123	-15,000
All sources (tons/yr)	391,000	--	--
% 2008, stationary	--	0.1%	-11.6%
% 2008, total	--	0.0%	-3.8%
PM			
Stationary sources (tons/yr)	31,000	131	6,000
All sources (tons/yr)	776,000	--	--
% 2008, stationary	--	0.4%	19.4%
% 2008, total	--	0.0%	0.8%

5.1.2.3.3 National Emissions

Dramatic increases in air quality regulations over the last 40 years have resulted in dramatic decreases in air pollutant emissions throughout the country over that period. The period from 1990 to 2008 witnessed decreases in nationwide SO_2 emissions of 50 percent, NO_x emissions of 35 percent, and PM_{10} emissions of 47 percent. Proposed and future regulations, some of which are described in the next section, are expected to continue this trend into the foreseeable future.

5.1.2.3.4 Foreseeable Air Quality Regulations

Several state and federal regulations, existing and proposed, limit and will further limit emissions of NO_x, SO_2, and PM.

Minnesota Acid Rain Rule

This rule, which has been effective since 1986, can be found at Minn. Rule Parts 7021.0010-7021.0050. It sets a cap on allowable statewide SO_2 emissions and applies specific caps to Minnesota power generation facilities belonging to two power companies. It also applies a limit to allowable wet sulfate deposition within certain sensitive areas (see Chapter 5.2).

Federal Acid Rain Program

This regulation is required by Title IV of the CAA and has been in effect since 1995. It establishes a nationwide cap on SO_2 emissions from affected electric utility generators (EGUs) and applies NO_x emission limits on each affected EGU. It has reduced EGU SO_2 emissions by approximately 50 percent since its inception.

Maximum Achievable Control Technology (MACT) Standards

Section 112 of the CAA requires that EPA limit emissions of a set of identified toxic air pollutants. The primary rules implementing this requirement are known as National Emissions Standards for Hazardous Air Pollutants (NESHAPs) found at 40 CFR Part 63. NESHAPs establish pollutant emissions limits for specific industries and emitting unit categories based on a technology standard referred to as the "maximum available control technology" (MACT). Two recently promulgated NESHAPs and one pending NESHAP are of particular interest for their PM reducing potential:

<u>Major Source Boiler NESHAP (40 CFR Part 63, Subpart DDDDD)</u>: This rule was revised February 2011 and potentially applies to approximately 13,800 industrial, commercial, and institutional boilers and process heaters at major sources of hazardous air pollutant emissions. The revised rule is expected to reduce nationwide emissions of direct PM by 47,000 tons/yr, SO_2 by 440,000 tons/yr, and volatile organic compounds (VOCs) by 7,000 tons/yr.

<u>Area Source Boiler NESHAP (40 CFR Part 63 Subpart JJJJJJ)</u>: This is a new NESHAP promulgated February 2011. It imposes PM and carbon monoxide limits on certain existing and new boilers installed at facilities that are area (non-major) sources of hazardous air pollutant emissions. Nationwide, it could potentially affect 187,000 existing and 2,400 new boilers within the next three years. EPA estimates it will reduce approximately 2,500 tons/yr of PM emissions.

<u>Utility NESHAP (40 CFR Part 63 Subpart UUUUU)</u>: EPA has committed to proposing a new NESHAP for EGUs by the middle of March 2011 and finalizing the rule by November 2011.

EPA Transport Rule

EPA proposed a rule, known as the Transport Rule, intended to reduce ozone and fine particulate air concentrations that result from emissions transported over long distances. It was officially proposed August 2010 and is expected to be finalized by the third quarter of 2011. It will apply to 31 states in the eastern, southern, and central sections of the country and will impose statewide limits on SO_2 and NO_x emissions from power plants. The rule's requirements would take effect in 2012 with a planned downward adjustment to some SO_2 limits in 2014. In addition, EPA has announced its intention to propose a second transport rule in 2011 to address an expected decrease in allowable ambient ozone concentrations.

Regional Haze Rule and Best Available Retrofit Technology (BART)

The Regional Haze Rule and BART requirements are described in more detail in Section 5.1.1.1. Several Minnesota facilities are required to reduce SO_2, and NO_x emissions through installation of BART, including six taconite facilities and five EGU facilities, three of which are in Northeastern Minnesota.

National Ambient Air Quality Standards (NAAQS) Changes

In 2010, EPA finalized new ambient standards for one-hour averages of NO_2 and SO_2. These will combine to reduce fine particulate in areas with high concentrations and throughout the country. EPA has also proposed, in January 2010, to reduce allowable ambient concentrations of ozone. A lower ozone NAAQS will have the effect of reducing VOC and NO_x emissions because both are precursor chemicals for ozone. A proposal to revise particulate matter NAAQS is currently scheduled for the latter part of 2011.

More stringent NAAQS generally reduce emissions in two ways. First, they pressure new and modified facilities to reduce potential pollutant emission rates as they are required to demonstrate NAAQS compliance—often through modeling—as part of the permitting process. Second, in areas where the NAAQS have been exceeded, states must develop and implement state implementation plans (SIPs) that include measures for reducing existing emissions to establish NAAQS compliance.

Other Actions

Several other regulations are expected to, or will continue to, limit emissions of haze-producing pollutants. They include:

- Tier II for on-highway mobile sources
- Heavy duty engine standards
- Low sulfur fuel standards
- Federal control programs for non-road mobile emissions
- Control of emissions from unregulated non-road engines
- $PM_{2.5}$ and ozone SIPs for Wisconsin and Michigan

5.1.3 MITIGATION

As identified in Chapter 4.2, screening level modeling indicates visibility impacts on BWCAW and VNP from the proposed ESMM project are above the threshold of concern defined by responsible Federal Land Managers (FLMs). Therefore, as a condition of receiving a permit to construct and operate, Essar would be required to reduce its emissions and demonstrate an acceptable level of visibility impact.

Potential mitigation measures include accepting a lower NO_x emission limit than currently proposed. This would be contingent on results of one-quarter-scale pilot tests planned for the proposed new indurating furnace design. Other potential mitigation measures include installing add-on NO_x controls to the furnace exhaust system, reducing NO_x emissions from other sources within the facility or at nearby facilities, or purchasing and retiring tradable NO_x or SO_2 emissions allowances from sources impacting the surrounding Class I areas. Any of these mitigation measures would need to be successfully incorporated into the visibility impacts screening analysis to gain FLM approval.

In addition to these potential pollution reduction actions, other air quality impact mitigation measures are incorporated into the proposed ESMM project design. They include:

- Using larger trucks and optimizing the mine plan to reduce haul truck vehicle miles traveled, thereby reducing particulate and hazardous air pollutant emissions.
- Implementing emissions control technologies that are currently required by the current MSI air quality permit. Examples include material handling baghouses, implementation of a dust control plan, and wet scrubbing indurating furnace emissions.

- Using an indurating furnace design that produces lower NO_x emissions per unit of pellet production than standard furnaces.

Although anthropogenic haze persists at Minnesota's Class I areas—and at all Class I areas—regional and nationwide haze-producing emissions have been declining and will continue to do so. Overall Class I area visibility is projected to improve in coming years based on existing and proposed regulatory efforts aimed at continuing historical declines in PM and PM-producing emissions. As evidenced by its proportional contributions to statewide emissions (reported in Table 5.1-5), the proposed ESMM project would have a negligible adverse effect on declining statewide emissions. It would furthermore have a minimal effect on Minnesota's plan to reduce regional haze in accordance with the Regional Haze Rule.

5.2 Cumulative Air Quality Class I Acid Deposition and Ecosystem Acidification

Chapter Summary

This chapter was prepared to address the proposed ESMM project emissions and deposition of sulfur and nitrogen onto Class I areas and present the findings of a semi-quantitative approach to assess the potential cumulative effects on ecosystem acidification.

The MSI FEIS included a cumulative impacts analysis of acid deposition and ecosystem acidification. This chapter provides updated data and analyses and specifically incorporates effects related to the proposed ESMM project.

The proposed ESMM project modifications that would appreciably affect sulfur and nitrogen emissions are the substitution of a new pellet plant indurating furnace and increased pellet production capacity. These would have the effect of increasing sulfur oxides, SO_x (as sulfate, SO_2) emissions by 307 tons/yr (a 73 percent increase) and nitrogen oxides, NO_x, emissions by 123 tons/yr (an eight percent increase).

The chapter is organized according to the following sections:

Affected Environment, Section 5.2.1, provides a summary of general sources of acid deposition and consequent ecosystem effects.

Environmental Consequences, Section 5.2.2, summarizes project-related emissions, cumulative emissions, and potential ecosystem acidification effects.

Mitigation, Section 5.2.3, provides a statement of the technology Essar has committed to as feasible for minimizing emissions of sulfur and nitrogen gases.

Project Alternatives Relevant to this Issue (see Chapter 3.0):

- Proposed Action (proposed ESMM project) and associated Technology Alternatives
- No Action Alternative (the original MSI project)

Regulatory Framework:

This issue is addressed in accordance with Minnesota Statute and standards listed below.

- Acid Deposition Control Act, 1982, Minn. Statutes 116.42-116.45.
- 1986 MPCA wet sulfate deposition standard and statewide SO_2 emission cap.

The Acid Deposition Control Act directed the MPCA to identify resources sensitive to acid deposition effects and to establish a control plan including limits to protect those resources. As a result, MPCA published a report in 1985 that led to the adoption in 1986 of a wet sulfate deposition standard of 11 kilograms per hectare (kg ha-1) and a statewide SO_2 emissions cap of 194,000 tons per year (tons/yr). The most recent available data, from 2008, show the wet sulfate deposition rate in northeastern Minnesota ranged from approximately 5 to 9 kg ha-1, and the statewide SO_2 emission rate was approximately 129,000 tons/yr (Barr, 2010).

Several other state and federal initiatives to regulate air pollutants, including SO_2 and NO_x, have been proposed or are in various stages of implementation:

- EPA Acid Rain Program (Title IV of the 1999 Clean Air Act Amendments); Phase II implementation began in 2000.
- The Clean Air Interstate Rule (CAIR) replacement, called the Transport Rule, modifying 40 CFR Parts 51, 72, 73, 74, 77, 78, 96.
- Regional Haze Rule, including Best Available Retrofit Technology (BART) requirements for certain sources. On July 6, 2005, the U.S.EPA published final amendments to its 1999 regional haze rule in the Federal Register, including Appendix Y, the final guidance for BART determinations (70 FR39104-39172).
- National Ambient Air Quality Standards including 1-hr standards for NO_x and SO_2, reconsiderations of the 2008 ozone standards, and additional changes to the standards for SO_2, NO_x and PM.
- Various mobile source emissions reductions initiatives.

Cross-Referenced Chapters:

- Chapter 4.2 Air Quality

Key Issues:

- Trends in SO_2 and NO_x air emissions
- Projected cumulative impacts due to ecosystem acidification

Documentation to Prepare Chapter 5.2
Barr Engineering. 2010. Cumulative Impacts Analysis; Minnesota Iron Range Industrial Development Projects; Assessment of Potential Ecosystem Acidification Cumulative Impacts in Northeast Minnesota. Version 2. October, 2010.

5.2.1 AFFECTED ENVIRONMENT

5.2.1.1 Atmospheric Acid Deposition

Acid deposition is often and informally referred to as acid rain, and is associated with ecosystem acidification. Overall, acid deposition can occur from both wet (rain or snow) and dry deposition fall out from the atmosphere to earth and objects. A considerable body of literature exists on monitoring, modeling, and studying acid precursor emissions, ecosystem acidification and their interactions. From the details provided in Barr (2010), a brief summary of the sources of atmospheric acids is provided below.

With respect to this review, the atmospheric constituents that lead to acid rain are nitrogen and sulfur compounds emitted by fuel combustion processes. The predominant acid precursor compounds are sulfur oxides (SO_x) and nitrogen oxides (NO_x).

In 1978, a consortium of federal and state agencies established a network of precipitation monitors to collect data on precipitation chemistry for the purpose of monitoring acid deposition conditions and evaluating trends. Analysis of data from a subset of the network in northeastern Minnesota indicates that wet sulfate deposition (SO_2 transformed to SO_4) has declined overall by about one-third since the early 1980s, but the rate of decrease has leveled since about 1997, remaining near 6.0 kg ha-1 on average. Total inorganic nitrogen deposition in the northeastern Minnesota region has remained relatively steady at a rate of between 6 and 8 kg ha-1 since the mid-1980s. MPCA estimates approximately ten percent of sulfate deposition in northeastern Minnesota is derived from local emissions sources, with some of the approximately 90 percent long distance transport from as far as Texas. National emissions of SO_2 have decreased by about 50 percent from 1990 (17.1 million tons/yr) to 2008 (11.4 million tons/yr). National emissions of NO_x have decreased by about 35 percent from 1990 (25.0 million tons/yr) to 2008 (16.3 million tons/yr).

Combustion-derived SO_2 emissions result from sulfur-containing fuel. MPCA estimates electric utilities have accounted for 62 to 68 percent of total statewide SO_2 emissions, with a decline occurring from 1985 to 2010. The other emission categories in descending order were stationary industrial sources, mobile sources, non-road sources, and “other”.

Fuel combustion also leads to NO_x emissions, but predominantly from high temperature reactions with atmospheric nitrogen and oxygen. A relatively small proportion of NO_x results from oxidation of nitrogen in fuel. MPCA in a 2009 report listed source category contributions to statewide NO_x emissions as follows: non-road sources, 26 percent; gasoline vehicles, 21 percent; electric utilities, 19 percent; point sources excluding electric utilities, 14 percent; diesel vehicles, 13 percent; and fuel combustion (nonpoint), 9 percent.

On average, nitrogen compounds account for approximately 40 percent of total acid deposition and sulfur compounds account for the remainder (Barr Engineering, 2010).

5.2.1.2 Ecosystem Acidification

Ecosystem effects associated with acid deposition of atmospheric acid compounds and acid precursors tend to be complex and nonlinear. Effects are influenced by many physical and chemical interactions between existing and introduced elements and compounds in soil, water, and directly on vegetation. Ecosystems generally are considered to vary in susceptibility to ecosystem acidification according to their buffering capacity or ability to neutralize the addition of acid or acid precursors. From the details in Barr (2010), a brief summary of mechanisms of action and some examples of effects on plants in terrestrial and aquatic systems is provided below.

5.2.1.3 Terrestrial Systems

Sulfur and nitrogen are necessary plant nutrients naturally found in soils and commonly added for commercial production. Over-saturation or loading of soil elements, particularly nitrogen, can be detrimental to the health of some forest species. It can also lead to leaching (water-soluble transport) into surface and ground waters, though some field studies have failed to demonstrate a close link between nitrate loading in aquatic systems and soil nitrogen leaching.

Acids introduced to soil can react with calcium, magnesium, and potassium, three other necessary plant nutrients, creating leachable compounds which wash from the soil and are unavailable for plant uptake. Leaching of calcium, magnesium, and potassium can lead to soil acidification, at which point other important nutrients, namely phosphorus and iron, can become unavailable for plant uptake. Besides loss of soil plant nutrients, soil acidification can lead to aluminum toxicity by turning the normally insoluble aluminum to a soluble form that can move into plant roots.

Acids directly deposited by rain onto plant leaves and conifer needles can move into the tissue and leach nutrients such as magnesium and calcium. This can result in plant nutrient deficiencies and resultant effects on plant growth.

5.2.1.4 Aquatic Systems

Both abundance and diversity of aquatic plants can be adversely affected by acidic conditions resulting from acid deposition. Similar to terrestrial plants, aluminum toxicity can occur through the unavailable form converting to a bio-available form in acidified sediments. A large majority of acid in most aquatic systems originates from atmospheric deposition in the watershed and hydrologic contributions, rather than direct atmospheric deposition on the water body, and is subject to the buffering capacity of the watershed.

Within a lake or stream the natural capacity to buffer acid is expressed quantitatively as acid neutralizing capacity (ANC). Aquatic systems with a low ANC would be more affected by acid deposition than high ANC systems. MPCA maintains a long term northeastern Minnesota lake monitoring dataset for examining the ANC and considers these lakes to be sensitive to ecosystem acidification. Over the record of observations, there appears to be a high correlation with decline in surficially sampled lake SO_4 and SO_4 deposition at the precipitation monitoring points. However, the source of the SO_2 emissions deposited in Minnesota cannot be simply identified from these data.

5.2.2 ENVIRONMENTAL CONSEQUENCES

5.2.2.1 Cumulative Effects Evaluation Area

This assessment provides an update to the cumulative effects analysis prepared in support of the MSI FEIS. It addresses a six-county zone of interest in northeast Minnesota which contains some of the state's most acid-sensitive ecosystems and includes the state's two Class I areas: Boundary Waters Canoe Area Wilderness and Voyageurs National Park. The six counties that comprise the zone of interest are Carlton, Koochiching, Itasca, St. Louis, Lake, and Cook. Chapter 4.2 addresses potential effects on Class I areas of all regulated air emissions, not just sulfur and nitrogen.

5.2.2.2 Project-Specific and Cumulative Local (Northeastern Minnesota) SO_x and NO_x Emissions

Planned projects which could lead to increases or decreases in SO_2 and NO_x emissions in the six-county zone of interest in northeastern Minnesota between 2007 and 2015 for significant sources are summarized in Table 5.2-1 (Barr, 2010). Foreseeable increases are defined as proposed projects under construction or in environmental review. Emissions decreases are defined as existing projects that are either underway or committed to decreasing emissions. The difference between all increases and decreases is a reduction of 13,404 tons/yr (tpy) SO_2 and 14,662 tons/yr NO_x. These reductions do not include potential effects of proposed federal regulatory programs aimed at reducing SO_x and NO_x.

In Table 5.2-1 the project-specific emissions are shown from the original MSI project in accordance with the existing air permit, and the proposed ESMM project as estimated June 2010 for just the modifications. The total Essar contributions would be from adding these two lines. These data show that for all operations and sources combined, the original MSI project acid deposition emissions are lower than the proposed ESMM project. Further detail comparing all project emissions is found in Chapter 4.2.

Table 5.2-1. Acid Deposition Emissions from Cumulative Local (Northeastern Minnesota) Planned Projects

Project	Location in Minnesota	SO_2 (tpy)	NO_x (tpy)	BACT/MACT [16]
Increases				
Excelsior Energy, Mesaba Energy Project [1]	Taconite or Hoyt Lakes, St. Louis or Itasca County	1,390	2,872	Yes
Mesabi Nugget Phase I LSDP [2]	Hoyt Lakes, St. Louis County	417	954	Yes
Mesabi Nugget Phase II [3]	Hoyt Lakes, St. Louis County	7	282	Yes
Essar Steel Minnesota LLC (formerly Minnesota Steel Industries) – original MSI project [4]	Nashwauk, Itasca County	421	1,505	Yes
Essar Steel Minnesota LLC – proposed ESMM project [5]	Nashwauk, Itasca County	307	123	Yes
Northshore Mining Company: Furnace 5 Reactivation [6]	Silver Bay, Lake County	56	200	Yes
PolyMet Mining, NorthMet Project [7]	Hoyt Lakes, St. Louis County	30	159	Yes
SAPPI Cloquet [13]	Cloquet, Carlton County	48	87	Yes
UPM/Blandin Paper Mill Expansion: Project Thunderhawk [8]	Grand Rapids, Itasca County	213	169	Yes
US Steel Keewatin, Keetac Expansion [9]	Keewatin, Itasca and St. Louis Counties	125	39	Yes
United Taconite Green Production Project [14]	Forbes, St. Louis County	35	35	No [14]
Total Increase		**3,060**	**6,447**	
Decreases				
Minnesota Power – Taconite Harbor Energy Center Unit 2, emission control modifications for SO_2, NO_x and mercury [10], [12]	Schroeder, Cook County	-1,549	-1,149	
Minnesota Power – Laskin Energy Center Unit 2 NO_x reductions [12]	Hoyt Lakes, St. Louis County	-143	-1,381	
Minnesota Power – Boswell Energy Center Unit 3 [12]	Cohasset, Itasca County	-11,952	-9,683	
US Steel Minntac [12]	Mtn. Iron, St. Louis County	n/a	-7,624	
Hill Wood Products [15]	Cook, St. Louis County	3	-113	
Northshore Mining Company: BART Reductions [12]	Silver Bay, Lake County	-583	-1,159	
United Taconite BART Reductions [12]	Forbes, St. Louis County	-2240	n/a	
Total Decrease		**-16,464**	**-21,109**	
Difference Between Increases and Decreases		**-13,404**	**-14,662**	

Updated June 2010; updated September 2010:

[1] Emission estimates (Phase I and Phase II) based on emissions used in the air quality analysis in support of the draft EIS, website: http://www.netl.doe.gov/technologies/coalpower/cctc/EIS/mesaba_pdf/Mesaba_DEIS_Appx_B.pdf , accessed on November 29, 2008. Updated for Mesaba Final EIS dated November 2009. http://www.netl.doe.gov/technologies/coalpower/cctc/ccpi/bibliography/demonstration/adv-gen/ccpi_mesaba.html , accessed on June 7, 2010.

[2] Mesabi Nugget Proposed Large Scale Demonstration Plant (LSDP): No crushing/grinding at the site; receive concentrate from off-site. Technical Support Document for MPCA Permit 13700318-001. Included in Northeast Minnesota Plan Project Tracking for MPCA SIP, version 2-01-2010.

[3] Preliminary emission estimates Barr Engineering.

[4] Baseline emissions from potential to emit in Technical Support Document for Minnesota Steel (MPCA Permit #06100067-002).

[5] Project expansion preliminary emission estimates, Barr Engineering, EI spreadsheet on 6/7/10.

[6] Northshore Mining's Furnace 5 Project: reactivating two crushing lines, nine concentrating lines, one pellet furnace (Furnace 5); new sources emissions only (MPCA Permit #07500003-003).

[7] PolyMet Mining's Proposed Facility: crushing/grinding of ore, reagent and materials handling, flotation, hydrometallurgical processing. Emission estimates from Barr Engineering report dated November 2008 *Stationary and Mobile Source Emission Calculations for the NorthMet Project –Combined Report (RS57)*, submitted to MNDNR.

[8] Net Emission Increase from Blandin Project Thunderhawk MPCA Permit #06100001-009 No change in emissions for -010 or -011.

[9] U. S. Steel Keewatin, Keetac mine expansion and restart of taconite processing line – preliminary emission calculations, Barr Engineering. Submitted to MPCA 12/3/08 on CD.

[10] Facility shutdown. Emission reduction estimate based on average emissions for last five years of operation from MPCA emission inventory database.

[12] Emission estimates provided by MPCA from the "Northeast Minnesota Plan Emission Tracking Spreadsheet" 2-02-2010.

[13] Permit 01700002-010 TSD Table 2 EAW/AERA Applicability – Maximum Emission Changes associated with BLS Project (tpy) Preliminary net emission change estimates from draft EAW dated 7/1/2008. Plant expansion, new paper machine, new boiler.

[14] United Taconite's Green Production Project involves fuel changes and improvements to the concentrator and the Line 1 pellet plant to increase pellet production and was a Prevention of Significant Deterioration (PSD) minor project. Because it was a PSD minor project, specific considerations for BACT/MACT were not required. However, the Line 1 pellet plant has an existing wet scrubber to control particulate and SO_2 emissions. Emission estimates are taken from the "Application for a Major Permit Amendment" dated July 18, 2008 (Updated April 8, 2010), Tables 12e, 12d and 12b. Permit Number 13700113-005 authorizing the project was issued on August 19, 2010.

[15] Proposed major modification, public notice emission summary and draft TSD posted May 21, 2010 for public comment on Air Emission Permit No. 13700030-003.

[16] Abbreviations:

tpy = tons per year
BACT = Best Available Control Technology
MACT = Maximum Achievable Control Technology
SO_2 = sulfur dioxide
PM_{10} = particulate matter less than 10 micrometers in size
NOx = nitrogen oxides
n/a = not applicable

Existing northeastern Minnesota emissions were compared to the planned emissions (from Table 5.2-1) and summarized in Table 5.2-2. The comparison shows that acid deposition emissions can be expected to decline in the range of a quarter to a third from the existing conditions, if the planned projects go into effect. This overall reduced cumulative effect is in large part attributed to the planned emissions changes at the Minnesota Power Boswell Energy Center Unit 3.

Table 5.2-2. Acid Deposition Emissions from Cumulative Local (Northeastern Minnesota) Existing and Planned Projects

	Existing (2007 Six-County) Emissions (tpy)	Planned Emissions (tpy)	Net Planned Emissions (Increases plus Decreases) (tpy)[1]	Difference Between Existing and Net Planned
SO_2	40,386	3,060	-13,404	-33%
NO_x	53,090	6,447	-14,662	-28%

[1] See Table 5.2-1 and *Cumulative Impacts Analysis; Minnesota Iron Range Industrial Development Projects; Assessment of Potential Ecosystem Acidification Cumulative Impacts in Northeast Minnesota, Version 2* (Barr 2010), Table 1.1 for details.

5.2.2.3 Comparison of Statewide and Cumulative Local Acid Deposition Emissions

Statewide SO_2 emissions have decreased from approximately 140,000 tons/yr in 1994 to 129,000 tons/yr in 2008. Of the total 2008 SO_2 emissions, 102,000 tons/year (79 percent) came from point sources. Planned projects estimated SO_2 emissions increases of 3,060 tons/year (Table 5.2-1) represent approximately three percent of statewide SO_2 point source emissions. Incorporating local planned projects decreases in SO_2 emissions provides a reduction of 13 percent from 2008 statewide point source SO_2 emissions.

Statewide NO_x emissions were estimated to be 391,000 tons/year in 2008. Approximately 33 percent of the total was from point sources, and approximately 34 percent was from vehicle exhaust. Point source NO_x emissions declined from approximately 150,000 tons/year in 2002 to 129,000 tons/year in 2008, with most of the reduction occurring between 2005 and 2008.

Planned projects estimated NO_x emissions increases of 6,447 tons/year represent approximately five percent of statewide NO_x point source emissions. Incorporating local planned projects decreases in NO_x emissions provides a reduction of 11 percent from 2008 statewide point source NO_x emissions.

5.2.2.4 Potential Effects on Ecosystem Acidification

The data presented show an expected net decline in acid deposition emissions from cumulative sources in northeastern Minnesota by 2015. These data cannot say where the northeastern Minnesota emissions would deposit on the landscape or exactly how deposition would translate in ecosystem effects as a result of the variables related to mechanisms of action. Long distance emissions sources which could have the potential for depositing in northeastern Minnesota also were not considered.

It is reasonably safe to conclude that no significant adverse effect on ecosystems as a whole would be likely from the acid deposition emissions evaluated. This is principally substantiated by the projected decreases in cumulative local emissions by up to a quarter (SO_2) or third (NO_x) over existing conditions by 2015. The national network of precipitation gauges and monitoring in northeastern Minnesota continues to be in effect, and could be expected to identify any unanticipated changes in deposition. As stated earlier in Section 4.2.1, the overall trend in precipitation gauge network shows SO_4 deposition is not increasing and is correlated with a trend in declining northeastern lake SO_4 concentration. The contribution of the proposed ESMM project to acid deposition emissions, although higher than the original MSI project, is part of a larger cumulative change that is not expected to lead to adverse effects.

5.2.3 MITIGATION

Cumulative effects from acid deposition are not considered significant, and mitigation for potential effects on acid deposition and ecosystem acidification is not required. NO_x emissions are evaluated in Chapter 4.2 in accordance with air permitting requirements, and for that Essar has committed to installing an indurating furnace designed to limit NO_x emissions. Essar will also install and operate all NO_x and SO_2 emissions controls that are determined to qualify as BACT in accordance with air permit modifications for the proposed ESMM project.

5.3 Cumulative Mercury Deposition

Chapter Summary

This chapter examines the potential cumulative effects on human health of mercury emissions from multiple sources and bioaccumulation in fish. The effects of mercury emissions from just the proposed ESMM project are addressed as part of the human health risk assessment presented in Chapter 4.4.

Mercury is found at low levels in the mined rock and in the fuels and other materials used during processing. Accordingly, mercury would be emitted from process operations. Many other sources of mercury emissions other than the mine site contribute to current levels of mercury in the environment. Mercury is considered to be among the most pervasive of chemicals known as persistent, bioaccumulative, and toxic (PBT). These factors have led to elevated concentrations of mercury in many water bodies throughout the United States, including northern Minnesota. Federal and state fish consumption advisories have been established to help ensure that people consume safe amounts of fish.

The evaluation of risk presented in this chapter is organized into three principal parts.

- Section 5.3.1, Affected Environment, describes how mercury is released, transported and ultimately accumulated in fish. More specifically, it describes the emission inventory, dispersion modeling, and statistical analysis of MPCA's fish tissue dataset that was conducted to support the assessment.
- Section 5.3.2, Environmental Consequences, presents the findings of the cumulative mercury assessment. The ways in which combined emissions of sulfate and mercury relate to MMREM results are described. Other aspects of the MMREM assessment are also described.
- Section 5.3.3, Mitigation Measures, identifies actions that could be taken to assess whether future predicted fish tissue concentrations are consistent with current predictions. The types of practices identified in Chapter 4.2 that could be used to reduce mercury emissions are also provided here.

The assessment finds that existing concentrations of mercury in fish tissue in lakes near the proposed ESMM project are at levels that may cause adverse health impacts for both the recreational and subsistence consumer of locally caught fish. The amount of increase in mercury fish tissue concentrations and risks that are predicted to result from future mercury emissions from all four facilities included in this assessment ranges from 1 to 3 percent, depending on the lake and its proximity in the prevailing downwind direction from one or more of the facilities. The proposed ESMM project provides the largest contribution to the potential incremental increase for Big Sucker, O'Brien, Snowball and Oxhide Lakes (Barr, 2010a). Even with the higher rate of mining, planned emission controls are expected to maintain mercury emissions at levels equal to or below that for the original MSI project.

Regulatory Framework

The MPCA has established a federally-approved long-term plan, called a Total Maximum Daily Load (TMDL), to reduce mercury emission rates. According to the MPCA[1]:

> "Approximately two-thirds of the water impairments on Minnesota's 2006 Impaired Waters List were due to mercury. As required by the Clean Water Act, the Minnesota Pollution Control Agency (MPCA) prepared a Total Maximum Daily Load (TMDL) study that evaluated the sources of mercury and quantified the reductions needed to meet water-quality standards. The TMDL established a cap on water discharges of 24.2 lb/yr and an air emission reduction goal of 789 lb/yr."

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1 see http://www.pca.state.mn.us/index.php/topics/mercury/minnesota-s-plan-to-reduce-mercury-releases-by-2025.html?menuid=&redirect=1

A Strategy Framework for Implementation of Minnesota's Statewide Mercury TMDL has been developed by MPCA. As pertains specifically to the taconite industry, this plan establishes the following goal (MPCA, 2009, p. 14):

> *"The ferrous mining and processing industry, including the six existing taconite producers, Essar Steel, and Mesabi Nugget has set a target of reducing mercury air emissions to 210 lb/yr by 2025 from all plants collectively. This would result in an estimated reduction in mercury emissions of 631 lb/yr. However, plant-ready mercury-reduction technology does not currently exist for use on taconite pellet furnaces.[2] Therefore, achieving the mercury reduction target will initially focus on research to develop the technology in the near term and installation of mercury-emission-control equipment thereafter."*

The assessment supports these policy objectives by:

- Identifying the amount of mercury to be emitted by the proposed ESMM project,
- Estimating what effects this would have on current levels of mercury in fish tissue in lakes near the mine site, and
- Interpreting fish tissue levels in terms of potential health impacts to those who regularly consume locally caught fish.

The assessment was completed by Barr (2010a) in general accordance with MPCA (2006a) guidance. The assessment involved the following steps:

1. Estimate project related air emission rates and emission rates for other nearby facilities.
2. Apply emission rates to dispersion modeling to predict concentrations in air above designated watersheds and the amount of mercury that reaches water bodies of potential concern.
3. Determine existing mercury fish tissue concentrations by conducting statistical analysis of measured mercury concentrations for fish sampled from designated watersheds.
4. Use the MPCA Mercury Risk Estimation Method (MMREM) spreadsheet tool to calculate the incremental increase in mercury fish tissue concentrations due to the project and the incremental increase in the risks to people who consume fish from the designated lakes.

MMREM is a simplified screening model developed by MPCA to assess the effect of a new or expanded mercury emission source on fish contamination. This assessment is considered a cumulative assessment because it applies a known amount of mercury in air derived from non-local sources as a basis for understanding the relative implications of the proposed project and other nearby facilities. It therefore determines the combined effect of the proposed project related air emissions with existing sources of mercury in air.

There are no regulatory standards or criteria for interpreting the MMREM results or to guide decisions about possible mitigation needs. However, this assessment does describe the ways by which emissions are to be controlled for the proposed ESMM project, and how these controls differ from the original MSI project. Additional detail on mercury control technology for the proposed ESMM project is provided in Chapters 3.0 and 4.2.

[2] Since 2009 when this statement was crafted, activated carbon is being installed as part of the U.S. Steel Keetac Expansion project and is proposed for use in the proposed ESMM project.

Documentation for Preparing Chapter 5.3

Barr, 2011. Response to Comments on the Cumulative Impacts Analysis Estimated Mercury Air Emissions and Local Deposition and the Potential for Bioaccumulation in Fish v1, final Essar/Barr Response 2/17/2011.

Barr, 2010a. Cumulative Impacts Analysis, Estimated Mercury Air Emissions and Local Deposition and the Potential for Bioaccumulation in Fish, Version 1, Prepared for Essar Steel Minnesota LLC, December 2010.

Barr, 2010b. Mercury Control Technology Evaluation Report, Version 2, Prepared for Essar Steel Minnesota LLC, September, 2010.

Berndt, M. and Engesser, J. (2005). Mercury Transport in Taconite Processing Facilities: (I) Release and Capture During Induration, Iron Ore Cooperative Research Final Report, Minnesota Department of Natural Resources, Division of Lands and Minerals, August 15.

Minnesota Pollution Control Agency (MPCA), 2010. Bruce Monson, personal communication.

Minnesota Pollution Control Agency (MPCA), 2009. A Strategy Framework for Implementation of Minnesota's Statewide Mercury TMDL, October, 2009.

Minnesota Pollution Control Agency (MPCA), 2006a. MPCA Mercury Risk Estimation Method (MMREM) for the Fish Consumption Pathway (Local Impacts Assessment), Version 1.0, http://www.pca.state.mn.us/publications/aq9-16.pdf, December 2006.

Minnesota Pollution Control Agency (MPCA). 2006b. Mercury Speciation Profiles. Email from Ms. Anne Jackson at MPCA to Mr. Cliff Twaroski at Barr Engineering Company, with attached spreadsheet. October 11, 2006.

Persell, 2004. Letter from J. Persell to M. Watkins, January 19, 2004.

5.3.1 AFFECTED ENVIRONMENT

5.3.1.1 Total Mercury Emissions

Mercury exists in ambient air as a result of numerous emissions associated with human activity. The MPCA has determined that background concentrations throughout Minnesota are fairly constant. This suggests that most mercury in ambient air comes from distant sources. The MMREM spreadsheet assumes that mercury in air deposits onto soil and water throughout the state at an average rate of 12.5 $ug/m^2/year$ (MPCA, 2006a).

Mercury will also be emitted from existing and proposed mine site operations. Stack emissions from the pellet plant are the primary source of predicted emissions. Pellet plant stack emissions for the original MSI project were estimated to be 66 lbs/year, while emissions from the pellet plant for the proposed ESMM project are estimated to range from 22 lbs/year at 80 percent removal efficiency to 111 lbs/year at zero percent removal efficiency. Note that the emission inventory, as reported in Table 4.3-1, indicates a total facility mercury emission rate of 104 lbs/year based on operating 24 hours per day, 365 days per year; however, the level of control efficiency assumed in the emission inventory is unknown.

While pellet production would increase from 4.1 to as much as 7.0 million metric tons per year (see Chapter 3.0 for explanation) for the proposed ESMM project, the project adds an activated carbon injection step to the indurating furnace air pollution control system to reduce mercury emissions. An additional difference between the original MSI project and the proposed ESMM project is that the stack height for the pellet plant has been approximately doubled to 100 meters high. The higher stack is expected to reduce the amount of mercury that deposits locally. See Chapter 3.0 for additional details on the proposed air pollution control system.

Application of activated carbon injection on a taconite pellet furnace is a new technology, so there is uncertainty about the degree of control that can be achieved. While assessment of similar technologies used in power plants indicates removal efficiencies may be as high as 80 percent, removal efficiencies of 30 percent have been used to assess emissions, such as at the U.S. Steel Keetac Expansion project pellet plant. Likewise, the assessment for the proposed ESMM project assumes a likely worst case removal efficiency of 30 percent, which equates to a mercury emission rate of 78 lbs/year from the pellet plant (Barr, 2010a). This assumption is more conservative than the 50 percent worst case assumption presented in the Mercury Control Technology Evaluation Report (Barr, 2010b). However, data from taconite plants employing the kind of straight grate pollution control system included in the proposed ESMM project and potentially involving different concentrations of reactive components indicate mercury removal efficiency may be as low as 10 percent (Berndt & Engesser, 2011).

The DRI plant and steel mill would also emit mercury, and were included as sources in the air emission inventory (December 17, 2010; revised January 14, 2011) and modeling supporting this assessment. For the original MSI project, the maximum mercury emission rate from all sources used for assessing mercury accumulation in fish was estimated to be 81 lbs/year. For the proposed ESMM project, using the 30% removal scenario for the pellet plant, total mercury emissions are estimated to be 93 lbs/year (Barr, 2011), distributed among the three major sources as follows:

- Pellet plant (78 lbs/year, 30% removal efficiency model)
- DRI plant (14 lbs/year)
- Steel mill (1 lbs/year; from the melt shop and rolling mill)

Other sources of mercury emissions are also identified in Table 3-7 of the Mercury Control Technology Evaluation Report (Barr, 2010b) as follows:

- Mining/Crusher (0.08 lbs/year)
- Concentrator (0.03 lbs/year)
- Tailings basin (0.51 lbs/year)

While mining/crusher, concentrator, and tailings basin emissions were not included in this assessment, the relatively small amounts involved would not be expected to have a significant impact on the conclusions of this assessment.

Three additional facilities that emit mercury exist within 25 kilometers of the proposed ESMM project (see Figure 5.3-1), and were therefore included in this cumulative assessment in accordance with MPCA (2006) guidance. Laurentian Energy is a power plant that is estimated to emit 7 lbs/year. The proposed U.S. Steel Keetac Expansion project is a similar iron mine and taconite processing facility that was estimated to release 64 lbs/year. The proposed Excelsior Energy power plant is estimated to release 54 lbs/year.

5.3.1.2 Mercury Speciation, Transport, and Deposition in Watersheds

The overall objective of this environmental effects assessment is to determine the potential impacts to mercury concentrations in fish tissue. The approach is to analyze mercury deposition rates into lakes surrounding the proposed ESMM project and three other facilities (Figure 5.3-1). The following eight lakes, also shown on Figure 5.3-1, were targeted for this assessment:

- Snowball Lake
- Oxhide Lake
- Big Sucker Lake
- Coons Lake
- Horsehead Lake
- Kelly Lake
- O'Brien Lake
- Swan Lake

All of these lakes are located within 20 kilometers of the proposed ESMM project. The lakes were selected to provide an evaluation of the nearest fishable lakes at various directions from the proposed ESMM project and at locations between the site and other local mercury sources. The lakes range in size from 17 acres (Kelly Lake) up to 2,470 acres (Swan Lake). Watershed areas range from 135 acres (Horsehead Lake) up to 71,000 acres (Swan Lake) (Barr, 2010).

Mercury emission rate data at various locations were used for the modeling to predict concentrations of mercury in air at the targeted lakes. AERMOD, EPA's preferred air dispersion model for addressing short-range concentration impacts, was used to predict annual average air concentrations of mercury at points on a grid on and around the mine site boundary. Modeling was performed for total mercury, without considering loss of mercury with distance due to deposition (Barr, 2011b). While this approach leads to slightly high estimates of mercury concentration in air, it allows deposition to be assessed using the MMREM spreadsheet model.

The AERMOD grid includes parts of the Class II grid from both the proposed ESMM project and the Keetac Expansion Project, respectively, and includes nodes placed at distances to provide areal coverage of targeted nearby lakes and watersheds. Grid node spacing on the Essar and Keetac property boundary was 50 meters. In the 15 x 10 km "block", grid node spacing is 500 meters. Outside of the 15 x 10 km "block", polar grid nodes (converted to Cartesian grid receptors) were extended out to 25 kilometers. Specific nodes were also placed over the surface of each targeted lake (Barr, 2011b). This pattern of nodes and the resulting total mercury concentrations in air are shown on Figure 5.3-1.

The mercury air concentration over the surface of Big Sucker, Horsehead, Kelly, Coon, Snowball, and Oxhide Lakes was estimated from one node. For Swan Lake and O'Brien Lake, the maximum modeled concentration from the three nodes placed on the respective lakes was used. All lakes except Swan and O'Brien were judged by Barr to have relatively small watersheds. For lakes with small watersheds, average air concentrations over the terrestrial portion would not be expected to vary significantly from the concentrations over the waterbody. For these lakes, the air concentration over the water surface for these lakes was also used for the terrestrial watershed. To account for greater potential variability in mercury air concentrations across the larger watersheds of Swan and O'Brien Lakes, the average mercury air concentration over the terrestrial watershed was calculated using all of the AERMOD nodes that were located within the watershed boundary. The lakes, grid points, and watershed boundaries are shown in Figure 5.3-1. For portions of the watershed not covered by the grid, such as the area within the Keetac and ESMM project boundaries, the average modeled concentration along the mine site boundary was calculated. GIS methods, including overlaying of raster grid files and a "zonal statistics" tool were used to calculate the average concentration on the respective boundaries and the overall average concentration across the watershed areas for Swan Lake and O'Brien Lake, respectively (Barr, 2011b).

Once the total mercury concentration in air over targeted watersheds is determined, the MMREM model requires an assessment of how much of the mercury in air settles into the water. Mercury exists in several different chemical forms, often called species, which strongly control how it can move through the environment. This assessment assigns different deposition rates (i.e. the degree to which it settles onto soil or water) to the following three commonly recognized species of mercury in air:

- Elemental mercury (Hg0): This form of mercury can be transported long distances, having an average residence time in the atmosphere of several months to a year or more. This form of mercury has an atmospheric deposition rate that is very slow, perhaps 100 times slower than oxidized mercury, but not zero. In the MMREM modeling conducted for this project, 93 percent of the total mercury is estimated to be elemental mercury based on stack testing conducted for taconite facilities (MPCA, 2006b). Data for coal fired power plants using a dry conventional pollution control system similarly indicates that 93 percent of emitted mercury is elemental mercury (Barr, 2010b). The MMREM model estimates a relatively slow deposition rate for elemental mercury of 0.01 cm/second.

- Oxidized mercury (Hg2+): This is a water-soluble form of mercury that has a relatively high potential to be captured by air pollution control systems. If oxidized mercury is emitted from a facility, the propensity for the oxidized mercury to associate with water and particles tends to result in a significant proportion of oxidized mercury being deposited relatively close to an emission source, typically within 100 kilometers (62 miles) of the emission source. In the MMREM modeling conducted for this project, 6 percent of the total mercury is conservatively estimated to be oxidized mercury based on stack testing data for taconite facilities indicating that 5 percent of total mercury is emitted as oxidized mercury (MPCA, 2006b). Data for coal fired power plants using a dry conventional pollution control system similarly indicates that 6 percent of emitted mercury is elemental mercury (Barr, 2010b). The MMREM model estimates a relatively high deposition rate for oxidized mercury of 1.10 cm/second, which is 110 times faster than estimated for elemental mercury. Since this form of mercury has the most rapid deposition rate, it is important to not underestimate this fraction when conducting a conservative, screening-level assessment of mercury accumulation in fish.

- Particle-bound mercury (Hgp): This form of mercury also has a relatively high potential to be captured by air pollution control systems. If particle-bound mercury is emitted from a facility, there also is a tendency for coarse particles (greater than 2.5 microns) to be deposited locally within 100 kilometers of a facility and for fine particles (less than 2.5 microns) to be transported further. In the MMREM modeling conducted for this project, only 1 percent of the total mercury is estimated to be particle-bound mercury based on stack testing data for taconite facilities (MPCA, 2006b). Again, data for coal fired power plants using a dry conventional pollution control system similarly indicates that 1 percent of emitted mercury is in particulate form (Barr, 2010b). The MMREM model estimates a relatively low deposition rate for particulate mercury of 0.05 cm/second, which is five times faster than estimated for elemental mercury.

The results of the modeling, shown on Figure 5.3-1 identify highest mercury concentrations closest to both the ESMM and Keetac facilities. Concentrations decrease with distance from these facilities, with higher concentrations dispersed in the direction of prevailing winds. The wind rose indicates that the most frequent and strongest winds come from a northeasterly and southeasterly direction. The wind rose uses wind data collected at the Hibbing Airport.

5.3.1.3 Mercury Methylation and Bioaccumulation of Mercury in Fish

Many variables can affect the degree to which mercury in water bioaccumulates in fish tissue. For the general pathways of mercury transport in the environment, refer to Illustration 4.3-2. The form of mercury deposited, water quality characteristics, sediment quality characteristics, types of food available to fish, and the types and ages of fish species can influence the relationship between the amount of mercury deposited and resulting fish tissue concentrations.

Certain general principles are known to influence the degree to which mercury bioaccumulates in fish. Mercury deposited in lake sediment and wetlands can be transformed into methylmercury by bacteria, especially bacteria that consume sulfate, known as sulfate-reducing bacteria. Methylmercury readily bioaccumulates in the food chain and accounts for nearly all the mercury present in fish.

Methylmercury production in aquatic ecosystems depends on the presence of multiple reactants, in particular sulfate and organic matter. Changes in concentrations of such reactants can limit the production of methylmercury and therefore the uptake of mercury into fish. Due to the importance of sulfate-reducing bacteria in mercury methylation, it may be possible to obtain changes in methylmercury formation by changes in sulfate concentrations. One source of sulfate is project-related emissions of sulfur dioxide in air. Swan Lake may also receive sulfate from dewatering flows permitted for the original MSI project from Pits 1, 2 and 5, and minor amounts from the tailings basin deep seepage losses (Barr, 2010a). It is important to note that even when mercury and sulfate deposition are uniform, the efficiency of mercury methylation and delivery to surface water varies significantly across the landscape because of variation in hydrology and conditions that favor the sulfate-reducing bacteria that methylate mercury. Consequently, the degree to which sulfate deposition affects methylation and bioaccumulation varies between lakes.

The MMREM model seeks to avoid such complexities in predicting fish tissue concentrations by relying upon actual measurements of mercury levels in fish tissue. The MPCA regularly samples fish from lakes throughout Minnesota and tests the edible portion of the meat for mercury. The sampling program targets Northern Pike and Walleye species because they are predator species that have greater propensity to accumulate mercury through the food chain than do other common sport fish in Minnesota. Since background concentrations of mercury in air are fairly constant throughout the state, comparing the ratio of background concentrations in air to lake-specific concentrations in fish provides a lake-specific proportionality constant. This proportionality constant can be used to estimate how much fish tissue concentrations will increase with additional mercury in air associated with the proposed project and other nearby projects, provided that other variables influencing methylmercury production are unchanged. This assumption of a lake-specific proportionality constant is also used by the MPCA and other regulatory agencies (e.g., USEPA) for TMDL studies.

Barr obtained fish tissue mercury concentration data for targeted lakes from the MPCA in April 2010 (MPCA, 2010a). An adequate data set was available for Snowball (21 measurements), Oxhide (10 measurements), Swan (9 measurements), and O'Brien Lakes (13 measurements) to calculate a 95 percent upper confidence limit (UCL) of the mean fish tissue concentration. Reported fish lengths range from 12 to 32 inches. In many cases the fish tissue concentration and fish lengths are the average for multiple fish, with sometimes as many as thirteen fish sampled and mixed into a single composite sample for mercury analysis.

Fish tissue concentration data were not available for Big Sucker, Coons and Kelly Lakes. In addition, there is not enough data for Horsehead Lake (1 measurement) to calculate a statistically valid 95 percent UCL of the mean. For these four lakes, a 95 percent UCL of the mean fish tissue concentration was calculated based on fish tissue data from eleven lakes in the Nashwauk area. This approach provided 114 measurements collected since 1980 that could be used to estimate background fish tissue concentration.

MPCA review of the methodologies used to determine background fish tissue concentrations identified three technical issues that contribute to uncertainty in the assessment: addressing statistical outliers, using fish tissue data more than 10 years old, and addressing composite data. These issues are addressed in Appendix D and summarized in the Section 5.3.2.3, Uncertainty in the Mercury Deposition Assessment (see "Background fish tissue concentrations" bullet).

5.3.2 ENVIRONMENTAL CONSEQUENCES

The MMREM spreadsheet tool was used to calculate how much fish tissue levels might change under the proposed ESMM project and to calculate how much this translates into risks associated with consuming fish caught in local waters. The calculations make certain assumptions about how much fish is consumed and the toxicity of mercury.

5.3.2.1 Exposure and Toxicity Assumptions

The MMREM assesses both a recreational angler and a subsistence angler. A recreational angler is assumed to consume 30 grams of fish per day. This value is based on survey data of the amount of fish eaten by anglers in Wisconsin and Ontario. The amount of freshwater fish consumed by anglers varies from none to more than one meal every day. Thirty grams per day is equivalent to an average of one half-pound meal of freshwater fish per week, or 26 pounds a year (MPCA, 2006a). Since the fish tissue data are for the predatory fish that have a greater tendency to bioaccumulate mercury, i.e. Northern Pike and Walleye, the assumption is that a recreational fisherman is consuming these species.

A subsistence/tribal angler is assumed to consume 224 grams of Northern Pike or Walleye per day. Minnesota does not have a recommended fish consumption rate for subsistence populations, although Native American Tribes, which have subsistence anglers and consumers, may have site-specific information and recommendations. For someone living a subsistence lifestyle, EPA suggests using 142 grams/day to represent the uncooked weight intake of freshwater/estuarine finfish and shellfish. This would equate to eating about a half-pound of fish 4 to 5 times a week (MPCA, 2006a). There are no known studies of actual consumption rates in Minnesota or in the area of the proposed ESMM project (Barr, 2010a). However, this assessment is consistent with past assessments that have relied on a fish consumption value of 224 grams/day as an estimate of consumption rates for present Native Americans subsistence lifestyles (J. Persell letter to M. Watkins, January 19, 2004).

EPA risk assessment methodology is used to estimate the methylmercury hazard quotient for fish consumption. This methodology assumes there is a dose, called a reference dose (RfD), below which exposure is not expected to cause adverse effects. The reference dose for methylmercury is 1E-04 milligram of methylmercury consumed per kilogram of body weight per day. A number of adverse health effects associated with exposure to methylmercury have been identified in human and animal studies. The nervous system is considered to be the most sensitive target organ for which there are data suitable for derivation of an RfD. The RfD established by EPA is intended to protect against methylmercury-related developmental neurotoxicity. More simply and specifically stated, the most sensitive effects observed in studies to date have involved subtle effects on brain development in children as a result of exposure in the womb as a fetus.

5.3.2.2 MMREM Results

The results of cumulatively evaluating background concentrations and multiple proposed projects using the MMREM assessment are presented in Table 5.3-1 (from Barr 2010a). Please refer to Chapter 4.3 for the MMREM assessment results for project-specific assessment of the proposed ESMM project.

Existing concentrations of mercury in fish tissue, expressed as the 95% upper confidence limit of the mean, are reported by Barr (2010a) to range from 0.3 to 0.6 mg/kg across the various lakes included in this assessment (Table 5.3-1). The amount of increase predicted to result from future mercury emissions from all four facilities included in this assessment ranges from 1 to 3 percent, depending on the lake and its proximity in the prevailing downwind direction from one or more of the facilities. The proposed ESMM project provides the largest contribution to the potential incremental increase for Big Sucker, O'Brien, Snowball and Oxhide Lakes (Barr, 2010a). However, although the project proposes a 60 percent increase in pellet plant capacity, the mercury control technology is expected to maintain total mercury emissions approximately at or below emission levels estimated for the original MSI project (refer to mercury emission rates in Table 4.3-1, hazardous air pollutants).

Table 5.3-1. Cumulative Effects of Mercury Deposition in Area Lakes.

Lake	Fish Tissue Concentrations			Hazard Quotients***			
				Subsistence/Tribal Angler		Recreational Angler	
	Existing* (mg/kg)	Predicted Increase** (mg/kg)	Predicted Increase (%)	Existing	Predicted Increase	Existing	Predicted Increase
Big Sucker Lake	0.47	0.008	2%	16	0.3	2	0.04
Coons lake	0.47	0.006	1%	16	0.2	2	0.03
Horsehead Lake	0.47	0.007	2%	16	0.3	2	0.03
Kelly Lake	0.47	0.013	3%	16	0.4	2	0.06
O'Brian Lake	0.59	0.009	2%	20	0.3	3	0.04
Swan Lake	0.42	0.009	2%	14	0.3	2	0.04
Snowball Lake	0.6	0.006	1%	21	0.2	3	0.03
Oxhide Lake	0.3	0.005	2%	10	0.2	1	0.02

*The 95% upper confidence limit of the mean of measured fish tissue data available since 1980.

**Predicted increase associated with all four projects included in cumulative assessment.

***Unitless ratio value. Values below 1.0 indicate little to no potential for adverse effects.

The hazard quotients (HQ) presented in Table 5.3-1 are an expression of the potential for adverse toxic effects, which is calculated as:

$$HQ = \frac{Amount\ Consumed\left(\frac{\frac{mg}{kg}}{day}\right)}{RfD\left(\frac{\frac{mg}{kg}}{day}\right)}$$

A hazard quotient value of less than 1.0 indicates that the amount of mercury consumed is below the level that is known to cause adverse toxic effects in some people. Consuming mercury at levels below the RfD would be expected to cause little or no adverse effects. Hazard quotients results are generally considered meaningful at one significant figure (e.g. 2 rather than 2.3) due to the inherent limitations and accuracy of the risk assessment process.

The hazard quotient results presented in Table 5.3-1 indicate that consumption of fish for both the recreational and subsistence consumer in the amounts described in Section 5.3.2.1 may cause adverse health effects under both existing and proposed conditions. The existing hazard quotients for the recreational angler range from 1 to 3, while the existing hazard quotients for the subsistence/tribal consumer range from 10 to 20, depending on the lake. These hazard quotients are based on existing fish tissue concentrations as determined by measurements of mercury in fish tissue. The incremental increase in hazard quotients that is predicted to occur from future mercury emissions associated with the four facilities included in this cumulative assessment range from 1 to 3 percent, the same as it does for fish tissue concentrations.

5.3.2.3 Uncertainty in the Mercury Deposition Assessment

Uncertainty is inherent to any assessment of risk (refer to Section 4.4.3.2.2 for more information about risk assessment uncertainty). Every variable used in this assessment to quantitatively determine mercury deposition and risk involves some level of variability or uncertainty. The following assumptions are deemed particularly important for understanding the accuracy and precision of the quantitative results:

- **Emission rates**. Mercury emissions for the proposed ESMM project are based on worst case assumptions about the efficiency of the proposed mercury control technology. Whereas the mercury control efficiency was assumed to be 30 percent for the pellet plant stack emission, removal efficiencies of as much as 80 percent may be possible with the new activated carbon control technology. Conversely, past work at taconite plants showed that scrubbers at straight grates removed only about 10% of the mercury. Even with the higher rate of mining, Essar expects planned emission controls to maintain mercury emissions at levels equal to or below that estimated for the original MSI project.

- **Sulfate effects on bioaccumulation**. The MMREM methodology assumes that the future proportionality constant between air and fish tissue concentrations of mercury will remain constant. Many variables associated with water quality, sediment quality, food availability, and composition and ages of fish could influence the proportionality constant. Project-related releases could potentially lead to increases in sulfate concentrations in area lakes, which in turn could potentially increase methylation rates. According to Barr 2011b, considerable uncertainty exists regarding the potential magnitude of this effect on fish tissue concentrations in the study area.

- **Background fish tissue concentrations**. Certain statistical methods used by Barr to determine concentrations of mercury in fish may have underestimated actual fish tissue concentrations. The approach used omitted higher measurements (fish lengths), and did not assess the implications on the statistics of using data more than 10 years old and data based on composite sampling. The degree to which these differences in methodology affect the incremental change in fish tissue concentration and risk is likely small in comparison to the fish tissue concentrations and risk associated with background sources of mercury. See Appendix D for further explanation.

- **Fish consumption rates**. Consumption rates of locally caught fish vary considerably. Local fish consumption behavior has not been studied (Barr, 2011b); however, it is expected that few if any individuals consume fish caught in the study area in the amounts used in this assessment. This local consumption practice does not diminish, however, ongoing federal and state efforts to reduce mercury emissions to levels that minimize adverse health impacts.

- **Methylmercury toxicity**. The reference dose (RfD) used to determine toxicity from exposure to methylmercury was derived by the EPA from studies that observed neurological effects in young children as a result of prior exposure to methylmercury by women during pregnancy. This is the most sensitive type of adverse effect yet observed. Fetuses, nursing infants, children under age 15, and people who rely on fish for much of their diet are considered to be most at risk from methylmercury, which can hamper normal development of the central nervous system. However, all individuals are not equally sensitive to toxicity from exposure to mercury, and there are many other adverse effects associated with higher levels of exposure. In adults, exposure to methylmercury at sufficiently high levels can result in damage to the nervous system and other organs. It is important to recognize that the magnitude of any toxic effect is not necessarily proportional to the increase in exposure. Accordingly, a hazard quotient of 4 does not imply twice as much risk as a hazard quotient of 2.

5.3.3 MITIGATION

As described at Section 4.2.3, regarding mitigation measures for air emissions, impacts to air quality resulting from the proposed ESMM project are estimated to be less than current regulatory limits. Before proceeding with construction of the proposed ESMM project, Essar would be required to obtain a revised air quality permit from MPCA that would include enforceable emissions limits intended to achieve regulatory limits. The assessment of mercury in this chapter is not directly tied to any specific regulatory requirement. Rather, it serves as an informational tool to achieve broader policy objectives pertaining to mercury in the environment, and more specifically, the previously stated goals established for the taconite industry as part of the statewide mercury TMDL program (see Regulatory Framework).

Efforts to control risks associated with mercury in fish can involve two different approaches: 1) additional site-specific assessments can be performed to ensure that future predicted mercury fish tissue concentrations remain at or below the concentrations predicted, and 2) actions can be taken to reduce emissions from current predicted amounts.

5.3.3.1 Additional Site Assessment Options

While there are several variables that could be further investigated to reduce the uncertainty associated with this assessment, as a practical matter monitoring mercury emissions and continued monitoring of mercury in fish tissue would allow for comparison of actual future conditions with the predictions of this assessment. Mercury may be measured in air at the points of release or in ambient air at potential worst case locations identified by AERMOD modeling conducted for this assessment. Also, periodic reassessment of mercury concentrations in fish tissue would enable comparison of future conditions with the predictions of this assessment. Increases of 1 to 3 percent predicted by this assessment would likely be within the measurement error of any future monitoring such that no significant increase in mercury concentrations should be measured. Significant increases observed in either of these measurement programs could indicate the need for an adaptive management strategy. A first step of the strategy would be to identify any cause for increases in fish tissue concentrations. As reviewed by this assessment, many variables other than mining related emissions can influence mercury accumulation in fish tissue.

5.3.3.2 Emission Reduction Measures

The main source of emissions is the proposed new indurating furnace for the pellet plant. As described in Sections 3.3.2 and 4.2.2.3.2, Emissions Controls, and described in the Mercury Control Technology Evaluation Report (Barr, 2010b), Essar has evaluated alternative technologies to control mercury emissions from the proposed new indurating furnace. The proposed ESMM project would include an activated carbon injection system to reduce mercury emissions. While this assessment assumes only 30 percent control efficiency, Essar expects to achieve at least 50 percent mercury emissions reduction. A 50 percent control efficiency would produce 70 lbs/year of total mercury emissions, or 11 lbs/year less than the total mercury emissions estimate of 81 lbs/year reported in the MSI FEIS. Accordingly, even though taconite pellet production rates would increase from 4.1 to as much as 7.0 million metric tons per year for the proposed ESMM project (see Chapter 3.0 for explanation), the pellet plant is estimated to emit about 55 lbs/year of mercury compared with 66 lbs/year estimated for the original MSI project (Barr, 2010a).

Mercury emissions for other sources would remain the same or increase slightly in proportion to the increased rate of mining. Section 4.2.2.3.2, Emissions Controls, identifies additional emissions control technologies for the proposed ESMM project. A subset of these that could also reduce mercury emissions are:

- Clean fuels (natural gas) for SO_2, NO_x, particulate and HAPs;
- Good combustion practices for CO, VOC, particulate and HAPs;
- Enclosures with fabric filters or wet scrubbers for particulate and HAPs;
- Absorber / wet scrubber for SO_2, fluorides, and sulfuric acid mist;
- Best practices for fugitive dust control via a fugitive dust control plan.

5.4 Cumulative Climate Change

Chapter Summary:

This section addresses greenhouse gas (GHG) emissions associated with the proposed ESMM project. Proposed processes, production rates, fuel alternatives, energy efficiency measures, and carbon sequestration and offsets inform the potential environmental consequences of the proposed ESMM project.

Project Alternatives Relevant to this Issue (see Chapter 3.0):

- Proposed Action (the proposed ESMM project) and associated Technology Alternatives
- No Action Alternative (the original MSI project)

Regulatory Framework:

- See Section 5.4.1.1 Climate Change Policy

Cross-Referenced Chapters:

- Chapter 3.0 Proposed Action and Alternatives
- Chapter 4.2 Air Quality
- Appendix B. GHG Comparisons for Operational Items

Key Issues:

- Reporting information available from governmental and scientific sources on climate change.
- Evaluating potential environmental effects due to climate change.
- Evaluating how climate change may potentially affect the proposed ESMM project.
- Projecting potential environmental impacts associated with increases in GHG emissions from the original MSI project.
- Evaluating GHG emissions reductions and mitigation measures considered for the proposed ESMM project.

Documentation to Prepare Chapter 5.4:

Barr Engineering. 2010a. Climate Change Evaluation Report. September 2010.

Barr Engineering. 2010b. Air Pollution Control Alternatives Analysis. November 2010.

Center for Climate Strategies. 2008. Minnesota Greenhouse Gas Inventory and Reference Case Projections 1990-2025. Office of the Governor of Minnesota. March 2008.

Council on Environmental Quality. 2010. Memorandum for Heads of Federal Departments and Agencies: Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions.

Eilers, J.M. and J.A. Bernert. 1997. Temporal Trends and Spatial Patterns in Acid-Base Chemistry for Selected Minnesota Lakes. Report to the Minnesota Pollution Control Agency.

Hellmann, et. al. 2010. Climate change impacts on terrestrial ecosystems in metropolitan Chicago and its surrounding, multi-state region. Journal of Great Lakes Research, 36(74-85). Elsevier.

IPCC. 2007a. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning (eds.)].

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Luyssaert, S., et al. 2008. Old Growth Forests as Global Carbon Sinks. Nature 455: 213-215.

Midwestern Greenhouse Gas Reduction Accord (MGGRA). November 15, 2007. http://www.midwesternaccord.org/midwesterngreenhousegasreductionaccord.pdf

MNDNR. 2010. U.S. Steel Keetac Taconite Mine Expansion Project Final Environmental Impact Statement.
http://www.dnr.state.mn.us/input/environmentalreview/keetac/index.html

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Union of Concerned Scientists. 2003. Great Lakes Communities and Ecosystems at Risk.

U.S. EPA. 2009. Climate Change – Science: State of Knowledge. http://www.epa.gov/climatechange/science/stateofknowledge.html#ref September 2009.

U.S. Global Change Research Program. 2010. Regional Climate Change Impacts Midwest. USGCRP; http://globalchange.gov/publications/reports/scientific-assessments/us-impacts/regional-climate-change-impacts/midwest

Warner, James. 2008. Memorandum to Affected Air Permit Applicants on Completion of a Greenhouse Gas Emissions Evaluation. MPCA July 16, 2008.

The MSI FEIS did not address climate change (CC), but did account for GHGs. Since 2006 the regulatory basis for addressing climate change in accordance with state environmental review guidance and rules has changed. The SEIS Preparation Notice stated that this chapter would discuss the background issue of CC, extrapolation of potential environmental effects at the state level, and potential effects to natural resources. Nonpermit-related recommendations are considered in accordance with MPCA guidance, including optimizing energy efficiency of processes throughout the facility, and carbon sequestration.

MSI GHG emissions are based on types of pellets and capacities described in detail in Chapter 3.0, Table 3-1. The GHG emissions were calculated as part of the Emissions Inventory methodology described and reported in Chapter 4.2, Air Quality. Direct (scope 1) and indirect (scope 2) GHG emissions from the original MSI project were calculated using revised methods to make comparable the emissions estimates for the original MSI project to the proposed ESMM project. This includes assessment of changes in GHG emissions and the project energy and GHG efficiency, both of which are subject to MPCA-approved guidance. The MSI FEIS evaluated impacts related to emissions of criteria and toxic air pollutants but did not address emissions of GHGs such as carbon dioxide, methane, and nitrous oxide. The summary calculations on GHG emissions are reported herein.

5.4.1 AFFECTED ENVIRONMENT

The affected environment includes a summary of environmental policy in climate change science (Section 5.4.1.1) and a summary of the science (Section 5.4.1.2). For a more detailed discussion see *Climate Change 2007: The Physical Science Basis* (IPCC 2007a) or *Climate Change – Science: State of Knowledge* (USEPA 2009).

5.4.1.1 Climate Change Policy

Changes to policy and reporting on global CC can be expected to change regularly. In December 2009, the EPA identified GHG as a threat to public health and welfare. This is referred to as the Endangerment Finding, and led to the following Clean Air Act (CAA) rules in 2010.

- EPA, April 2010 – GHG emission control rule for light duty vehicles
- EPA, May 2010 –GHG thresholds for new and existing industrial facility affecting two permit programs: 1) New Source Review Prevention of Significant Deterioration (PSD) for construction permits and 2) Title V Operating Permit. One of the requirements of a PSD permit is to apply Best Available Control Technologies (BACT) to new or modified emission sources with emissions above program thresholds (MPCA 2010). This May 2010 rule is commonly referred to as the Tailoring Rule.

The Tailoring Rule establishes a schedule that will initially focus CAA permitting programs on the largest sources with the most CAA permitting experience. The rule then expands to cover the largest sources of GHG that may not have been previously covered by the CAA for other pollutants, as follows:

- Step 1 (January 2, 2011- June 30, 2011): During this period, no sources will be subject to CAA permitting due solely to GHG emissions. Only sources currently subject to the PSD permitting program would be subject to permitting requirements for their GHG emissions under PSD, and among these only projects with GHG increases of ≥75,000 tons per year (tpy) CO_2-e would need to determine BACT for GHG emissions. Similarly, for operating permits, only sources currently subject to the program would be subject to Title V requirements for GHG.

- Step 2 (after June 30, 2011): During this period, new and modified sources can be subject to CAA permitting solely due to GHG emissions if they meet certain thresholds. EPA estimates this will impact approximately 550 new Title V permits and 900 additional PSD permitting actions each year. New construction projects that emit GHG emissions of at least 100,000 tpy will become subject to Title V, and existing facilities that increase GHG emissions by at least 75,000 tpy will need to apply BACT.

EPA will undertake another rulemaking (to begin in 2011 and conclude no later than July 1, 2012) that may phase in additional GHG permitting requirements. No permit requirements for smaller sources will be considered by EPA until at least April 30, 2016, and permit requirements will cover no sources with emissions below 50,000 tons.

In September 2010 the EPA developed the GHG mandatory reporting rule developed in response to FY2008 Consolidated Appropriations Act (H.R. 2764; Public Law 110-161).

On December 23, 2010, EPA announced that it will, by the end of 2012, be finalizing rules for New Source Performance Standards (NSPS) for GHGs for power plants and oil refineries. New and modified affected electric generating units must comply with the forthcoming applicable EPA NSPS for GHGs. In the case of existing electric generating units, which fall under Section 111d of the CAA, the EPA will establish GHG emissions guidelines, which states will be required to implement.

Up until this time, the Minnesota Environmental Policy Act has not required the effects of CC be evaluated in environmental review. However, the Environmental Quality Board is proposing to amend one of its rules (MN Rules 4410.4300 subpart 15) to change its list of mandatory reporting categories to include GHG emissions. A hearing before the Environmental Quality Board on this matter took place as recently as March 2011. The MPCA issued guidance in 2008 for proposed actions requiring both an air permit and environmental review.

The State has committed to long term GHG reduction targets of 60 to 80% below current emission levels. Minnesota is part of the Midwestern Greenhouse Gas Reduction Accord along with Illinois, Iowa, Kansas, Michigan, Wisconsin, and Manitoba. Participants in the Accord have reached an agreement to implement a regional cap and trade system as well as a regional GHG emissions tracking system (MGGRA, 2007).

In December 2006 the State announced the Next Generation Energy Initiative, which outlined a process for the development of a plan to reduce GHG emissions. In 2007 the Next Generation Energy Act was signed by the Governor. The Act outlined goals for statewide GHG emission reductions of 15% by 2015, 30% by 2025, and 80% by 2050. In January 2008, the Governor outlined a four part initiative emphasizing the role of local projects and research and development assistance. The initiative also established a 15-member panel, the Clean Energy Technology Collaborative. The Panel is responsible for developing a Clean Energy Technology Roadmap. In addition, the initiative also called for the establishment of the Minnesota Office of Energy Security (OES) to coordinate energy and climate issues. By state statute, Commissioner of Commerce sets state climate policy.

In January 2008 the Minnesota Climate Change Advisory Group approved a number of strategies to reduce Minnesota GHG emissions 30% by 2025 (see Center for Climate Strategies reference). In April 2008 the Group issued a final report with recommendations for reducing the emissions. Pursuant to the report, the Minnesota Senate and House approved bills establishing guidelines for the Legislature’s role in a regional, market-based system to control emissions. The result was a House version of the Green Solutions Act of 2008 (ch. 340 session law) which directs the legislature to approve a regional cap-and-trade accord and authorizes studies of the program’s effects on the environment, economy, public health, and how revenue from the program would be managed. Under Minn Stat. 216H.07, subd 3, the Minnesota Department of Commerce and the MPCA are required to make interim reduction recommendations toward meeting the state's goals of reducing emissions by 15% by 2015, 30% by 2025, and 80% by 2050.

After extensive public input on the Minnesota Environmental Quality Board Statement of Need and Reasonableness (SONAR) for the Minnesota Environmental Review Program (including preparation of a State EIS), the August 2009 proposed rules for environmental review do not have an amendment to generally address GHGs as part of project alternatives and mitigation. Since then, additional consideration to GHGs as part of State environmental review has started . A SONAR for rulemaking authorized November 18, 2010 describes amending the air pollution category at part 4410.4300, subpart 15 to provide an explicit threshold level applicable to GHGs. As of this date, the proposed rulemaking is still under consideration.

On July 16, 2008, the MPCA issued a memo titled *Completion of a Greenhouse Gas Emissions Evaluation*, which requires project proposers to develop a greenhouse gas inventory or carbon footprint of any project that requires an Environmental Assessment Worksheet. In addition, the MPCA guidance requires the project proposer conduct a separate greenhouse gas and energy efficiency analysis if a) a proposed facility requires a new air permit for new construction or an existing facility requires a major modification to its permit, and b) the proposed or existing facility requires an air toxics risk assessment (Warner 2008). As part of the guidance, the proposers are required to submit a GHG emissions inventory for their proposed action. This reporting is for 'direct' emissions from within the project boundary and 'indirect' emissions from purchase of electricity. The primary GHGs are the same as those in federal reporting, and optional reporting of CFCs is encouraged. Reporting is to be called a 'carbon footprint' and is to follow the General Reporting Protocol of the Climate Registry and/or be completed in consultation with the appropriate MPCA staff.

Also in 2008 (updated for minor changes in 2009), a guidance document titled *General Guidance for Carbon Footprint Development in Environmental Review* was formulated for addressing carbon footprint in Minnesota (MPCA 2009). According to the guidance provided by the MPCA, proposers of projects that must obtain both an air emissions permit and also complete environmental review are asked to prepare a carbon footprint (GHG emission inventory) for the environmental review. GHG emissions from the Essar facility will be evaluated during both air permitting and environmental review

Minnesota State Statute 216H.021 was passed in 2009, which requires the commissioner of the MPCA to establish a system for reporting and maintaining an inventory of GHG emissions.

The legislative work passed on or after March 2008 took into consideration the relative contributions of various state industry sector past, present and future projected GHG emissions (Center for Climate Strategies 2008). From MPCA 2009 GHG monitoring, energy use in million metric tons CO_2-equivalent ($MMtCO_2e$) is summarized by state sector and estimated at 152.5 $MMtCO_2e$ total emissions for 2006 and 1.6 $MMtCO_2e$ for taconite production (not including combustion-based emissions).

5.4.1.2 Climate Change Science

Adaptive planning to continually learn of, reduce uncertainties, and improve adaptation outcomes is an important consideration in light of CC during the timeframe of the proposed ESMM project. Permit renewals throughout the life of the project would provide the opportunity to consider unanticipated effects on the project which may be related to CC.

For environmental effects described in this chapter and emissions reported in Chapter 4.2, GHGs are those compounds addressed in the proposed September 2010 U.S. Greenhouse Gas Reporting Rule, excluding other specified fluorinated compounds, as well as being listed in the 2007 Next Generation Energy Act for Minnesota. In accordance with Section 19(i) of Executive Order 13514, GHGs are defined as:

- Carbon Dioxide (CO_2),
- Methane (CH_4),
- Nitrous Oxide (N_2O),
- Sulfur Hexafluoride (SF_6),
- Hydrofluorocarbons (HFCs), and
- Perfluorocarbons (PFCs).

The class of compounds characterized as GHGs continues to be the focus of ongoing scientific study, as well as increasing public and political discussion. As defined by the IPCC, "Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, which absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds." (IPCC WG2 Appendix I, Glossary.) The proposed ESMM project would emit CO_2, CH_4, and N_2O. The proposed ESMM project would also emit the gases sulfur hexafluoride (SF_6) and hydrofluorocarbons (HFC), listed for federal and state reporting, but these were judged to be de minimus under the TCR General Reporting Protocol.

The IPCC states that changes in atmospheric concentrations of GHGs and aerosols, land cover, and solar radiation are drivers of climate change. GHGs absorb and emit radiation. To remove heat to space, the surface of the earth emits long wave radiation upward into the atmosphere. Some of this is absorbed by atmospheric gases (water vapor, carbon dioxide and other gases), which in turn reradiate this energy back to the surface in the form of down-welling radiation, effectively warming both the surface of the earth and the lower atmosphere (IPCC, 2007a). Illustration 5.4-1 displays general information about the absorption and emission of radiation in the atmosphere.

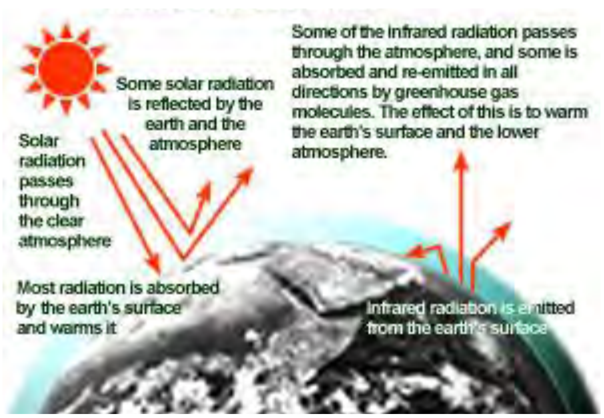

Illustration 5.4-1. The Greenhouse Effect
Source: http://www.pca.state.mn.us/climatechange/index.html#science

A few illustrations provide examples regarding specific sources and cycling of GHGs: in this case, CO_2 and CH_4. Illustration 5.4-2 shows the global carbon dioxide (CO_2) cycle between the earth/water and atmosphere. Illustration 5.4-3 shows the sources of methane (CH_4) in the atmosphere. The globally averaged concentration of carbon dioxide in the atmosphere has increased from 325 ppm in 1970 to 385 ppm in 2008, a rate of increase of 1.6 ppm per year (NOAA 2010). As of 2004, 49 billion tons of CO_2-e GHGs per year are emitted into the atmosphere by human activities: 77% from CO_2, 14% from CH_4, 8% from N_2O, and 1% from F-gases (IPCC 2007b). A total of 49 billion tons CO_2-e GHGs emitted per year in 2004 represents a 71% increase from 28.7 billion tons emitted in 1970 (IPCC 2007b).

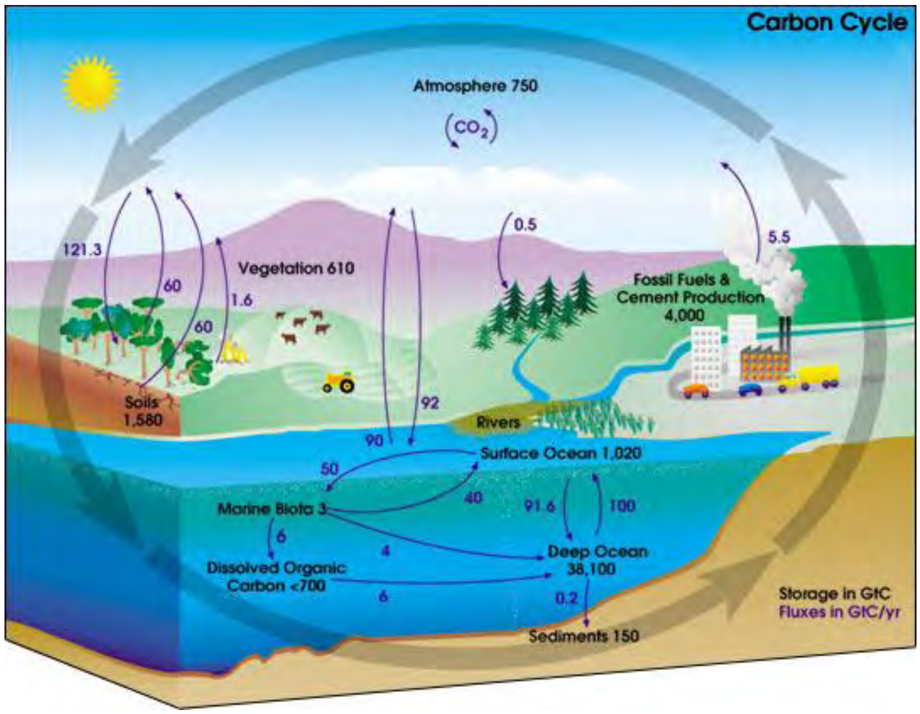

Illustration 5.4-2. Carbon Dioxide Cycle
Source: NASA Earth Observatory

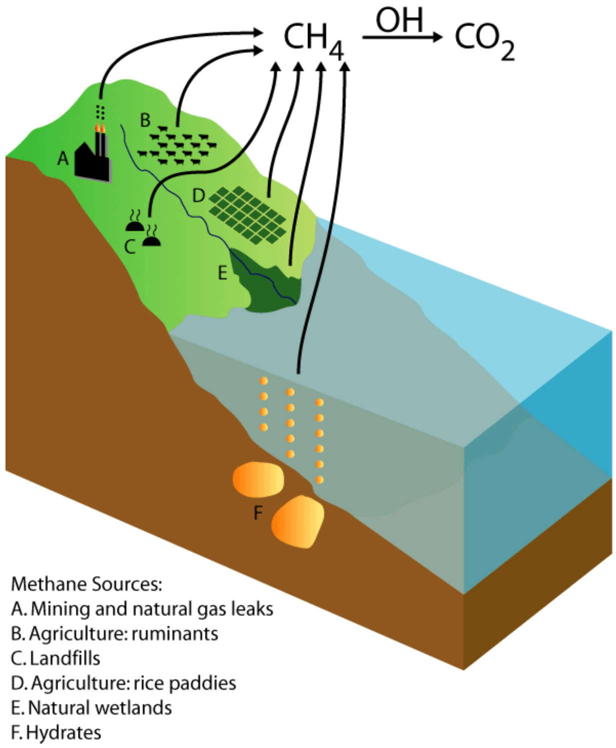

Illustration 5.4-3. Methane Sources
Source: NASA Earth Observatory

The IPCC has stated it is highly likely that the rise in surface air temperature over time has resulted from increased atmospheric GHG concentrations. Increasing global surface air temperatures could lead to effects on the global water budget, vegetation patterns, as well as other biogeochemical and ecological systems. These changes are generally referred to as CC. Climate scientists anticipate average global surface air temperature will continue to rise with continued rise in atmospheric GHG concentrations (EPA 2009).

The Intergovernmental Panel on Climate Change (IPCC) maintains a broad definition of climate change, which encompasses natural variability and human activity, whereas the United Nations maintains a perspective of CC in the United Nations Framework Convention on Climate Change (UNFCCC) as human activity that is in addition to natural variability over time.

"Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations" (IPCC, 2007).

The issue of CC and GHG emissions is a complex scientific issue. The role of anthropogenic, human activity-induced GHG emissions in CC continues to be examined. From USEPA and IPCC reports, the following can be concluded:

- Human activities are changing the composition of Earth's atmosphere. Increasing levels of greenhouse gases like CO_2 in the atmosphere since pre-industrial times (ca. 1750) are well-documented and understood (USEPA 2009).
- The atmospheric buildup of CO_2 and other greenhouse gases is largely the result of human activities such as the burning of fossil fuels (USEPA 2009).

- An "unequivocal" warming trend of about 1.0º to 1.7º F occurred from 1906-2005. Warming is observed over and at various depths of the world's oceans and in both Northern and Southern Hemispheres (IPCC 2007a).

- Increasing greenhouse gas concentrations warm the planet (USEPA 2009).

The Midwest region is experiencing temperature changes with that may be associated with the following events. Data over the past 30 years indicate the length of the frost-free or growing season has been extended by one week. Lake ice has decreased, heavy downpours are twice as likely as 100 years ago, and record-breaking floods and heat waves are anticipated to continue. (U.S. Global Change Research Program 2010).

Advances in the science of CC enable the scaling down from global CC models to regional models, facilitating assessment of potential regional effects of CC (U.S. Global Change Research Program (USGCRP) 2010). The following CC effects are expected on water resources and natural habitats.

The baseline used for assessment of and comparison to potential future effects is 1961-1990. Quantitatively, estimates for the region are for average annual surface temperatures in Minnesota to increase 6 to 10° F in the winter and 7 to 16° F in the summer by the end of the 21st century relative to the 1961-1990 baseline, depending on the range of future anthropogenic GHG emissions. Precipitation estimates indicate an increase of 10 to 20% by the end of the century, generally in the winter. We assume that present trends toward increasing regional and statewide warmth and wetlands will continue over the duration of the ESMM project.

The incidence of summer heat waves is thought to be likely to increase as mean annual global surface temperature rises. This is expected to change the winter survival rate and summer populations for a variety of insects, including ticks and mosquitoes. The implications could be an increased stress on wildlife populations from insect-carrying diseases and the potential for local extinctions if populations are already at low levels.

The precipitation pattern characteristics that already are observed are expected to continue (USGCRP 2010). This includes heavier winter and spring precipitation events (at a time period when soil infiltration is reduced), greater summer evaporation, and reduced but heavier rain events during summer. The implications include potentially more frequent summer flash flooding, but, paradoxically, lower mean water levels during the summer.

Overall, all major groups of animals are expected to be affected as they relocate to environments having more ideal characteristics for the species. Species with relatively broad adaptive abilities may travel less distance, whereas species with restricted environmental needs may have to relocate to survive; and if their rate of relocation lags the rate of CC-related environmental changes, populations may decline or fail. (USGCRP 2010).

Regionally, the northern hemisphere has experienced relatively greater warming in the winter and spring, with average winter temperatures increasing more than 7 degree F. The mid-latitudes show widespread reductions in the number of frost days, increases in the number of warm extremes, and reduction in the number of cold extremes. Increases in precipitation in eastern parts of North America have been significant. The snow cover has decreased in northern hemisphere winter months except for November and December. River and lake ice cover has been reduced across the northern hemisphere, although with quite a bit of spatial variability.

Predicting changes to environmental parameters at regional scales (i.e. the area of Minnesota, or even northeastern Minnesota) is being done by scaling down global climate models, changing CC-related model parameters (e.g. carbon dioxide), and experimenting using controlled environmental conditions (US GCRP 2010). Minnesota is situated in a continental location that makes the state sensitive to the potential effects of CC. Anticipated impacts from CC such as average summer and winter temperature changes, changes in precipitation patterns, and shifts in the length of seasons are projected to effect ecosystems, water resources, agriculture, and human health over the next several decades.

5.4.2 ENVIRONMENTAL CONSEQUENCES

We assume that present trends toward increasing regional and statewide warmth and wetlands will continue over the duration of the ESMM project. Environmental consequences were considered by Barr (2010a) for resources in the vicinity of the proposed ESMM project that were evaluated in the MSI FEIS and are being reported by USGCRP (2010) as showing evidence for change at the present time or likely to change by 2025. The potential for environmental consequences discussed in Section 5.4.2.1 are qualitative only and subject to change based upon future reporting by USGCRP. For Minnesota as a whole, predictions for the long term climate change forecast models include the scenario of a drier Great Plains climate, much like that found in Nebraska, or a warmer, humid climate scenario like that of Ohio. The latter scenario is used as the basis of discussion in Section 5.4.2.1, except for ecosystem acidification, which examines both.

5.4.2.1 How Climate Change May Potentially Interact with the Proposed Action

5.4.2.1.1 Vulnerability or Sustainability of Proposed Action

Water modeling leading to the facility design did not treat the range of possible, even likely, future climatic conditions; modeling future risk from CC was not identified in the Final Preparation Notice for evaluating the proposed ESMM project. Draft Council on Environmental Quality (CEQ) guidance requires that these issues, including design modifications to address the range of possible climatic changes over the life of the project, undergo in depth consideration. The following discussion identifies potential vulnerability or sustainability of the proposed ESMM project as the result of CC-induced effects.

The facility water balance predicts an increased need for water as the project develops over time, which results in a significant drawdown of Pits 1 and 2 by year 15 of the proposed ESMM project (refer to Chapter 4.1 for details). Anticipated effects of climate change include greater precipitation in the winter and spring with less precipitation, but heavier storms, in the summer. The water storage sites of the proposed ESMM project may not be designed to capture high runoff volumes that might be seen as the result of changing precipitation patterns. This might result in unanticipated surface water discharges such that the facility does not maintain zero discharges as proposed. Inability to capture high runoff volumes from heavy precipitation events may also mean less volume is available for facility water demand and stream augmentation. The DRI and Steel Mill facilities would be the major sources of water demand.

CC-induced increases in temperature would increase evaporation. Increased evaporation could mean less volume is available for facility water demand and stream augmentation than what is anticipated as proposed. Depending on the seasonality of increased precipitation and temperatures, there could be an offsetting effect.

CC-induced changes to water levels in pits throughout the project area would affect deep seepage and groundwater inflow to (and between) pits. Ultimately, changes to deep seepage, which discharges to downstream waters such as Swan Lake, would alter the water quality impacts to downstream waters.

5.4.2.1.2 Adding to, Modifying, or Mitigating Potential Effects on the Environment

The resources discussed in this section are addressed by permit to mine, air, wetland, water quality, and water use appropriation permits for the original MSI and proposed ESMM projects. The qualitative analysis and potential concerns of CC adding to impacts already permitted, could be considered in future permit modifications.

<u>Watersheds, Wetlands, Lakes, and Streams</u>

As reported in MSI FEIS Chapter 4.1, wetlands affected by the original MSI project include open marsh, shrub, wet meadow, open water and forested types. According to Barr 2010a, based upon the expected changes in future hydrology, it is possible that the more intense storms could lead to greater water level fluctuations and possibly alterations in hydrologic regimes of wetlands near the project. Indirect hydrologic effects on wetlands were permitted for the original MSI project. With CC, the potential exists for a greater magnitude of indirect hydrologic effects on wetlands. This would likely depend greatly on the existing and potential future degree of disturbance to the natural watershed-scale hydrology contributing to the wetlands. As identified in the MSI FEIS, water resources potentially impacted include surface water flows to O'Brien Creek, Pickerel Creek, Snowball Creek, and Sucker Brook, and water levels in Little Sucker Lake, Snowball Lake, Swan Lake, Little McCarthy Lake, O'Brien Lake, and Oxhide Lake. As described in the MSI FEIS, no significant impacts are expected as a result of watershed alteration in O'Brien Creek, Pickerel Creek, Sucker Brook, or Snowball Creek, assuming augmentation flows are established for Snowball Creek and Oxhide Creek. Additionally, no substantial impacts on lake levels are expected in Oxhide, Snowball, O'Brien, Little Sucker, Swan or Little McCarthy Lakes. With that said, larger storm events are anticipated with CC, and as such, watershed rates or volume could increase and change the lake and stream conditions described above. How this would affect augmentation flows is uncertain. A CC-based hydrologic model scenario could potentially increase the certainty about the future.

Increased intensity of storm events from CC, could potentially lead to increased erosion or changes in river and stream channel morphology.

Estimates for increasing regional temperatures have been discussed in terms of potential effects on biota and their range migration (both plants and animals) (Union of Concerned Scientists 2003). The plant hardiness zones have been predicted to shift north. This should be taken into consideration in the selection of species for mine site reclamation. In addition, wetland plant species associated with one or another hardiness range can thus be expected to migrate. Species dominance could shift over time, altering plant community compositions. Research is ongoing for specific species and wetland types expected to shift over the 21st century and thus to some extent over the life of the project. Animal, viral, and bacterial species hardiness can also be considered. Currently an outbreak of an insect affecting ash trees (emerald ash borer) could potentially affect the forested wetlands with this species. The relationship between the prevalence of the insect and CC is being studied. The potential synergistic effect of CC and emerald ash borer on wetlands near the proposed ESMM project is relevant to the acres of forested wetland with black or green ash as a component of the canopy.

Warmer water temperatures are likely from increasing surface air temperatures. As reported by Barr 2010a, several activities could be affected by this. Mercury bioavailability is one of these. Temperature is one of several methylation variables, including background concentration of sulfate, presence of sulfate-reducing bacteria, organic matter load, and hydraulic residence time in wetlands associated with lakes, streams, and rivers.

Increasing air temperatures would also increase evaporation from open water surfaces and evapotranspiration (Et) from vegetated surfaces. Wetland Et varies with wetland type.

Increasing air temperature could lead to higher rates of biological activity in sites where temperature has been a limiting factor. This could occur both through a new normal of less severe winters being above the kill threshold and warmer water temperatures. Many variables would interact, likely in a dynamic fashion, if temperatures do not stabilize, to have significant ecological effects. Effects could include natural or anthropogenic changes in available nutrients, hydrologic changes discussed above, and changes in interspecies competition dynamics.

Increasing temperature may affect lakes in the project area (Sucker Lake, Snowball Lake, Swan Lake, Little McCarthy Lake, O'Brien Lake, Oxhide Lake) that normally establish a seasonal temperature gradient with depth (thermocline). Changes to the length or presence of the thermocline could have effects on oxygen levels, solubility of chemicals in the substrate, and biological activity (as noted earlier).

Ecosystem Acidification

Ecosystem acidification is principally of concern with respect to lake ecosystems in Minnesota and deposition of airborne pollutants. As reported by Eilers and Bernert (1997), the lake systems in Minnesota evaluated in the 1990s had more buffering capacity against acid deposition than had been previously assumed. This suggests that these representative northern Minnesota lakes should be buffered against current and foreseeable levels of acid deposition. The effects of climate change on lake buffering capacity have not been investigated. The proposed ESMM project potential effects on ecosystem acidification are addressed with respect to whether emissions of SO_2 and NO_x would change compared to the existing air permit for the original MSI project. The air permit requires best available control technology (BACT) emission control to meet federal standards considered to be protective of the environment.

Ecosystem acidification can occur from wet deposition of airborne pollutants and is influenced by precipitation amount and frequency (i.e., how often material is washed out of the atmosphere), the amount of SO_2 and NO_x (precursors to sulfate and nitrate aerosol, respectively) emitted to the atmosphere, and the reaction rates for acid formation. Various researchers are investigating CC-induced temperature increases potentially enhancing the rate at which SO_2 and NO_x are oxidized to sulfuric and nitric acids in the atmosphere.

Threatened, Endangered, and Special Concern Species

The three animal species in the vicinity of the proposed ESMM project are the gray wolf, Canada lynx and bald eagle. The gray wolf and the bald eagle have large ranges that cover many climate zones. Vulnerability of gray wolf populations in Minnesota over the lifetime of the proposed project would be addressed based upon the monitoring and population thresholds set in the 2001 state management plan. The Canada lynx populations would be addressed through the USFS monitoring.

Botrychium oneidense, currently a state listed endangered and proposed threatened species, *Carex flava*, a state species of special concern, and one state threatened (*B. rugulosum*) plant species are present at the proposed ESMM project site. *B. rugulosum* is typically in upland coniferous forests. *B. rugulosum* is widely distributed across three Canadian provinces and four border states (MI, MN, NY, VT) as well as Connecticut, and is only listed in two states as threatened (Minnesota) or endangered (New York), although it is considered vulnerable across its range. *B. rugulosum* was probably never common in Minnesota, as this is the southern edge of its range. Blunt-lobed Grapefern (*B. oneidense*) is endangered in Minnesota with approximately thirty populations statewide. *B. oneidense* tends to grow on the margins of vernal pools within forest complexes, but can be observed near mining roads adjacent to early successional forest edges. Northeast Minnesota may be the western limits of its range. Yellow sedge (*C. flava*) is listed as special concern in Minnesota with approximately twenty known populations in the state. *C. flava* is found in northeast Minnesota and is typically found along small waterways in swampy areas.

The range of solar, moisture, and soil physical and nutrient conditions within which each plant species establishes need to be considered to postulate potential CC-induced effects on the populations in Northern Minnesota.

5.4.2.1.3 Adding to, Modifying, or Mitigating Potential Effects on Public Health and Safety

Air Pollution

Health risks from air pollutants are discussed with respect to the original MSI and proposed ESMM projects in Chapter 4.3.

On a global and national scale, more frequent and intense heat waves, more severe wildfires, degraded air quality, more heavy downpours, and flooding, increased drought, greater sea-level rise, more intense storms, harm to water resources, harm to agriculture, and harm to wildlife and ecosystems are potential negative effects of CC. According to the EPA Administrator, these would be impacts on public health and welfare within the meaning of the Clean Air Act, and are likely to fall disproportionately on the poor, the elderly, the disabled, and the uninsured.

Visibility could be altered through changes in relative humidity. Class I areas for visibility are the Boundary Waters Canoe Area Wilderness, Voyageurs National Park, Isle Royale National Park, and Rainbow Lakes Wilderness. Potential impairment as described in the MSI FEIS would be primarily driven by sulfate and nitrate particles in the atmosphere. These particles are created when sulfur dioxide and nitrogen oxide, emitted from the facility, react in the atmosphere to form ammonium sulfate and ammonium nitrate. These particles readily absorb water and grow rapidly. They grow to a size that is disproportionately responsible for visibility impairment as compared with other particles that do not uptake water molecules. CC-induced changes or increased variability in weather patterns have the potential to modify dispersion patterns of emissions from the proposed ESMM project. This might affect the location and magnitude of ambient air quality impacts of criteria pollutants as well as the modeled visibility impacts. As research becomes published on how CC may affect air dispersion models, this could be taken into consideration in future air permit modifications for the proposed ESMM project. At this time there is insufficient information available to predict changes in local meteorology in terms of wind patterns; therefore, the magnitude and direction of additional CC-induced visibility impacts in the Class I areas are unknown.

Potential regional CC could alter the magnitude of formation of secondary particulate matter and ground-level ozone. Secondary particulate matter, a product of sulfur and nitrogen oxides and other atmospheric pollutants, has been linked to adverse respiratory impacts. Ground-level ozone, a gaseous irritant which has been causally linked to acute and chronic respiratory impacts, is primarily produced through the reaction of volatile organic compounds (VOCs) and NO_x in the presence of sunlight. CC-induced changes in temperature, wind speed, precipitation, and atmospheric transport would have effects on atmospheric particulates and ground-level ozone. Local and regional simulations of ground-level ozone formation point to increases in both the average long-term temperature and number of days with temperatures above a certain threshold. All else equal, in the presence of sufficient lower atmospheric reactants this is likely to increase the production of ground-level ozone by increasing the photochemical reaction rates. In the case of precursor emittants from the proposed ESMM project, this would act to magnify their effects, resulting in higher ozone production than would otherwise have been the case.

Increased temperatures are also likely to result in an increased emission of VOCs from local forests, shrubs and grasslands. Thus, if the limiting factor in the production of ground-level ozone in the project area is VOCs, then increased emissions from natural sources would magnify any facility-specific effect. In general, expected VOC concentrations in the vicinity of the facility are much lower than those measured in urban environments where ground-level ozone is a substantial human health concern. It is reasonable to expect that any effects of temperature-mediated changes to human health risk from ozone inhalation would be limited.

CC-induced changes in weather patterns are anticipated (USGCRP, 2010). The frequency of hot, stagnant air masses is expected to rise. When this occurs in counties exceeding existing air pollution standards this negative health effects will increase. Weather pattern and hydrological changes can also be expected to interact. The outcomes are unclear, and could include atmospheric chemistry alterations that alter ground level ozone formation and concomitant health effects.

5.4.2.2 How the Proposed Action May Potentially Effect Climate Change

5.4.2.2.1 Greenhouse Gas Contributions

GHG emissions are reported in CO_2-equivalents (CO_2-e) in this analysis using the global warming potential (GWP) values reported in the Intergovernmental Panel on Climate Change, Fourth Assessment, Working Group 1, Physical Science Basis (www.ipcc.ch/ipccreports/ar4-wg1.htm) and included in *General Guidance for Carbon Footprint Development* (MPCA 2009). Using the IPCC's GWP values, it is possible to express the 100-year integrated effect on climate of any single emission of one of the GHGs within the framework of a single unit or currency, CO_2-equivalent tons.

GHG emissions estimates for the proposed ESMM project included CO_2, NH_4 and N_2O. The gases sulfur hexafluoride (SF_6), perfluorocarbons (PFC), and hydrofluorocarbons (HFC), listed for federal and state reporting, were not included in the analysis because they are either judged to be de minimus under the TCR General Reporting Protocol or are not included in the MPCA guidance. Chapter 4.2 describes the emissions inventory methodology.

The following emissions sources were summarized and compared for the original MSI and proposed ESMM projects.

Direct (Scope 1) GHG emissions accounting for the following activities:

- Stationary combustion - diesel fuel in emergency engines or natural gas in boilers, heaters, flares, and the pelletizing furnace;
- Mobile combustion - diesel or gasoline in haul trucks, service trucks, mining equipment;
- Physical and chemical process emissions – arising from noncombustion processes involving raw materials and additives used to produce a finished product (see listing in Table 5.4-1); only emissions of fossil CO_2 (not biodiesel and biomass CO_2 emissions) are included in Scope 1 physical and chemical process emissions.

Table 5.4-1. Sources of Physical and Chemical Process Emissions

Process Location	Source
Entering Pelletizer	Concentrate Powder Coating Limestone Soda Ash
Entering DRI Plant	Natural Gas
Exiting DRI Plant	DRI Pellets
Entering Steel Mill	DRI Pellets Carbon Electrodes Limestone Casting Powder
Existing Steel Mill	Steel Slag

Indirect (Scope 2) GHG emissions accounting for the following activity:

- On-site use of electric power use, which is generated at offsite power plant locations [using the Midwest Reliability Organization West (MROW) emission factor from the EPA eGRID database].

A summary of GHG emissions from the processes evaluated is provided in Table 5.4-2 for the original MSI and proposed ESMM projects. GHG emissions reported for the proposed ESMM project represent the worst case scenario of pelletizer throughputs (refer to Chapter 4.2 and Table 5.4-2 footnotes that describe the pellet capacities used for estimation of GHG emissions). MSI GHG emissions are based on capacities described in detail in Section 3.2, Table 3-1.

Approximately 51% of the total project GHG emissions would be Scope 1. Of thse, 35% are associated with mobile and stationary combustion and 65% are physical and chemical process emissions. In general, combustion activities account for 18% while chemical process emissions account for 33% of total emissions.

Scope 2 indirect emissions from purchased electricity would make up 48.9% of total project emissions.

Relative to the original MSI project, GHG mobile source Scope 1 emissions are slightly reduced for the proposed ESMM project, presumably reflecting a reconfigured and more efficient haul road design. However, relative to the original MSI project, Scope 2 electric-powered mining and crushing equipment emissions at the proposed ESMM project are calculated to be noticeably higher due to increased electricity demand for these sources. Furnace combustion and process emissions from, as well as Scope 2 energy use at, the proposed ESMM project pelletizer would be noticeably higher than those calculated for the original MSI project, since under the proposed ESMM project taconite pellet production would be increased substantially. Much of this is from natural gas to run the indurating furnace. Concentrate would be fed to the pelletizer, where unfired or green pellets are produced, hardened into oxide pellets in the indurating furnace.

Table 5.4-2. GHG Emissions Summary from Processes Evaluated

Process Area	GHG Emissions (metric ton CO_2-equivalents per year) [1]											
	Direct (Scope 1) - Combustion		Direct (Scope 1) – Process		Direct (Scope 1) – Total		Indirect (Scope 2) [2]		TOTAL Scope 1 + Scope 2		Biogenic CO_2	
	MSI	Essar [3]	MSI	Essar [3]	MSI	Essar [3]	MSI	Essar [3]	MSI	Essar [3]	MSI	Essar [3]
Mining and Crushing (Mobile Sources)	39,936	39,584	0	0	39,936	39,584	269,216	450,792	309,550	490,773	4,209	4,337
Concentrator	397	397	0	0	397	397					47	47
Pelletizer [4]												
Furnace	102,579	211,248	75,034	303,541	177,614	514,789	138,950	232,667	316,564	747,456	3,390	2,712
Emergency Engines	417	417	0	0	417	417	0	0	417	417	37	37
DRI [5]	501,647	501,647	727,474	727,474	1,229,121	1,229,121	255,934	255,934	1,485,054	1,485,054	60	60
Steel Mill	32,655	32,655	462,378	462,378	495,034	495,034	1,256,817	1,256,817	1,751,851	1,751,851	43	43
Space Heaters	18,611	18,611	0	0	18,611	18,611	0	0	18,611	18,611	0	0
Facility-wide	**696,243**	**804,560**	**1,264,886**	**1,493,393**	**1,961,129**	**2,297,952**	**1,920,917**	**2,196,210**	**3,882,046**	**4,494,162**	**7,785**	**7,236**

[1] CO_2-e includes emissions of CO_2, CH_4, and N_2O. Emission factors used for most sources are based on Climate Registry or EPA GHG data.

[2] Midwest Reliability Organization (West) emission factor is used for Essar as recommended by USEPA and MPCA.

[3] Worst case scenario based on throughputs of 3.66 mmtpa high flux pellets and 3.34 mmtpa low flux pellets (see chapter 4.2 for further discussion).
The revised project will involve production of high flux and/or low flux pellets, depending on the construction status of the steel mill, as well as market conditions. The maximum production rate of high flux taconite pellets will be 6.5 mmtpa. The maximum production rate of low flux taconite pellets will be 7.0 mmtpa. The low flux pellets will be used as feed pellets to the DRI/steel mill. The high flux pellets will be shipped to Essar Steel Algoma in Ste. St. Marie, Ontario Canada or sold on the open market. The DRI/Steel mill requires 3.34 mmtpa of low flux feed pellets to produce the design capacity of steel. When the DRI/Steel mill is operating at full capacity, only 3.66 mmtpa of high flux pellets would be produced. Due to market conditions, any range of pellet type may be produced. Due to differing fuel usage requirements to produce the two types of pellets, as well as differing pellet compositions, GHG emissions are higher for producing high flux pellets when just the taconite pelletizing process is considered. However, Essar will use the low flux pellets to produce steel, which adds GHG emissions from the DRI and steel making process. The maximum throughput into the steel making process is 3.34 mmtpa low flux taconite pellets. Therefore, the worst case scenario for annual GHG emissions is production of 3.34 mmtpa of low flux pellets and 3.66 mmtpa of high flux pellets.
The Minnesota Steel GHG emission calculations are based on production of 4.18 mmtpa of low flux pellets with 3.34 mmtpa of low flux taconite pellets sent to the DRI/Steel Mill. Calculation methods are the same for Essar and MSI.

[4] Process emissions are 42% of direct emissions for low flux scenario, which compares favorably to Keetac stack test results (44.5% non-combustion direct emissions).

[5] HYL vendor data were used for natural gas usage at DRI and steel plant for the proposed ESMM project; "Natural Gas Tables" were used for the original MSI project natural gas usage.

Direct GHG emissions not accounted for in Table 5.4-2 are from the following:

Disturbance of terrestrial systems.

Terrestrial emissions are from disturbance of terrestrial ecosystems / loss of stored ecosystem carbon due to loss of wetland and upland land cover types. These were evaluated in the Climate Change Evaluation Report (Barr, 2010a). The assessment considers the combined effects of changes in carbon emissions and sequestration, and variables in accurately quantifying these emissions were discussed. An effort was made to quantify carbon cycle impacts by land cover type and age and soil type using four literature references for soil carbon storage and biomass carbon storage (in metric tons carbon per hectare) and an annual carbon sequestration rate to calculate carbon and sequestration losses, however, the data were not related to the specific upland or wetland cover types reported in the original MSI FEIS. The land cover type analysis is reported in Appendix D of the Climate Change Evaluation Report, cited above, with the most recent update to the table received April 11, 2011. After performing the land cover type calculations, the project proposer provided a land cover categorization according to wetland, forest, and grass/shrub cover types as shown in Table 5.4-3.

The total scope 1 terrestrial emissions on an annual basis reported in Table 5.4-3 with the total scope 1 emissions for ESMM in Table 5.4-2 provide a per year scope 1 emissions of 2,366,652 metric tons CO_2-e per year. This indicates that terrestrial emissions amount to almost 3% of the total on an annual basis.

Table 5.4-3. Scope 1 Terrestrial Emissions Summary

Terrestrial Emissions Source	Acres Impacted	Estimated Emissions over Project Life (m.t. $CO_{2\text{-}e}$)	Estimated Annual Emission (m.t. $CO_{2\text{-}}$) (1)
Wetlands	710		
Potential Wetland Carbon Stock Loss Due to Direct and Indirect Impacts		319,000	21,000
Potential Annual Wetland Sequestration Loss for Lag Time Between Wetland Impact and Mitigation (2)			100
Annual Emissions Subtotal - Wetlands			21,100
Forests	1060		
Potential Forest Carbon Stock Loss Due to Project Impacts		329,000	22,000
Potential Annual Forest Sequestration Loss (3)			2,700
Annual Emissions Subtotal - Forests			24,700
Grass/Shrub & Grasslands	1540		
Potential Grass/Shrub & Grassland Carbon Stock Loss Due to Project Impacts		292,000	19,000
Potential Annual Grass/Shrub & Grassland Sequestration Loss			3,900
Annual Emissions Subtotal - Grass/Shrub & Grassland			22,900
Total	3310		
Project Emissions Total - Wetlands, Forests, Grass/Shrub & Grasslands		940,000	
Annual Emissions Total - Wetlands, Forests, Grass/Shrub & Grasslands			68,700

(1) Estimated emissions were converted to annual emissions based on a 15-year project life.

(2) 0.2 MT/acre/yr, Anderson et. al, The Potential for Terrestrial Carbon Sequestration in Minnesota: A Report to the Department of Natural Resources from the Minnesota Terrestrial Carbon Sequestration Initiative, Feb. 2008.

(3) 2.52 MT/acre/yr, Lennon, M and Nater, E., 2006. Biophysical Aspects of Terrestrial Carbon Sequestration in Minnesota. ©2006 by the Regents of the University of Minnesota.

(4) Includes land cover types PEMA, PEMB, PEMC, PEMF, PEMG, PFOA, PFOB, PSSA, PSSB, PSSC, PUBF, PUBG, and PUBH.

(5) Includes Planted Pine/SGQA, Upland Hardwood Forest, Upland Secondary Forest, and Wetland Secondary Forest.

(6) Includes Grass/Shrub, Grasslands, and Upland Shrub.

Scope 3 GHG emissions are considered the responsibility of other parties and therefore were not included in the analysis or included in Table 5.4-2.

CO_2 emissions from biodiesel and biomass combustion are biogenic sources of emission. They are not included in the facility's total direct (Scope 1) or indirect (Scope 2) emissions based on The Climate Registry (TCR) General Reporting Protocol (GRP) version 1.1 (May 2008) because GWPs have not been developed for biogenic CO_2 emissions. Therefore, biogenic CO_2 emissions are recorded separately. GWPs have been developed for CH_4 and N_2O emitted from biomass combustion; therefore, they are included in total (Scope 1 + 2) emissions.

Biogenic emissions (CO_2 emissions from biodiesel and biomass combustion) are not included in Scope 1 and Scope 2 emissions, but they are equal to less than 0.2% of Scope 1 and 2 emissions.

5.4.2.3 Project Alternatives Potential Effects on Climate Change

5.4.2.3.1 No Action Alternative

For comparison purposes, GHG emissions (Scope 1 and 2) were recalculated for the original MSI project using the same methods and emission factors that were used to calculate the proposed ESMM project emissions. Table 5.4-2 shows the recalculated original MSI project emissions.

5.4.2.3.2 Technology Alternatives

Essar would be required to identify and apply BACT to applicable modified emissions sources. Under the Tailoring Rule, emissions of GHGs would be subject to BACT requirements of the PSD program. Emission levels resulting from application of BACT would require approval from MPCA and would be included as emission limits in a modified air quality permit. See Chapters 3.3 and 4.2.2.3 for further discussion of air emissions controls. See Chapters 3.3 and 5.3 for discussion of mercury emissions controls.

5.4.3 MITIGATION

According to the Minnesota Next Generation Energy Act, state-level GHG emissions are to decline 15% from 2005 state-level baseline emissions by 2015. No project-specific requirements exist at this time for a cumulative reduction/mitigation. The current requirements are to report GHG emissions and perform a qualitative analysis of measures to reduce emissions.

Chapter 4.2, Air Quality, addresses mitigation for consideration in air permits for the proposed project. To the extent that recent guidance from the MPCA addresses GHG emissions in the air permit, mitigation for potential GHG emission effects on air quality shall be addressed therein. Permit requirements for GHGs for new facilities that meet certain permit thresholds went into effect on January 2, 2011. Permit requirements for GHGs for major modifications of existing facilities that meet certain permit thresholds also went into effect on January 2, 2011. The proposed ESMM project is subject to these requirements under the PSD for GHGs.

5.4.3.1 Conservation Opportunities and Mitigation of Energy Requirements

The Council on Environmental Quality (CEQ) recommends consideration of the following alternatives for their ability to reduce or mitigate GHG emissions: enhanced energy efficiency and renewability, improved GHG reduction technology, and planning for carbon capture and sequestration (CEQ 2010). Essar considered several GHG mitigation measures including emissions reductions, renewable energy, carbon sequestration and carbon offsets. These are described in greater detail below.

GHG Emissions Avoidance and Reduction

Essar has analyzed measures to minimize GHG emissions via both fuel choices and energy efficiency. The list below highlights some of the key areas where Essar has made equipment and process selections for energy efficiency.

- Maximize haul truck size;
- Dry cobbing of crude ore;
- Use autogenous grinding;
- Elimination of steel balls from SAG grinding;
- Use of hydraulic AG mill trammel;
- Use ball mill instead of cyclone in primary screening circuit;
- Maximize use of gravity flow to transport through crushing/grinding/concentration circuits;
- Filtration using ceramic filters;
- Use of Hytemp system to charge hot DRI pellets to steel mill.

Appendix B describes energy end-use efficiency improvements in the facility. Table 5.4-4 summarizes the selected process alternatives and GHG emissions savings expected to be achievable.

Table 5.4-4. GHG Emissions Savings from Reduced Power Production

Source	Estimated GHG Reduction (metric tons CO_2-e per year)
Dry Cobbing	10,700
Autogenous grinding	36,900
Hydraulic Trommel	7,700
Ball Mill Transport	34,100
Gravity Transport	18,600
Ceramic Filter	24,300
Hytemp Pellet Transfer	513,000
Total Savings Associated with Project	**645,300**

Additional technologies shall continue to be evaluated to improve efficiency and reduce energy use and GHG emissions. If deemed effective, Essar will consider use of these technologies:

- Running the ball mill using a balling disc instead of drum.
- Mixing using vertical mixers instead of horizontal mixers.

Renewable Energy

The Biodiesel Content Mandate under MN Statute 239.77 requires that diesel fuel used in internal combustion engines (stationary and mobile) be comprised of at least 10% biodiesel by May 2012. Though the emission factors of biofuels and biomass are not the smallest among all fuel options, emissions from biofuel and biomass combustion are removed from the atmosphere (through vegetative regrowth) faster than fossil CO_2 emissions. 100% renewable resources were considered as an additional emissions reductions option for fuel for haul trucks and the furnace. However, use of these energy sources was deemed infeasible due to factors such as cold climate operational restrictions and inability of the furnace burners to handle biomass. See Appendix B (Haul Trucks, Fuel Options for Furnace, Fuel Selection) for more information on the factors considered for fuel choices.

Biological Carbon Sequestration

The following biological sequestration strategies were evaluated for the proposed ESMM project (Barr 2010a). These methods are not proposed at this time, but could be considered in the future. Acres of forested and wetland cover types and wetland replacement types are reported in the MSI FEIS. In order to consider these strategies, an update of proposed ESMM project terrestrial emissions calculations and of any replacement areas so that net emissions values can be compared.

Biological Carbon Sequestration – Afforestation

Afforestation refers to converting land to forest where the land has not previously supported a forest. Carbon sequestration of existing forests in Minnesota cannot be considered a carbon credit because the forests would sequester carbon regardless of management. Reclaimed minelands and marginal farmlands are likely to offer possible afforestation projects. Red and white pine stands show the best potential for carbon sequestration because of their high biomass production. Biomass production is important because live woody tissues and slowly decomposing organic matter in litter and soil sequester carbon dioxide (Luyssaert et. al., 2008). These afforested systems are effective at sequestering above-ground carbon in biomass. Over short timescales afforested systems are effective at sequestering above-ground carbon in biomass, exhibiting carbon sequestration rates as high 7.65 MT CO_2 acre-1 yr-1 in Minnesota. This sequestration potential is, however, limited as the system reaches its steady state.

Biological Carbon Sequestration – Wetland Sequestration:

Recently published University of Minnesota studies indicate that under certain conditions, wetland restoration may provide one of the best terrestrial sequestration options in Minnesota (in areas with adequately reduced hydric soils) (Nater, 2007, personal communication). In many areas of Minnesota, particularly in the "Prairie Pothole Region" of Northern Minnesota, restoring wetlands re-establishes original hydrologic conditions and can lead to decreased rates of organic matter oxidation and potential increases in carbon sequestration. It has been demonstrated that restoring local hydrology and natural vegetation in a previously drained wetland area can sequester approximately 4.53 MT CO_2 acre-1 yr-1 in the upper 15 cm of soil. However, while wetlands do sequester carbon in biomass, the anaerobic decomposition that occurs in wetlands and peatlands results in the release of carbon as methane. Some current research indicates that wetlands with permanently pooled water are net GHG sources (in CO_2 equivalents) due to methane production. Flooded soils can be ideal environments for CH_4 production because of their high levels of organic substrates, oxygen-depleted conditions, and moisture. The level of CH_4 emissions varies with soil conditions as well as climate. Most freshwater wetlands are small net GHG sources to the atmosphere.

If wetland restoration is considered as a carbon sequestration strategy, a focus of restoration efforts on Type 1 and 2 ephemeral wetlands may be preferred, as they show the strongest potential for generating a net carbon sink. Essar will be restoring approximately 500 acres of wetlands in accordance with state and federal permits for the original MSI project. Measures to quantify carbon sequestration, storage are not required as part of the permits.

Biological Carbon Sequestration – Perennial Grassland

Since the settlement of Minnesota, extensive loss of prairie and grassland areas has occurred. Therefore, large-scale restoration of perennial grasslands could provide a source for carbon sequestration, in concert with several other ecosystem services. Establishment of grasslands results in decreased soil disturbance from tilling and increased above- and below-ground biomass production compared to row cropping systems. The potential for restoration exists in the conversion of cultivated cropland to grassland. Specific to the project site, mining reclamation could consider evaluating the sequestration potential of grassland restoration, although the existing state reclamation rules do not specify this. Available research indicates that perennial grassland systems may reach a steady state between 50 and 148 years, after which carbon sequestration benefits are negligible.

Carbon Offset Credits

Volunteer carbon credit trading markets have been established in the U.S. and elsewhere. Carbon offset credits involves purchasing conservation or sequestration measures on the open market, regardless of geographic location (although discussions continue among various representatives on forming a Midwest regional market). This measure could be considered at some point in the future for the proposed ESMM project.

GHG BACT Analysis

Since Essar's air permit application was not issued prior to January 2, 2011, Essar is required to perform a GHG BACT analysis for all applicable sources as a result of the proposed modifications at the facility. The additional GHG analysis will use the 5-step BACT approach and the CAA Advisory Committee's February 2010 guidance. This is not a traditional air emissions BACT analysis, but serves as the currently accepted framework for evaluating GHG alternatives.

- The analysis will evaluate only those units that are undergoing a physical change or change in method of operation;
- The analysis will not redefine the project as proposed. Therefore, the GHG analysis will not include controls that would change the fundamental type of project that is being proposed;
- The analysis will only consider those technologies that have been demonstrated in practice, and are available and applicable as technically feasible. A technology will be considered "demonstrated in practice" only if it has been successfully demonstrated on a commercial scale across a range of reasonable expected operating scenarios;
- The analysis assumes that with respect to site-specific feasibility of carbon capture and sequestration, the physical and legal availability of sequestration capacity (pore space) is relevant in determining feasibility. The GHG BACT will not evaluate changing the location of the source if there is no reasonable sequestration opportunity at or near the proposed site.

6.0 Consultation and Coordination

The SEIS for the proposed ESMM project (modifications to the originally-reviewed MSI project) is a State-only environmental review. Since there are no additional wetland impacts, the USACE has made a preliminary determination that a supplement to the MSI FEIS under NEPA is not required.

6.1 CONSULTATION AND COORDINATION WITH OTHER STATE AND FEDERAL AGENCIES AND TRIBE REPRESENTATIVES

Scoping Process

Several state and federal agencies and several Native American tribes have participated in the Draft SEIS process. State statutes for the MEPA govern the evaluation of potential social, environmental and economic impacts and mitigation options for the proposed ESMM project and its alternatives. Agency representatives relied on the MEPA for developing the Draft SEIS scoping process. Herein is a description of the consultation and coordination among the state and federal agencies and Native American tribes.

Minnesota Department of Natural Resources

The MNDNR is the RGU for implementation of MEPA for the proposed ESMM project. Agency staff involved in preparation and review of the entire Draft SEIS were from the following divisions: Lands & Minerals and Ecological & Water Resources. Participation included review and approval of collected data, evaluation of potential impacts, and approval of mitigation plans. The MNDNR also provided project management for the Draft SEIS.

Minnesota Pollution Control Agency

The MPCA evaluated the entire Draft SEIS and was particularly involved in the preparation of chapters pertaining to permit applications being evaluated for water quality standards, air quality, Section 401 certification, mercury, solid waste, and the evaluation of alternatives and mitigation of impacts related therein.

Minnesota Department of Health

The MDH participated in the review of water quality and air quality issues for the proposed ESMM project, particularly as related to the human health risk assessment.

Federal Land Managers

FLMs are responsible for protecting air quality related values in designated Class I areas. In Minnesota, Michigan, and Wisconsin, these Class I areas consist of the Boundary Waters Canoe Area Wilderness, Voyageurs National Park, Isle Royale National Park, and Rainbow Lake Wilderness. The associated FLMs for these areas are the U.S. Forest Service (USFS) for the Boundary Waters Canoe Area Wilderness and Rainbow Lake Wilderness and the National Park Service (NPS) for Voyageurs National Park and Isle Royale National Park. The project proposer and the MPCA are working closely with the FLMs to solicit their input on potential project impacts in advance of the completion of the air permit. This allows the FLMs to review the proposed ESMM project and associated mitigation plans to ensure compliance with FLM guidelines for protection of air quality related values.

Native American Tribes

The Mille Lacs Band of Ojibwe and Leech Lake Band of Ojibwe expressed interest in the opportunity to participate in the SEIS process for the proposed ESMM project. However, their participation was primarily in a monitoring role.

6.2 PUBLIC PARTICIPATION

Public notification and opportunities for agencies and the public to obtain information and submit comments on the proposed ESMM project began during the SEIS scoping process. On March 22, 2010, the MNDNR published the SEIS Preparation Notice in the Environmental Quality Board (EQB) Monitor to identify potentially significant environmental effects and request a 21-day public comment period. The comment period extended from March 22, 2010 to April 12, 2010, with a public informational meeting held March 25, 2010 in Nashwauk, Minnesota. The comments received were considered in making revisions to the issues identified in the Preparation Notice for evaluation in the SEIS. The Final Preparation Notice and Responses to Comments were issued in July 2010.

The Draft SEIS was published and circulated in accordance with the rules and requirements of Minnesota Rules (EQB Rules) 4410 and MEPA requirements. The Draft SEIS was distributed, as required, to allow for a minimum 35-day comment period to satisfy MEPA requirements. Written comments are being accepted during the public comment period. A public information meeting will be held to present information on the Draft SEIS, answer questions, and provide a forum for public comments. Comments received will be considered in assessing project impacts and potential mitigation for the Final SEIS. Responses to comments received will be prepared and included in the Final SEIS.

Record of Decision

Upon completion of the Draft SEIS public comment period, a Final SEIS and response to comments will be prepared. The Final SEIS serves as the complete SEIS for the proposed ESMM project. The MNDNR will receive comments on the adequacy of the Final SEIS during a 10-day public comment period.

6.3 DISTRIBUTION LIST

In accordance with MEPA requirements and Minnesota Rules 4410.2600, the Draft SEIS was made available for public review and comment. Copies were distributed to governmental units, public libraries, and interested parties. A list of Draft SEIS recipients is available from the MNDNR upon request.

Pursuant to Minnesota Rules, Ch. 4410.2700, Subp.3, copies of the Final SEIS will be provided to all persons receiving copies of the entire Draft SEIS; persons who submit substantive comments on the Draft SEIS; and to the extent possible, any person requesting the Final SEIS. Additional parties will receive the Executive Summary of the Final SEIS.

7.0 List of Preparers

The following table includes individuals and representative entities that have contributed to this SEIS.

Table 7.0-1. List of Preparers

AGENCY AND AFFILIATION	SEIS RESPONSIBILITY AND QUALIFICATIONS
Minnesota Department of Natural Resources (MNDNR)	
Lisa Fay	SEIS Project Manager B.S. Natural Resources and Environmental Studies 16 years experience in environmental review
Michael Liljegren	Mining Hydrologist B.S. Geosciences 15 years experience in hydrogeology/hydrology and 6 years in mine permitting and environmental review
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Peter T. Clevenstine	Manager of Engineering & Mineral Development B.S. Mining Engineering; M.B.A. Registered Minnesota Professional Engineer 30 years experience in mining engineering, mineral development, planning and operations
John Engesser	Chemical Engineer BCE; B.S. Chemistry and Mathematics Registered Minnesota Professional Engineer 29 years experience in mineral beneficiation research and mineral chemical extraction research
Kate Gunderson	Mineland Reclamation Specialist, Sr. B.S. Biology; M.S. Biology (emphasis: Wildlife Ecology) 2 years experience in mineland reclamation permitting and environmental review and Wetland Conservation Act administration
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Steve Ackerlund	Risk Assessor B.S. Chemistry and Environmental Science; M.S. Toxicology; Ph.D. Risk Communication and Environmental Conflict Resolution 25+ years of experience in environmental consulting; areas of specialty are project management, human health risk assessment, ecological risk assessment, and risk communication

AGENCY AND AFFILIATION	SEIS RESPONSIBILITY AND QUALIFICATIONS
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Jim Finley	Chemical Hydrogeologist B.S. Forestry; M.S. Geology/Hydrology; Ph.D. Geology/Geochemistry/Hydrology Registered Minnesota Professional Geologist 20+ years of experience in the application of geochemical and hydrological principles to address water quality and management issues in a variety of environments associated with natural resource extraction and use
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Nancy-Jeanne LeFevre	Water Resources Engineer B.S. Biology; M.S. Environmental Engineering 5 years experience in environmental and water resources engineering, hydrologic/hydraulic modeling, and development permitting
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