Laurentian Taconite Mine

DRAFT ENVIRONMENTAL IMPACT STATEMENT

MINNESOTA DEPARTMENT OF NATURAL RESOURCES

JUNE 1990

Draft Environmental Impact Statement for the Laurentian Taconite Mine Gilbert, Minnesota

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Abstract — This Draft EIS documents the analysis of potential impacts associated with developing or not developing the Laurentian Mine. Issues include surface water, groundwater, water quality, air quality, noise/vibration, vegetation/wetlands, fish/wildlife, and socio-economics.

Certification of Responsible Government Unit — I hereby certify that the information contained in this document is true and complete to the best of my knowledge and that copies of the completed Draft EIS have been made available to all points on the official EQB distribution list.

Karen L. Bowen — 6/15/90

Karen L. Bowen — Date
Assistant Commissioner for
Planning and Special Services

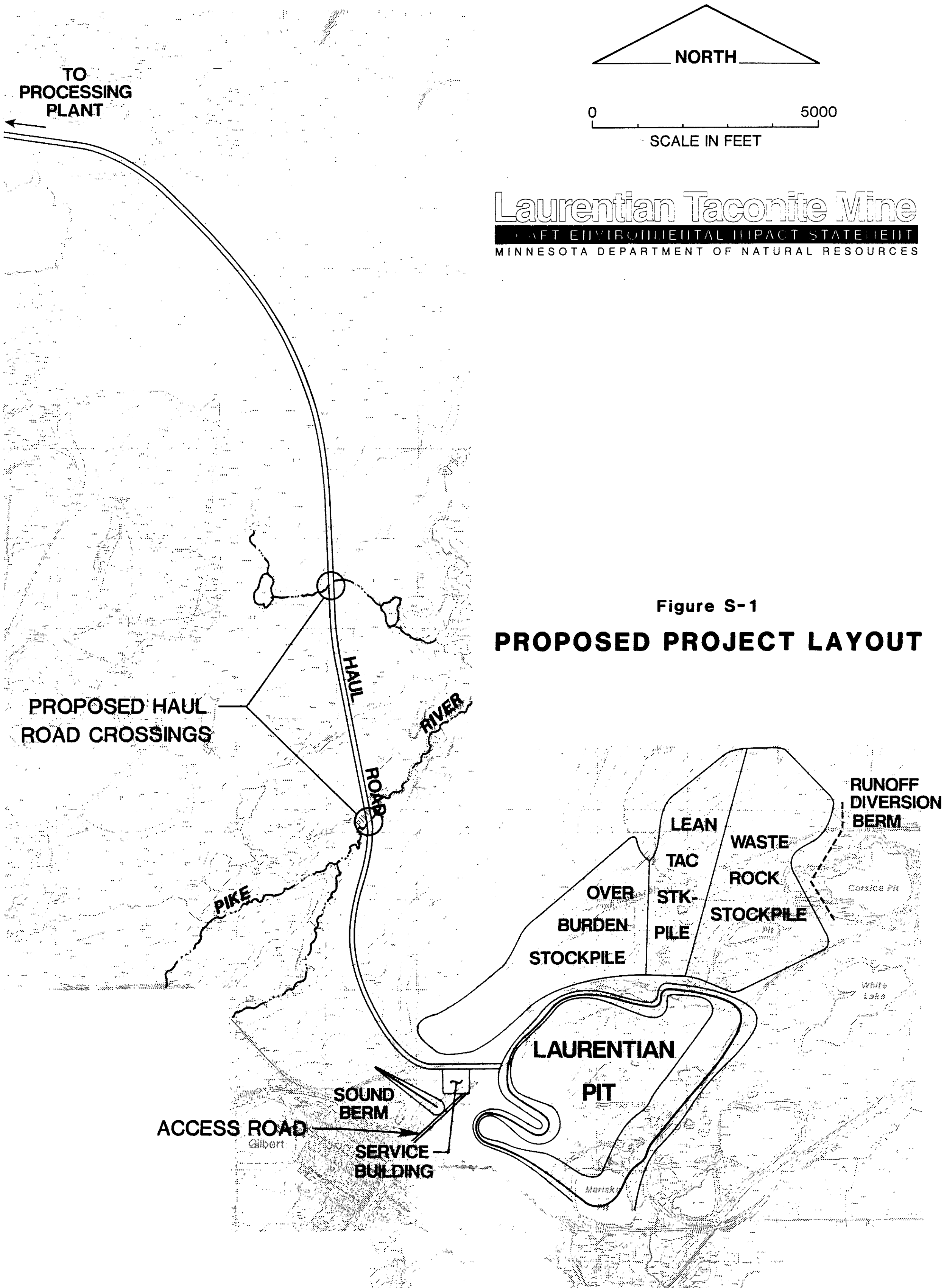

Figure S-1

PROPOSED PROJECT LAYOUT

SUMMARY: *Laurentian Taconite Mine Draft Environmental Impact Statement (EIS)*

The Proposed Mine and This Draft EIS

The proposed project is the development of a new open pit mine for the extraction of taconite ore. The 1,200-acre project would include construction of and mining from an open pit; establishing an adjoining stockpile area for overburden, waste rock, and lean taconite; constructing a 6-mile haul road for trucking the mined ore to the processing plant; and constructing a service building that would include an equipment maintenance shop, shower and locker facilities for the employees, and an office (Figure S-1).

The project proposer, Inland Steel Mining Company, currently operates the Minorca Mine facility approximately 6 miles northwest of the proposed Laurentian Mine. The Minorca facility includes an open pit taconite mine, a taconite pelletizing plant, a tailings disposal basin, and associated equipment and administration support facilities. This facility was the subject of an EIS prepared by the Department of Natural Resources (DNR) in 1973-1974. Taconite ore from the new Laurentian Mine would be hauled to the Minorca plant for crushing, processing, and pelletizing. At current mining rates, the Minorca Mine will be exhausted of minable crude ore at the end of 1992. Opening the Laurentian Mine would make it possible for Inland Steel to continue taconite pellet production at the Minorca plant for approximately 40 years.

In accordance with the rules of the Environmental Review Program, the DNR has prepared a Draft Environmental Impact Statement (EIS) to determine how construction and operation of the Laurentian Mine could impact:

Surface Water	Air Quality
Groundwater	Vegetation and Wetlands
Water Quality	Fish and Wildlife
Noise and Vibration	Socio-Economics

White Lake, Leaf Lake, and the Corsica Pit water levels should be monitored on a monthly basis during mine construction and operation and after mining has ended until water levels stabilize.

The Mariska Pit would be engulfed as the Laurentian Mine was expanded. It is anticipated that the Pike River and other surface waters in the area would experience no significant impact in terms of water quantity.

Groundwater

Mine dewatering could lower White Lake up to 6 feet by lowering the surrounding groundwater levels. This impact and potential corrective measures are discussed in the previous surface water section.

Mine dewatering could also lower Corsica Pit up to 3 feet and Lake Orebegone up to 1 foot, but these drops are not considered significant because the lakes are deep and have steep sides. However, these lake levels should be monitored on a monthly basis to promptly detect significant fluctuations.

Lake Orebegone is an important recreational area, so if its water level were to drop significantly, a portion of the Laurentian minewater should be diverted to the lake. If a water level drop restricted public access to the lake, corrective measures should be taken, such as pumping in minewater or extending the existing boat ramp.

The Laurentian Mine would not be expected to affect water levels in nearby wells.

Water Quality

Construction of the Laurentian project could degrade surface water quality because disturbed and exposed soil surfaces can more easily erode and add sediment and nutrients to the Pike River and area lakes. Temporary watershed Best Management Practices (BMPs) should be applied to protect water quality from construction-related impact.

Runoff from the haul road could have adverse water quality impacts on the Pike River during infrequent storm events or during periods of snowmelt if the runoff

This summary briefly describes the major impacts expected to result from the proposed project and discussed in the Draft EIS. Techniques to compensate for or reduce those impacts are identified as well. After a public review period, comments received on the Draft EIS will be addressed in a Final EIS to be prepared by the DNR.

The alternative to opening the new Laurentian Mine is to mine out the Minorca Mine and shut down the Minorca plant when the ore is exhausted. The impacts of this alternative are addressed in this EIS as well. Other alternatives were rejected during the scoping process.

Surface Water

Surface water impacts are changes in the amount of water in area lakes and rivers. Surface water would be affected by mine dewatering and changes in the size and nature of areas draining to lakes. These impacts would increase gradually throughout the mine's life, with the greatest impacts towards the end of mine operation, when the mine and stockpiles are largest. Significant surface water impacts would involve White Lake, Leaf Lake, and the proposed mine dewatering route.

White Lake could drop up to 6 feet. If the lake dropped below its historical range of fluctuation, some of the Laurentian Mine dewatering discharge could be sent to White Lake to maintain historical levels. After mining ended, the lake would still be about half a foot lower than before mining because less area would drain to it.

Leaf Lake would rise an average of 8 inches and up to 15 inches in the spring because water from the Laurentian pit would be discharged into the lake. The lake would return to its previous level after mining ended. These higher water levels could be reduced by replacing, and possibly lowering, the Chestnut Drive culvert that outlets the lake. Also, the channel immediately downstream of the culvert should be cleared of sediment and debris.

To avoid flooding along the dewatering ditch, culverts should be installed or enlarged at five locations. The ditch should also be cleared of trees, sediment, and debris.

The Corsica Pit (McKinley's water supply) could drop up to 3 feet, but this is not considered significant because the pit is deep with steep sides. No corrective measures are considered necessary, but the water supply intake might have to be modified.

While the resulting noise and vibration would be perceptible at some locations, it would be within the acceptable limits set by the Minnesota Pollution Control Agency and the Minnesota Department of Natural Resources, with two temporary or short-term exceptions:

1. during sound attenuation berm construction, and

2. during stockpiling (once stockpiles within 2,500 feet of the berm exceeded the berm height and only between 10:00 and 11:00 p.m., when nighttime noise standards apply).

Inland Steel is proposing the use of well-tested blasting procedures along with a blast monitoring program to minimize noise and reduce the risk of vibration damage. A small test blast would be used before each main (production) blast to determine if excessive noise and vibration would result from the main blast. If the test blast indicated the state's allowable air shock limits could be exceeded, the main blast would be postponed until ambient conditions improved. In addition, the sound attenuation berm near Gilbert would reduce sounds from the mine, service building, and haul road.

Beyond the measures indicated above, no additional action is considered necessary to mitigate noise and vibration impacts from construction and operation of the Laurentian Mine. However, it would be appropriate for Inland Steel to provide a 24-hour employee-staffed telephone "hotline" for citizens to register any complaints, comments, or questions regarding noise, vibration, and blasting impacts.

Vegetation and Wetlands

The Laurentian project as proposed would remove or alter approximately 860 acres of aspen-birch-balsam forest and 71 acres of wetland (primarily alder and coniferous swamps). The 600-acre stockpile area would be revegetated and reclaimed as required by state reclamation rules. Wetland losses should be compensated by replacement with wetlands of similar or better habitat value.

Approximately 20 acres of wetland would be affected by the proposed haul road. Alternative haul road routes, which could reduce the amount of wetland affected to 5-10 acres, are discussed in the Draft EIS. Culverts should be properly placed at wetland crossings to continue the natural flow of water and to avoid significant changes in wetland water levels.

were not controlled by BMPs. Runoff detention/sedimentation ponds, in combination with vegetated swales along the road, are possible corrective measures.

Water quality in Leaf Lake could degrade because the lake would receive Laurentian pit water, which, by virtue of its volume, could contain a significant amount of phosphorus. As a result, the lake could have increased algal growth in summer. White Lake would not be affected significantly in terms of summer water quality, but lower water levels could lead to winter fish kills. The Corsica Pit's water quality could improve because its watershed area and corresponding phosphorus load would be reduced. Long-term watershed Best Management Practices should be used to protect the water quality of all three lakes. Watershed BMPs are listed and described in Appendix E of the Draft EIS.

Air Quality

Construction and operation of the proposed Laurentian Mine would create dust through haul road truck traffic, stockpile wind erosion, materials handling, and blasting. Truck traffic on the haul road is expected to be the main cause of dust. Inland Steel would use a number of measures to mitigate air quality impacts, as currently required in their state air quality permit. These measures include watering the haul road; using proper stockpile design, location, and revegetation; and using certain blasting procedures.

With implementation of these measures, no significant air quality impacts are expected from construction and operation of the Laurentian Mine. Except for the haul road, operation of the Laurentian Mine would cause fugitive dust emissions similar to those at the Minorca Mine, which has consistently operated within state and federal air quality standards.

Noise and Vibration

The greatest noise and vibration impacts of the proposed project would result from haul road truck traffic, stockpiling, mine equipment operation, and blasting. Of particular concern are impacts on the nearest residence (which is 1,300 feet from the eventual project boundary), the residential area on the north side of Gilbert, and the Gilbert wastewater treatment plant near the proposed mine boundary. A sound attenuation berm would be constructed to reduce noise impacts.

6. The haul road should be closed to the public during the life of the mine, and abandoned and reclaimed after mining ends. This would be especially helpful in minimizing impacts to the eastern timber wolf.

Socio-Economics

If the Laurentian Mine were developed, no adverse socio-economic impacts are anticipated, and no mitigation is considered necessary. Rather, it is expected that the Laurentian Mine and on-going operation of the Minorca Plant would continue the socio-economic benefits currently provided by the Minorca facility.

If the Laurentian Mine were not developed, the Minorca Mine and plant would probably close sometime between 1992 and 1995, with resulting adverse impacts. For example, approximately 328 jobs and $12 million in annual employee compensation would be lost. Socio-economic impacts are the only adverse impacts that are expected to result from the no-build alternative.

Should the Minorca mine and plant close, a variety of state or federal programs could be implemented to assist the City of Virginia and the communities most heavily impacted by the closure and resulting loss of employment and tax revenues. For example, the Minnesota Department of Jobs and Training is implementing the federal Economic Dislocation and Worker Adjustment Assistance Act, which was created to assist workers and their communities facing a plant closing or permanent mass layoff. This act provides for programs such as retraining, counseling, testing, and limited relocation.

Wetland water flows could be reduced by mine dewatering and subsequent lowering of groundwater levels. Dewatering discharge could be rerouted to restore water levels to wetlands that appeared affected.

Fish and Wildlife

The Laurentian project would impact fish and wildlife primarily by disturbing or destroying their habitats. It is generally assumed that habitats surrounding the project area are at carrying capacity and that although displaced individuals may temporarily relocate, over time the population would be reduced. In addition, some individuals or eggs would be harmed during construction and mine operation.

The stockpile area would be revegetated; however, the habitat provided would be different than that destroyed. The mine pit would eventually become a 440-acre water-filled pit.

Two federally-designated threatened or endangered species are present nearby, the eastern timber wolf and the peregrine falcon. No significant impacts to either species are expected.

Measures to mitigate impacts on fish and wildlife include the following:

1. The Laurentian Mine should be designed to provide a cold- or coolwater fisheries habitat.

2. If necessary, route minewater to White Lake and/or install aeration systems to protect White Lake's fisheries.

3. Stockpile revegetation could be designed to encourage use by desired wildlife species. For example, stockpiles could be revegetated to serve sharp-tailed grouse, a wildlife species of special importance in northeast Minnesota.

4. To protect Pike River fisheries, the crossing culvert should be designed to promote fish passage and the road should have measures to control erosion and sedimentation.

5. The haul road could be relocated to impact fewer wetlands, which provide important fish and wildlife habitat.

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List of EIS Preparers

These are the people primarily responsible for preparing and reviewing this Draft Environmental Impact Statement on the Laurentian Mine. In summary, the Draft EIS was prepared by engineers and scientists from Barr Engineering Co. Assistance was provided by a subconsultant to Barr, David Braslau Associates. The EIS was guided and reviewed by personnel from the Minnesota Department of Natural Resources and the Minnesota Pollution Control Agency. Jon Holmes, Inland Steel's Project Manager for the proposed mine, provided relevant project details and background data required to determine existing conditions.

TIM SKOGLUND	**Barr Engineering Co.**
Project Role:	Provide Overall Administration and Quality Control (Principal-In-Charge) Manage Study of Water Appropriation Impacts
Years Experience:	15
Professional Discipline:	Civil Engineering
Focus of Experience:	Mining, Water Resources, Environmental Impacts
Education:	M.S., Civil Engineering Bachelor of Civil Engineering

FRANK SVOBODA	**Barr Engineering Co.**
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Professional Discipline:	Wildlife Biology
Focus of Experience:	EIS and Other Environmental Studies
Education:	M.S., Forestry Resources and Recreation B.S., Wildlife Management

DAVID BRASLAU	**David Braslau Associates** **Subconsultant to Barr Engineering Co.**

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Project Role:	Study Water Appropriation Impacts
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Focus of Experience:	Groundwater and Subsurface Studies
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Education:	B.S., Civil Engineering

ERIC EDWALDS | **Barr Engineering Co.**

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Focus of Experience:	Air Quality Studies
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Project Role:	Study Vegetation, Wetlands, Fisheries, and Wildlife Impacts
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Focus of Experience:	Fisheries, Wildlife, and Water Quality Studies
Education:	M.S., Water Resources Management and Aquatic Biology B.S., Biology

MEG RATTEI **Barr Engineering Co.**

Project Role:	Study Water Quality Impacts
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Professional Discipline:	Aquatic Biology
Focus of Experience:	Water Quality Studies
Education:	B.S., Biology

DAVID MELMER **Barr Engineering Co.**

Project Role:	Study Water Quality Impacts Study Vegetation, Wetlands, and Wildlife Impacts
Years Experience:	4
Professional Discipline:	Biology
Focus of Experience:	Water Quality Studies
Education:	B.S., Biology

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Professional Discipline:	Natural Resources Planning
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Education:	M.S., Wildlife Recreation Management B.S., Biology

THOMAS BALCOM	**Minnesota Department of Natural Resources** **Office of Planning**
Project Role:	Project Oversight
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Professional Discipline:	Natural Resources Planning
Focus of Experience:	Natural Resources Planning, Land Use Planning and Zoning, and Environmental Review
Education:	M.A., Geography (Pending) B.A., Geography

DON BUCKHOUT	**Minnesota Department of Natural Resources** **Office of Planning**
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Professional Discipline:	Natural Resources Planning
Focus of Experience:	Resources Planning and Environmental Review
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HOSSEIN AKHAVI-POUR	**David Braslau Associates Subconsultant to Barr Engineering Co.**

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Professional Discipline:	Economics
Focus of Experience:	Economic Studies and Research
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Focus of Experience:	Economic Studies and Research
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Years Experience:	19
Professional Discipline:	Mineland Hydrology
Focus of Experience:	Mineland Hydrology and Forestry
Education:	B.S., Forest Hydrology

LAUREL REEVES	**Minnesota Department of Natural Resources** **Division of Waters**

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Education:	B.A., Geology

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Professional Discipline:	Wildlife Management
Focus of Experience:	Wildlife Management, Wildlife Research, and Environmental Review
Education:	B.S., Wildlife

PAUL POJAR — **Minnesota Department of Natural Resources**
Division of Minerals

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Professional Discipline:	Geological Engineering
Focus of Experience:	Mineland Reclamation Engineering
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DENNIS ASMUSSEN — **Minnesota Department of Natural Resources**
Division of Minerals

Project Role:	Review Draft and Final EIS
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Division of Waters

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Project Role:	Collect and Review Wildlife and Fisheries Data Review Draft and Final EIS
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Focus of Experience:	Environmental Review
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JEFFREY LIGHTFOOT	**Minnesota Department of Natural Resources** **Division of Fish and Wildlife**
Project Role:	Collect and Review Wildlife Data
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Focus of Experience:	Wildlife Management
Education:	B.S., Wildlife Biology

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Project Role:	Review Draft and Final EIS
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Professional Discipline:	Biology
Focus of Experience:	Wildlife Biology, Natural Resources Planning, Environmental Review, Outdoor Recreation Planning, Pollution Control Coordination
Education:	B.A., Biology

Project Purpose and Overview

Inland Steel Mining Company proposes to develop the Laurentian Taconite Mine, a new open pit mine in St. Louis County near Gilbert and McKinley, Minnesota. This mine would provide a source of taconite ore to replace the supply nearing exhaustion at Inland's Minorca Mine in Virginia, Minnesota.

The Laurentian Mine would provide enough ore for the Minorca Taconite Plant to operate until 2031. Mine construction is proposed to begin in 1991 with operation continuing for 40 years.

The 1,200-acre project would consist of a 440-acre open pit, a 600-acre overburden and waste rock stockpile area, a service building, and a new 6-mile haul road leading to the existing Minorca Plant northeast of Virginia. The initial construction cost is estimated at $10 million.

Crude taconite ore would be mined using standard procedures, loaded onto mine haul trucks, and transported via the new road to the Minorca Plant for processing. The processing tailings would be disposed of in the existing, permitted Minorca tailings basin.

Figures and a detailed description of the construction and operation of the proposed Laurentian Mine are provided in Section 3, "Proposed Project and Alternatives."

SECTION 1: Introduction

Purpose of the Draft EIS

The purpose of this Draft Environmental Impact Statement (EIS) is to provide information needed to:

- Evaluate the proposed project's potential for significant environmental effects
- Consider alternatives
- Explore methods for reducing adverse effects
- Provide information to the public

The EIS is not intended to justify either a positive or negative decision on a project. Instead, it is to be used as a guide in issuing or denying permits or approvals for a project and in identifying measures necessary to avoid or mitigate adverse environmental effects.

An Environmental Impact Statement is required by the rules of the Minnesota Environmental Quality Board (EQB) for the construction of a new facility for mining metallic minerals (Minnesota Rules 4410.4400, Subpart 8). This Draft EIS discusses and evaluates the impacts, alternatives, and mitigation measures associated with construction of the proposed Laurentian Taconite Mine.

Minnesota Department of Natural Resources

Type of Permit: Water Appropriation Permit
Status: To Be Submitted

Comments: This permit is for pumping accumulated groundwater, rainfall, and snowmelt out of the Laurentian Mine.

Minnesota Department of Natural Resources

Type of Permit: Protected Waters Permit
Status: Submitted and Awaiting Approval

Comments: This permit is for building a crossing over the Pike River for the new haul road to the Minorca Plant. The Pike River is a DNR Protected Water. This permit is also for filling 3 acres of wetland for the crossing.

Minnesota Pollution Control Agency

Type of Permit: NPDES-SDS
Status: Pending

Comments: This permit is for discharging mine water to the surrounding environment and will contain water discharge effluent limits and monitoring requirements.

Minnesota Pollution Control Agency

Type of Permit: Permit for Storage of Liquid Substances
Status: To Be Submitted

Comments: This permit is for storing fuels and lubricants at the proposed project site. Since construction of these facilities is scheduled for 1991, this permit would be applied for at a later date.

SECTION 2: Government Approvals

Inland Steel Mining Company must obtain these permits and approvals for the proposed Laurentian Taconite Mine.

U.S. Army Corps of Engineers, St. Paul District

Type of Permit:	Section 404 Permit
Status:	Denied Without Prejudice
Comments:	Issuance of Permit requires MPCA 401 certification - see MPCA 401 certification comments.

Minnesota Department of Natural Resources

Type of Permit:	Amended Permit to Mine
Status:	To Be Submitted
Comments:	The process for amending Inland Steel's Permit to Mine has already begun. Inland Steel and the DNR held a pre-application conference to discuss the permit information that the company must provide. The Draft EIS is expected to contain much of the information needed for permitting. Additional data will be supplied by Inland Steel as necessary.

Minnesota Pollution Control Agency

Type of Permit:	401 Certification of Corps Section 404 Permit
Status:	Denied Without Prejudice
Comments:	401 certification may not be issued until the environmental review process has been completed.

St. Louis County, Minnesota

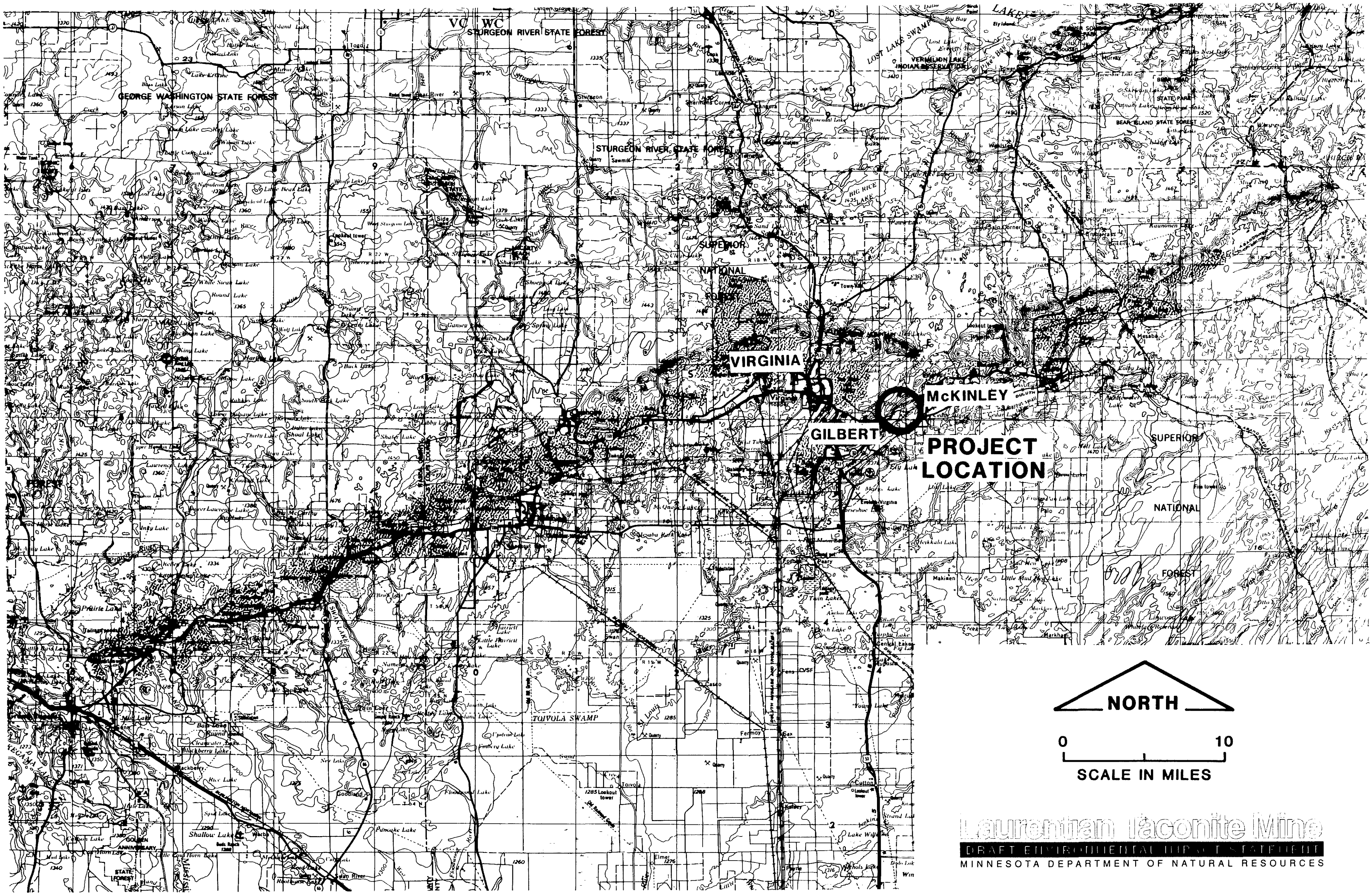
Type of Permit:	Zoning Change
Status:	To Be Submitted
Comments:	Section 19, T58N, R16W north of Highway 135 would need to be rezoned from rural residential to open mining.

St. Louis County, Minnesota

Type of Permit:	Land Use Permit
Status:	To Be Submitted
Comments:	Once section 19, T58N, R16W is rezoned to open mining (see above), a Land Use Permit for this area must be obtained from the County Planning Commission.

City of Gilbert, Minnesota

Type of Permit:	Zoning Change (Possible)
Status:	To Be Submitted (If Needed)
Comments:	A meeting between Inland Steel and the City of Gilbert in May will determine the need for a zoning change.



Laurentian Taconite Mine
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MINNESOTA DEPARTMENT OF NATURAL RESOURCES

Figure 3.1

PROPOSED PROJECT LOCATION

SECTION 3: Proposed Project and Alternatives

The Laurentian Taconite Mine

Inland Steel Mining Company proposes to develop the Laurentian Taconite Mine, a new open pit mine in St. Louis County between Gilbert and McKinley, Minnesota. Located in the Biwabik Iron Formation, the Laurentian Reserve would be a source of taconite ore to replace the supply nearing exhaustion at Inland's Minorca Mine in Virginia, Minnesota.

Mine construction is proposed to occur in 1990-1991 with operations continuing for 40 years until 2031. The 1,200-acre project would consist of a 440-acre open pit, a 600-acre overburden and waste rock stockpile area, a service building, and a new 6-mile haul road leading to the existing Minorca Plant northeast of Virginia.

Figure 3.1 shows the location of the proposed Laurentian Mine, Figure 3.2 shows the proposed project layout, and Figure 3.3 shows a cross section of the area to be mined. The proposed project consists of mine construction and mine operation.

During the scoping process, it was felt that operational phasing (i.e., the stages of mine development) was important to evaluate. Phase One would span the first 10 years and include pre-mining preparations such as tree and brush removal, overburden stripping, electrical powerline and haul road construction, and construction of a service building. Opening of the mine pit and mining activities would also be part of Phase One. Phase Two would consist exclusively of mining activities with expansion of the mine pit and stockpile areas.

In this Draft EIS, these two phases are generally referred to as mine construction and mine operation. These two aspects of the mining project are described in greater detail in the following text.

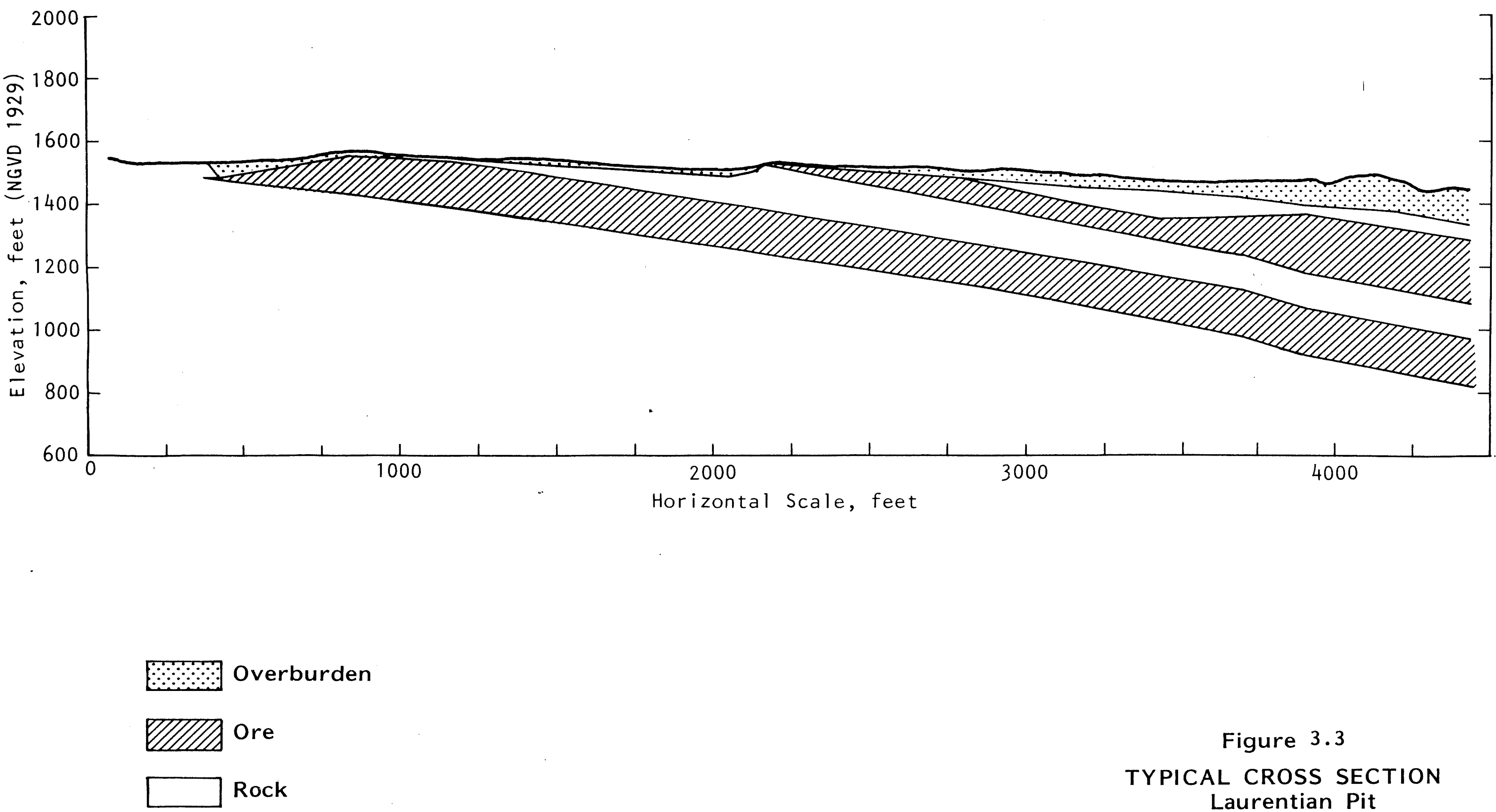

Figure 3.3

TYPICAL CROSS SECTION
Laurentian Pit

Laurentian Taconite Mine

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MINNESOTA DEPARTMENT OF NATURAL RESOURCES

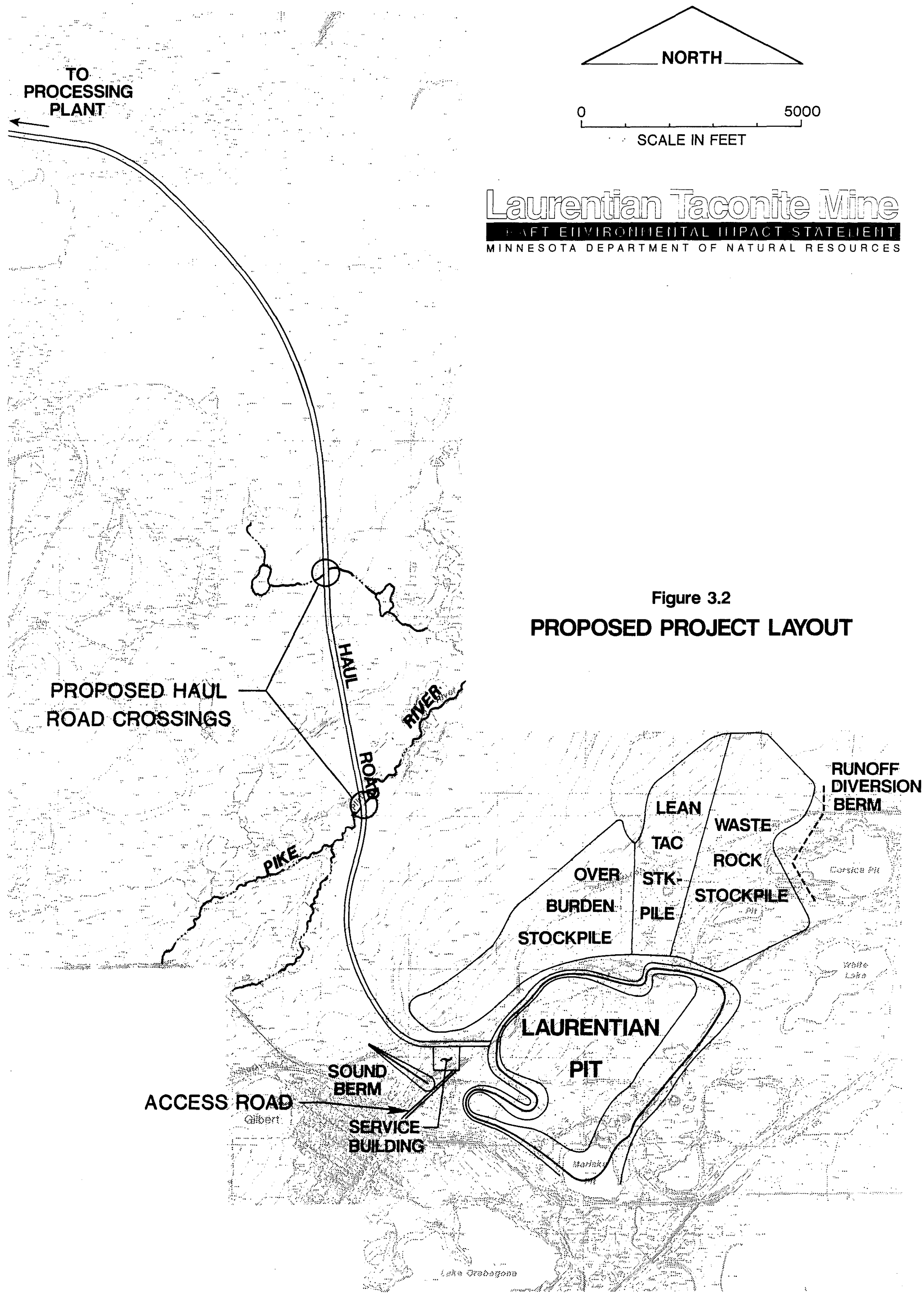


Figure 3.2

PROPOSED PROJECT LAYOUT

2. Haul Road Construction

During late 1990, a 6-mile haul road would be built for trucks to haul ore from the Laurentian Mine to the Minorca Plant northeast of Virginia, Minnesota. The road would be about 120 feet wide on the top; the base width would vary with the depth of fill. The road would be built of stripped glacial overburden overlain by a 6-foot layer of crushed mine waste rock removed from the existing Minorca Mine. The road embankment sideslopes would be covered by riprap (stones and rocks) for erosion control. The total volume of materials that would be used in road construction is estimated at 2.8 million cubic yards.

The road is proposed to cross the headwaters of the Pike River, a state Protected Water. The crossing would require wetland filling and installing a culvert with enough capacity to handle high water flows. A small creek bed, north of the crossing (Figure 3.2), would be culverted as well.

At the Pike River crossing are peat soils 4 to 5 feet deep for a distance of approximately 300 feet along the road alignment. Shallower peat extends further to the south. The peat would be excavated at the crossing's culvert and compressed under the road fill elsewhere. By using appropriate fill placement techniques, displacement of peat and the resulting disturbance of wetlands adjacent to the road could be minimized.

A zone cleared of trees would run along each side of the road. The width of the road plus clear zone is proposed to be 300 feet. Figure 3.4 provides a cross-section of the proposed haul road. In addition, an 1,800-foot long sound attenuation berm, with a maximum height of 50 feet, would be built along the south side of the road at the Gilbert end, between the road and the town (Figure 3.2). This berm would be vegetated for erosion control.

3. Transmission Line Construction

Minnesota Power and Light Company would build a transmission line to provide electricity solely for the proposed service building and electric mining machinery. This line would lead from an existing 30 kV powerline near the site's northern boundary to the proposed service building. The new 3.4-mile single pole line would run along the west side of the proposed haul road within the clear zone where possible. Construction details are still being determined by Minnesota Power.

Mine Construction

Inland Steel proposes to begin construction of the Laurentian Mine in 1990-1991. Mine construction would involve: clearing and brushing the pit and stockpile areas proposed to be used during the first ten years of operation; removing overburden from part of the mining area; and building the haul road, electrical transmission line, and service building. The initial construction cost is estimated at $10 million.

1. Initial Overburden Removal

Initially, approximately 1.2 million cubic yards of glacial overburden (soil and rock above the ore) would be removed from the north end of the Laurentian ore body. As mining progressed, overburden would be removed from other sections within the mining area (see Figure 3.3.).

Overburden would be removed during a five-day work week with two shifts per day using electric power shovels with bucket capacities of 11 to 14 cubic yards. The overburden would be loaded into 120- to 195-ton trucks and stockpiled north of the mine. In the initial stages of pit development, one production shovel and four production trucks per shift would be used in the stripping operation, with an average of 80 trips per shift between the pit and stockpiles. Equipment sizes and capacities could increase in the future, and stripping quantities and schedules could change over time as mining practices dictated.

The initially stockpiled overburden would be used in haul road construction and to create a berm near Gilbert to muffle noise (see Figure 3.2).

The scoping EAW indicated that areas of steep slopes ranging from 8 to 18 percent are present in the project area. Such slopes may be a source of erosion and sedimentation with potential impacts on water quality. In the case of the proposed Laurentian Mine, the soils creating these sloping areas would either be stripped away as part of the overburden removal process or covered with waste rock piles. In either case, erosion of the natural slopes would not occur. In the one instance, the natural slopes are removed and in the other they are protected from erosion by the overlying waste rock pile.

4. Service Building Construction

A service building would be constructed near the mine, just north of Gilbert. It would contain offices, shower and locker facilities for mine workers, and an equipment and truck repair shop. Building dimensions would be approximately 160 feet long, 100 feet wide, and up to 60 feet high. Adjacent to the building would be an equipment parking lot, a fueling station, and an employee parking lot. An access road would be built between the service building area and the City of Gilbert. Water and sewer utilities for the building would be connected to Gilbert's municipal system. Figure 3.2 shows the location of the proposed service building and access road.

Mine Operation

Mine operation would begin in 1991 and continue until 2031. The major operational activities of open pit mining would be drilling and blasting; removing and stockpiling overburden and waste rock materials; hauling the mined ore to the Minorca Plant; and discharging minewater.

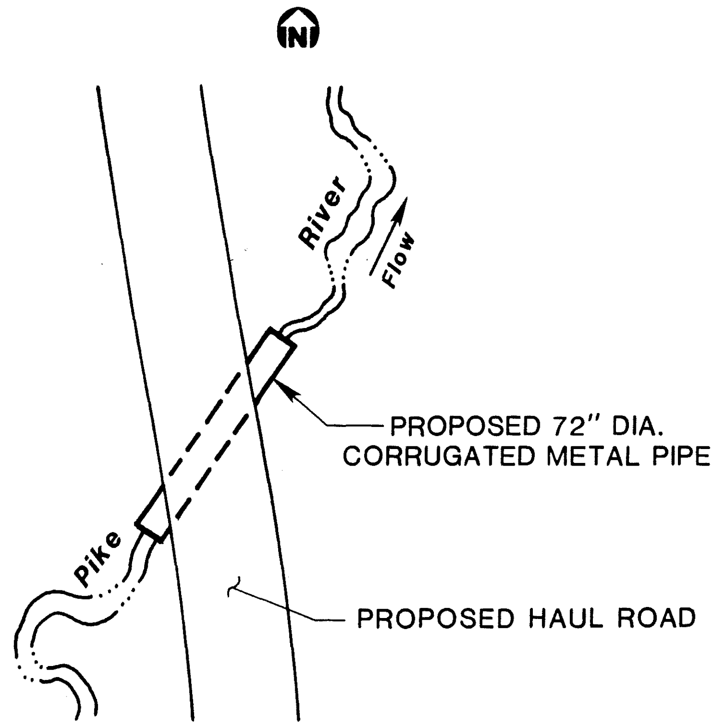
1. Open Pit Mining

Taconite ore mining would begin in early 1991 at a rate of 3.4 million long tons per year. During the first few years of operation, production from the Laurentian Mine would gradually increase with Laurentian Mine ore replacing ore from the Minorca Mine. The Minorca Mine will cease stripping operations in 1992 and removal will end by 1995. In 1995, the annual mining rate at the Laurentian Mine is proposed to increase to 7.2 million long tons or more for the remaining mine life.

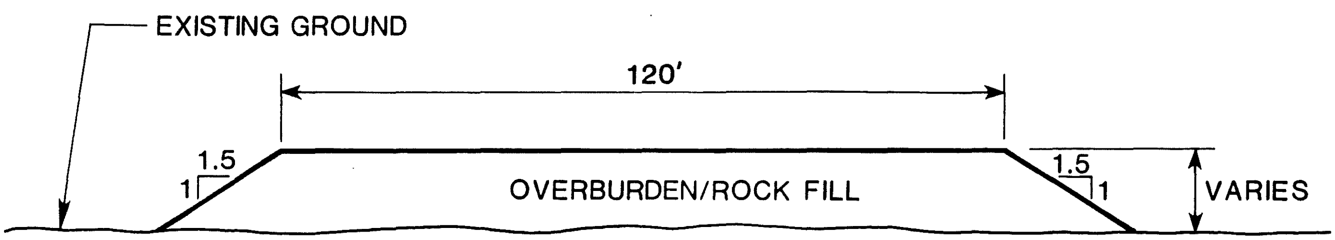
It is estimated that a total of 285 million tons of taconite ore would be removed from the Laurentian Mine. The mine would eventually reach 440 acres in size. Mining would initially be at least 2,000 feet from Gilbert residences, moving to within 1,300 feet of the nearest residence during later stages.

Mining would be accomplished by drilling and blasting the crude ore, loading it onto mine trucks, and transporting it to the Minorca Plant for crushing, processing, and pelletizing.

Drilling would be done with GD-120 rotary drills, using 13-3/4 inch diameter drill bits. Blast patterns would have anywhere from 30 to 200 drill holes with grid spacing averaging 30 by 34 feet. The drilled blast holes would be loaded with ANFO, emulsions, or a blend of the two products. The powder factor would be around 0.5

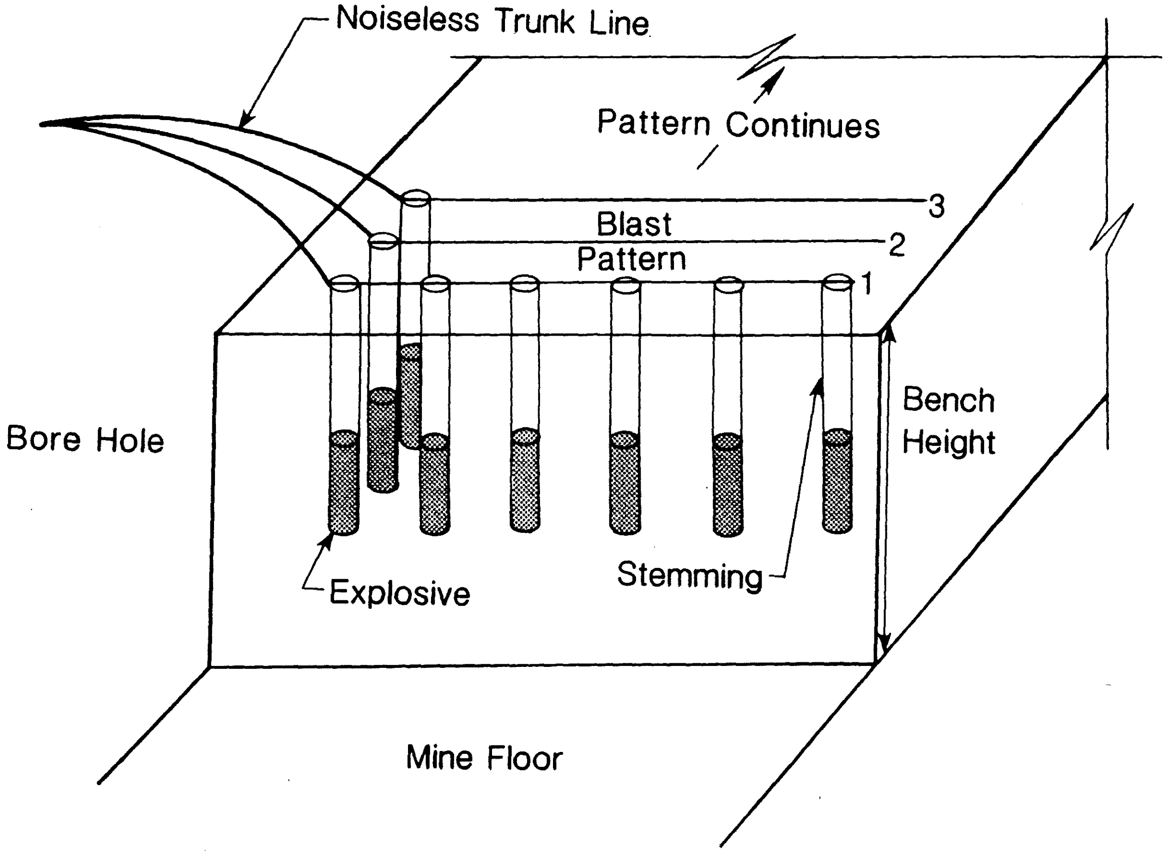


HAUL ROAD STREAM CROSSING
NOT TO SCALE



TYPICAL HAUL ROAD SECTION
NOT TO SCALE

Figure 3.4
PROPOSED HAUL ROAD



Notes:

Bore hole Diameter- 13-3/4"

Blast Pattern- 30 to 200 drill holes (Typically 140 holes)

Grid Spacing- 30 by 34 feet

Figure 3.5

TYPICAL BLASTING PATTERN

pounds of explosive per ton of material blasted. Figure 3.5 shows a typical blasting pattern. The actual pattern spacings, number of holes, and powder factor might vary with the area. Blasting would probably occur every two weeks, and no more than once a week.

Ore would be removed using electric power shovels with bucket capacities of 11 cubic yards or more, and/or front-end loaders with 12 cubic yards of capacity. Ore mining would take place on a five-day work week with three shifts per day.

2. Removal and Stockpiling of Other Materials

In addition to the taconite ore, approximately 2 million cubic yards of surface overburden, low-grade magnetic taconite, and waste rock would be removed annually.

Overburden stripping would be done as described above for initial overburden removal. Low-grade taconite (10 to 16 percent magnetic iron) and waste rock (less than 10 percent magnetic iron) would be drilled and blasted using the same methods as those described for higher grade ore.

The overburden, low-grade taconite, and waste rock would be separated into different stockpiles north of the Laurentian Mine. They would be stockpiled in landforms that comply with DNR Mineland Reclamation Rules and would be designed to maintain current natural watershed areas as much as possible.

Stockpile side slopes would include erosion-controlling benches to intercept runoff and carry it safely to natural ground. Internal drains constructed of coarse rock ("french drains") would also be used to control erosion by carrying water down through the stockpiles.

Stockpiling would begin approximately 1 mile from McKinley and could eventually reach 1,000 feet from the town. McKinley's water supply (the Corsica Pit) is located approximately 400 feet east of the proposed stockpiling area. A runoff diversion berm would be constructed to prevent stockpile runoff from directly entering the Corsica Pit. Figure 3.2 shows the location of the diversion berm.

Other Alternatives Considered

The EAW scoping process addressed and eliminated from further study a number of alternatives to the Laurentian Mine project. These include two alternative mining sites (Figure 3.6), non-mining alternatives, and alternative means of transporting ore from the mine to the Minorca Plant. These alternatives are summarized below, along with the reasons they were dismissed from further consideration.

Ordean Taconite Mine

The Ordean Reserve is just west of the existing Minorca Mine. It is permitted for mining and was a part of the original EIS for the Minorca Plant. However, developing an Ordean Taconite Mine was eliminated from further consideration in this Draft EIS for the Laurentian Mine because:

1. The reserve has fairly low-grade ore.
2. Much more overburden would have to be removed than from the Laurentian Mine.
3. The reserve is covered by wetlands.
4. Mining may cause serious slope failures along Highway 53.
5. The costs of resolving problems 1-4 above would make the Minorca Plant non-competitive with other taconite producers.

East Rouchleau Taconite Mine

The East Rouchleau Reserve is approximately 1 mile south of the Minorca Mine. Developing an East Rouchleau Taconite Mine was eliminated from further consideration in this Draft EIS because:

1. The reserve has fairly low-grade ore.
2. Much more overburden would have to be removed than from the Laurentian Mine.
3. Mining would occur next to Virginia's municipal water supply.
4. The reserve adjoins abandoned natural ore pits approximately 500 feet deep, which would make mining difficult.
5. The reserve is not controlled by Inland Steel.
6. The cost of resolving problems 1-5 above would make the Minorca Plant non-competitive with other taconite producers.

3. Minewater Discharge

Rainfall, snowmelt, and groundwater would be expected to accumulate in the new pit. This water would be pumped over land through a channel or pipe to the Mariska Pit, an abandoned water-filled mine on the southern boundary of the proposed site. Accumulated water would be pumped from the Mariska Pit to an existing drainage channel that flows south under Trunk Highway 135 to Leaf Lake about 1 mile south of the Mariska Pit. From Leaf Lake an existing drainage ditch would carry water approximately 3 miles to the Embarrass River. All proposed discharge-receiving waterbodies and courses are in the Lake Superior watershed.

During the last years of mine operation, the expanding Laurentian Mine would break into the Mariska Pit. At that time, the minewater would be discharged from sumps within the mine pit directly to the channel leading to Leaf Lake. If minewaters were to contain unacceptable levels of sediment, facilities for settling would need to be designed.

4. Taconite Transport and Processing, and Tailings Disposal

The taconite ore would be loaded into 120- or 195-ton production trucks and hauled 6 miles to the Minorca Taconite Plant. From 1991 to 1995, the Minorca Plant would receive ore from both the Minorca Mine and the proposed Laurentian Mine. During that time, there would be about 30 round trips per shift from the Laurentian Mine to the Minorca Plant. After the Minorca Mine is closed in 1995, the number of trips from the proposed Laurentian Mine would double.

The No-Build Alternative

If the Laurentian Mine were not developed, Inland Steel would consider closing the Minorca Taconite Plant permanently some time between 1992 and 1995. The plant now receives ore from the Minorca Mine, but this mine will be exhausted of mineable ore in 1992. Inland Steel considered other mining alternatives but determined that these alternatives would make the Minorca Plant non-competitive with other plants.

Non-Mining Alternatives

Recovery of ore from waste rock stockpiles was considered, but this alternative is not economically feasible at this time. However, most of the waste rock from the proposed Laurentian operation would be stored in segregated stockpiles in the event future technology makes recovery of ore from waste rock feasible.

Another alternative considered was using recycled materials as a full or partial substitute for taconite pellets at Inland's steel mill near Chicago. The production mill currently uses a mix of recycled materials and ore pellets. A certain percentage of ore-derived pellets is required to meet current production specifications.

Ore Transportation Alternatives

A conveyor system and a rail line were considered as alternatives to a new haul road to the Minorca plant, but were rejected during scoping because of high construction costs. Appendix B provides technical documentation about these alternatives.

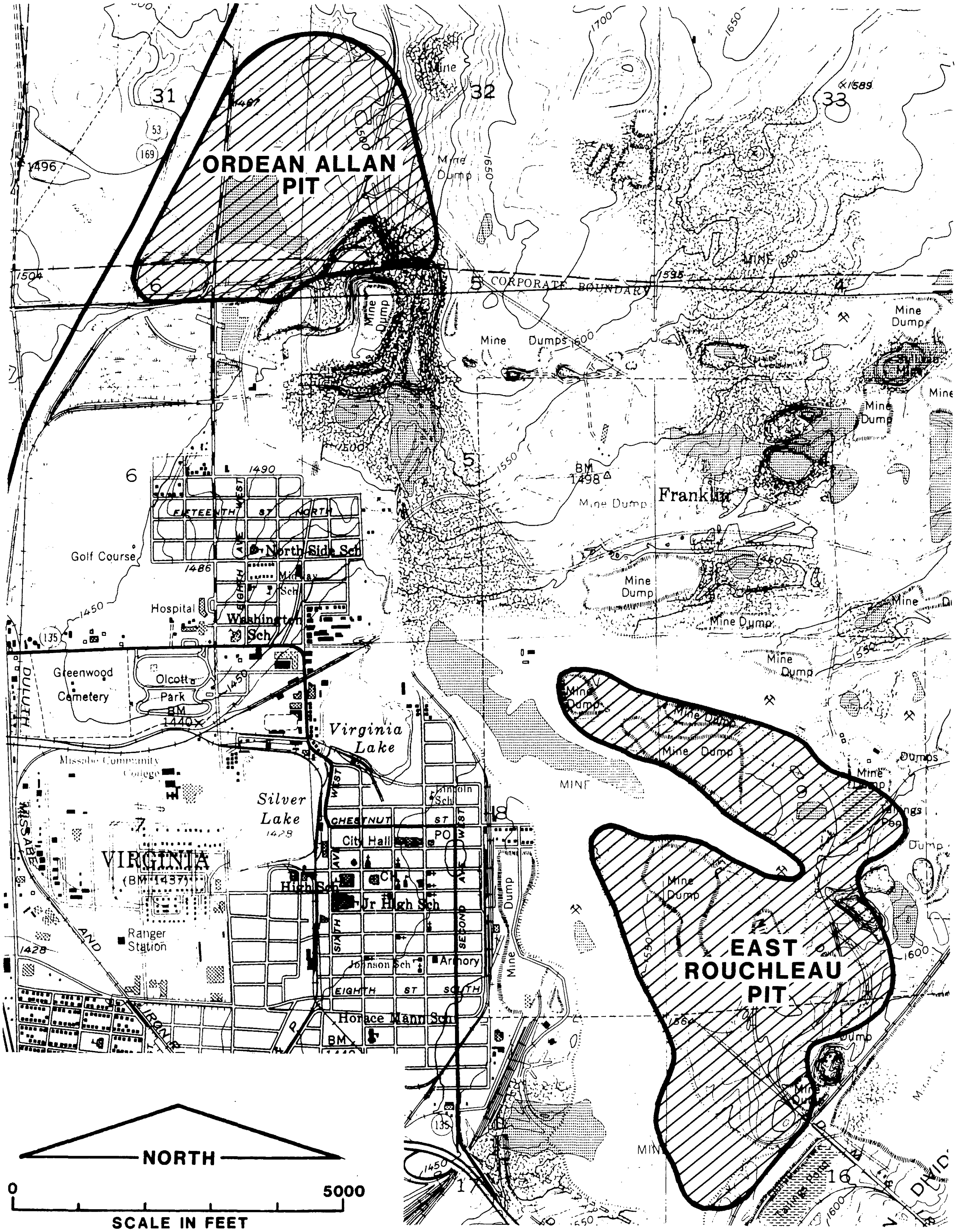


Figure 3.6

ALTERNATIVE POTENTIAL TACONITE MINES LOCATIONS DISMISSED FROM CONSIDERATION

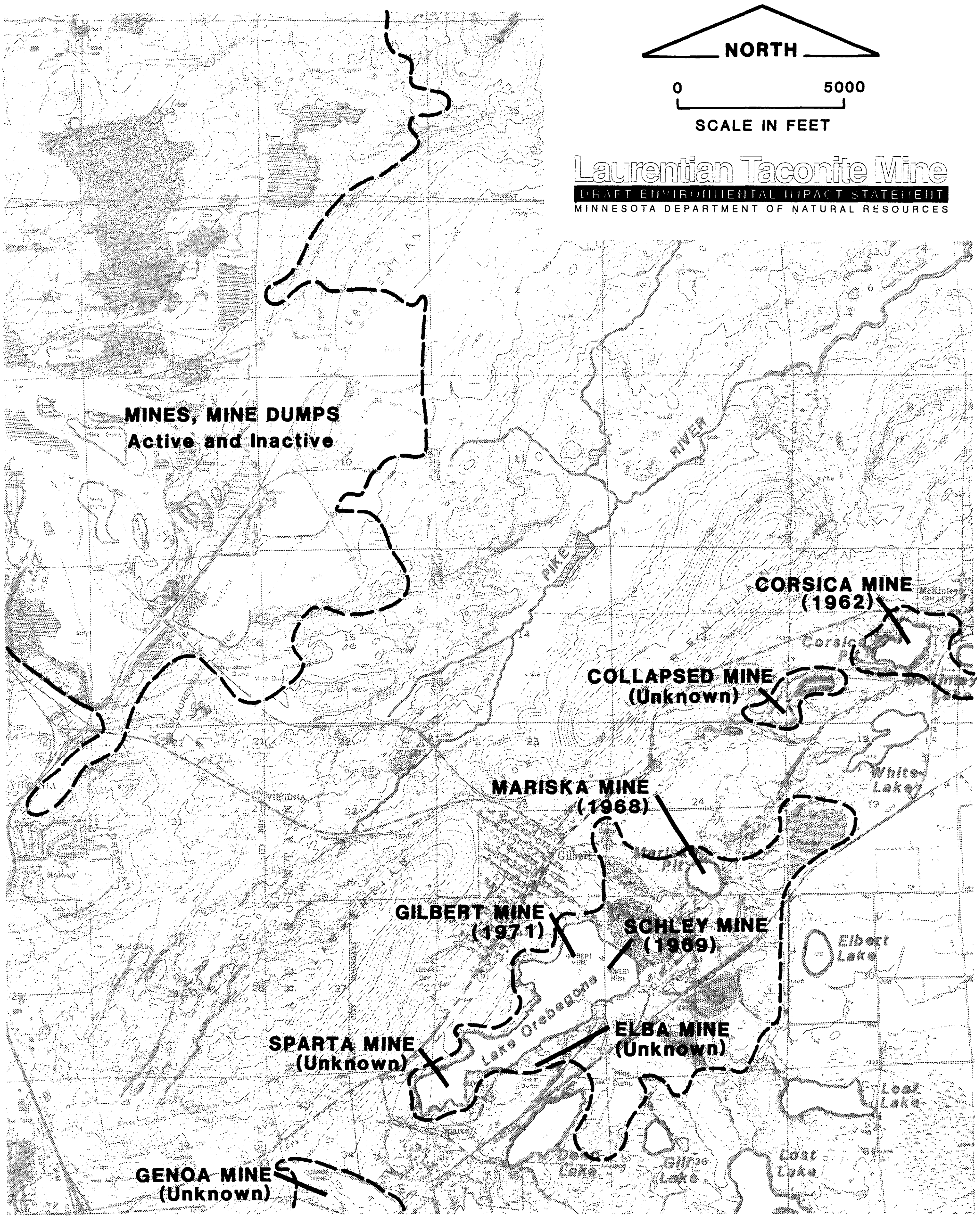


Figure 4.1

CORSICA MINE.......Mine Name
(1962).............(Date Last Used)

PREVIOUS AND CURRENT MINING ACTIVITY IN PROJECT AREA

SECTION 4: Existing Conditions

This section describes existing environmental and socio-economic conditions in the vicinity of the proposed Laurentian Mine project. Existing conditions are described in terms of:

- Surface Water
- Groundwater
- Water Quality
- Noise and Vibration
- Air Quality
- Vegetation and Wetlands
- Fish and Wildlife
- Socio-Economics
- Historical Background

Figure 3.1 (Section 3) shows the location of the proposed Laurentian Taconite Mine. The mine's northern boundary would be the Laurentian Divide, and the southern boundary would be Trunk Highway 135. To the northeast is the City of McKinley and to the southwest is the City of Gilbert.

Figure 4.1 shows past and current mining operations in the vicinity of the proposed Laurentian Mine. Much of the area in which the pit, stockpile area, and service building would be developed has been affected by past mining activities. The area contains abandoned and exhausted iron ore pits, old mine dumps, the abandoned mining town of Elcor, an abandoned farm, the abandoned Trunk Highway 135, a DM&IR railroad that will soon be abandoned, some second-growth forest, and small wetlands.

The proposed 6-mile haul road would cross a mixture of disturbed and undisturbed land. The road's northern 2 miles would cross land disturbed by the current Minorca operation, which is covered by a DNR Permit to Mine. The southern 4 miles would cross primarily undisturbed woodlands. However, much of this forested area is being harvested for timber products. The road would cross the headwaters area of the Pike River (a state-protected water), as well as some wetlands.

White Lake water level records are available for 1915 to 1978 (Figure 4.4). The historical water levels suggest that lake levels have been affected by past mining operations. After the Corsica Pit closed in 1954, lake levels followed a fairly consistent pattern, ranging between approximately Elevation 1421 and Elevation 1424. (All water level elevations in this Draft EIS are given in terms of height above mean sea level. Surveyors determine these elevations using a reference system known as the National Geodetic Vertical Datum of 1929.) The lake overflow point is estimated to be at Elevation 1423.2 but may be periodically affected by beaver activity.

Leaf Lake water levels are available for the period from 1948 to 1980 (Figure 4.5). The historical levels range from approximately Elevation 1387 to Elevation 1390. The pattern of historical levels suggests that the lake's outlet may have been raised approximately 1 foot in approximately 1965. A survey of the current outlet culvert (Elevation 1490.0) and the March 1990 water level (Elevation 1491.1) indicates that the outlet was raised approximately an additional foot since water level recording ceased in 1980. As expected, the lake level model indicates that existing condition water levels are well above historical levels.

The proposed dewatering route for the Laurentian Mine (Figure 4.10) would pass through Leaf Lake. It follows an existing ditch (figures 4.11 and 4.12) that flows from the vicinity of the Mariska Pit to an old sedimentation pond 1,200 feet northwest of Leaf Lake. Currently, the sedimentation pond has no surface outlet. The area between the sedimentation pond and Leaf Lake is currently wetland, and maps indicate a stream channel connecting the pond and Leaf Lake. Downstream of Leaf Lake, the proposed dewatering route would follow the existing ditch and stream that carry flow from Leaf Lake to the Embarrass River.

The existing surface water conditions summarized above are discussed in detail in the following pages.

Climate

The area of the proposed project averages approximately 27 inches of precipitation annually. At least 1 inch of snow is on the ground for 140 days in the

Surface Water

This section discusses the existing surface water conditions (primarily water levels) in the vicinity of the proposed Laurentian Mine project. Existing surface drainage patterns are complex due to the alterations in natural conditions caused by extensive past mining.

The land area that would be altered by the Laurentian Mine drains to four significant bodies of public water: the Corsica Pit, the Mariska Pit, White Lake, and Leaf Lake (Figure 4.2). Existing conditions of these lakes must be documented so that impacts of the proposed mining activities can be quantified.

Historical lake level data provide valuable information. However, predicting the impacts of mine construction and operation on surface water bodies can best be done with a computerized water budget model. Therefore, a model of existing conditions was developed as a basis for estimating impacts.

The model is based on the water budget illustrated in Figure 4.3. The model uses weather records to estimate how much precipitation returns to the atmosphere as transpiration from plants and evaporation from land and water surfaces. The remaining precipitation is divided between surface runoff and percolation to the groundwater. The model is adjusted so that the sum of surface runoff and percolation to groundwater equals the discharges observed for gaged watersheds in the region. The model totals the runoff and percolation estimated for the various types of land and water surfaces in each watershed. The model then routes the surface runoff and groundwater through the lakes and estimates lake levels. All of these calculations were done for each month using the local weather records for the period 1933 through 1986. This allows the development of modeled lake level records for either existing or impacted watershed conditions. Although the weather record uses past data, model results can be used to predict future averages and extremes.

Both the Corsica and Mariska pit lakes are assumed to approximately match the groundwater elevation. Modeling indicates that the pits seep water to the groundwater.

average year. On a long-term basis, precipitation exceeds water surface evaporation by about 5 inches annually.

Weather data used in the water budget analyses are summarized on average monthly and annual bases in Table 4.1. The averages represent the period of 1933 to 1986. The rainfall and temperature values are for the City of Virginia, Minnesota. The wind and relative humidity values are from Duluth and International Falls, Minnesota.

Surface Drainage Patterns

Figure 4.2 shows the lake watersheds that would be affected by the proposed project. The watershed of a lake is the land area whose surface water runoff flows to the lake. Mining activities that alter the land surface can change both the divides between watersheds and the amount of runoff from a given land area. In order to estimate the impacts mining would have on lake water levels, it is necessary to first establish existing conditions. Drainage from the land area that would be affected by mining activities flows to four public water bodies: 1) Corsica Pit, 2) Mariska Pit, 3) White Lake, and 4) Leaf Lake. Table 4.2 summarizes the acreages and land use for each lake watershed shown on Figure 4.2. The surface watershed of Lake Orebegone would not be altered by the proposed mining activities. Lake Orebegone is discussed in the groundwater sections of this Draft EIS.

The Corsica and Mariska pits have not been known to have surface outflow. Such lakes and their watersheds are termed "landlocked." All water that enters these landlocked pits seeps into the groundwater, evaporates, or, in the case of the Corsica Pit, serves as a water supply for McKinley.

The Leaf Lake watershed includes a landlocked area that flows to a sedimentation pond approximately 1,200 feet northwest of the lake. The lowest overflow point from this area leads to a pond a mile north of Leaf Lake, known locally as Elbert Lake. This landlocked area is considered part of the Leaf Lake watershed because it is believed to contribute to the lake via groundwater flow. It also would be part of the Leaf Lake watershed if the proposed mine dewatering route were used.

TABLE 4.1

MONTHLY CLIMATIC AVERAGES FOR MODELING PERIOD (1933-1986 AVERAGES)

Month	Precipitation* (inches)	Temperature* (degrees F)	Wind Velocity** (mph)	Relative Humidity**
Jan	0.93	5.7	10.4	.64
Feb	0.64	11.2	10.0	.63
Mar	1.21	24.0	10.3	.65
Apr	2.13	39.6	10.8	.62
May	2.84	52.6	10.1	.60
Jun	4.13	61.5	9.1	.65
Jul	3.77	67.1	8.3	.69
Aug	3.73	64.4	8.3	.74
Sep	3.18	54.7	9.2	.78
Oct	2.26	44.2	9.8	.74
Nov	1.52	26.4	10.5	.74
Dec	0.92	11.7	10.1	.71
ANNUAL	27.26	38.6	9.7	.68

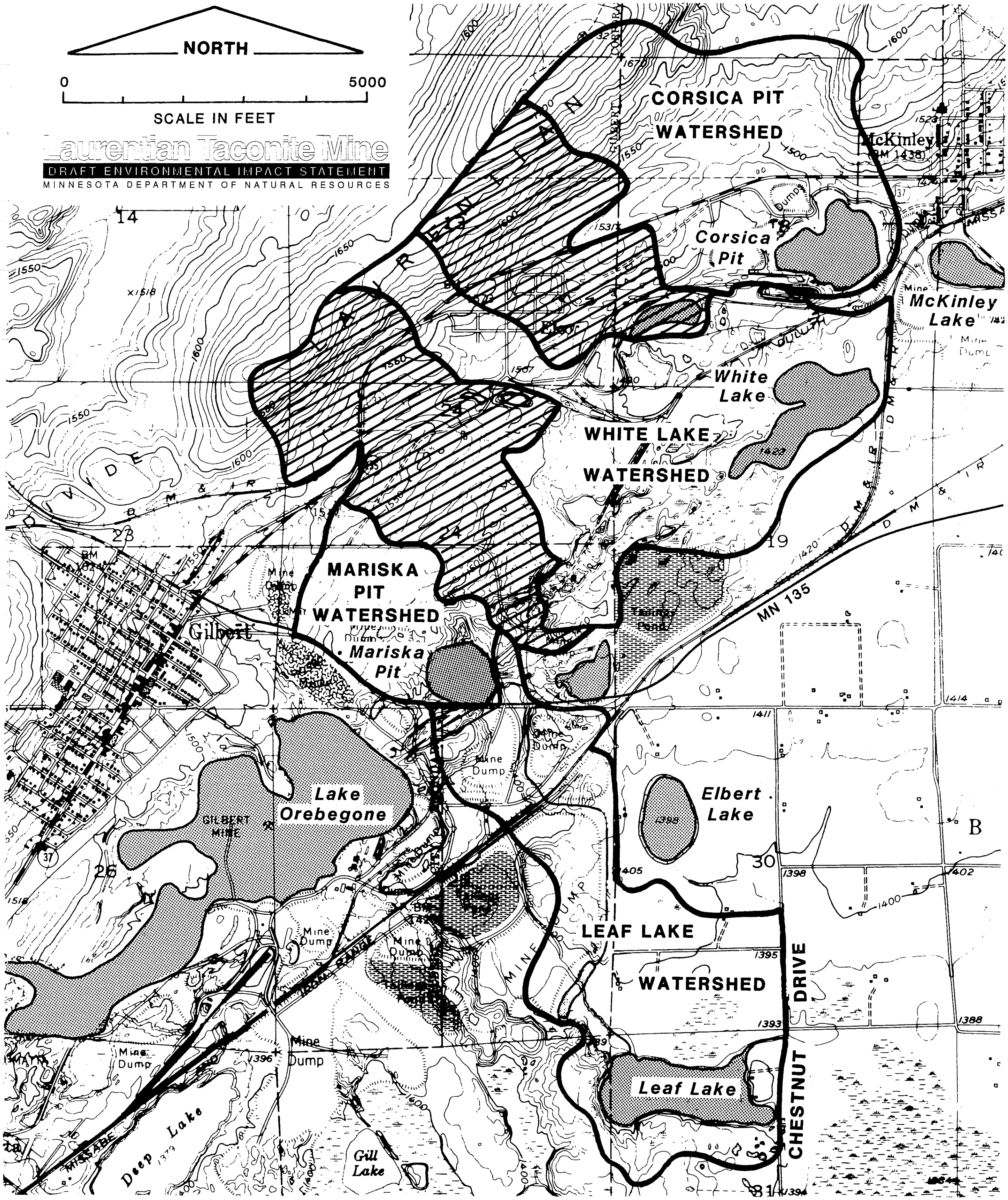
*Virginia, Minnesota Precipitation and Temperature data used in modeling. Where Virginia data were missing, Hibbing FAA data were used.

**International Falls and Duluth data were used for Wind Velocity and Relative Humidity monthly averages.

TABLE 4.2

EXISTING WATERSHED CONDITIONS

	Land Use Area (Acres)				
Watershed	Total Area (Acres)	Forest/ Grass	Stockpile	Wetland	Open Water
Corsica Pit	437.9	357.1	39.0	1.4	40.4
White Lake	550.9	471.8	11.5	17.3	50.3
Mariska Pit	160.4	120.6	9.3	1.5	29.0
Leaf Lake	528.1	325.7	100.3	48.8	53.3



Watershed Divide

Landlocked Watersheds Not Studied

Figure 4.2

EXISTING DRAINAGE

TABLE 4.3

GAGING DATA FOR DRAINAGES NEAR PROPOSED PROJECT SITE

Gaging Station	Average Discharge (in/yr)	Drainage Area (sq. mile)	Period of Record
Partridge River above Colby Lake, at Hoyt Lakes, MN	11.74	106	1978-1987
St. Louis River near Aurora, MN	11.80	290	1942-1987
St. Louis River at Forbes, MN	10.86	713	1964-1987
Pike River near Embarrass, MN	9.40	115	1954-1964, 1978
Embarrass River at Embarrass, MN	9.32	93.8	1942-1964
Embarrass River near McKinley, MN	8.81	171	1953-1962

Other areas that would be affected by the proposed mine include drainages that terminate in old mine pits (other than the Corsica or Mariska), collapsed underground mines, and dry depressions. These areas are landlocked and identified as "landlocked watersheds not studied" on Figure 4.2. These watersheds would be almost entirely incorporated into the ultimate mine or stockpile areas.

Regional Stream Flow Records

Several stream flow gaging stations exist in the region. Table 4.3 lists the gaging stations and their respective average annual discharges, drainage areas, and periods of record. Average discharges from the gaged watersheds vary from approximately 8.8 to 11.8 inches per year. This range in discharge reflects different periods of gage records, varying soil types and vegetation, and the varying percentage of wetlands and lakes in the watersheds. The sizes of the gaged watersheds are relatively large compared to the watersheds at the proposed project site. There are no stream gages in the watersheds of White Lake, Leaf Lake or the Corsica and Mariska pits.

Because of the need to predict impacts of proposed watershed modifications, a computer model is used to predict surface runoff and percolation to groundwater for the various existing and proposed land use types. The stream flow measurements are used to check the computations. It is assumed that the stream flow measurements represent the total of surface runoff and percolation to groundwater in the model. This is because stream gaging sites are normally at locations where percolation to groundwater in the upper portions of the watershed has reappeared as a discharge from the groundwater to the streams.

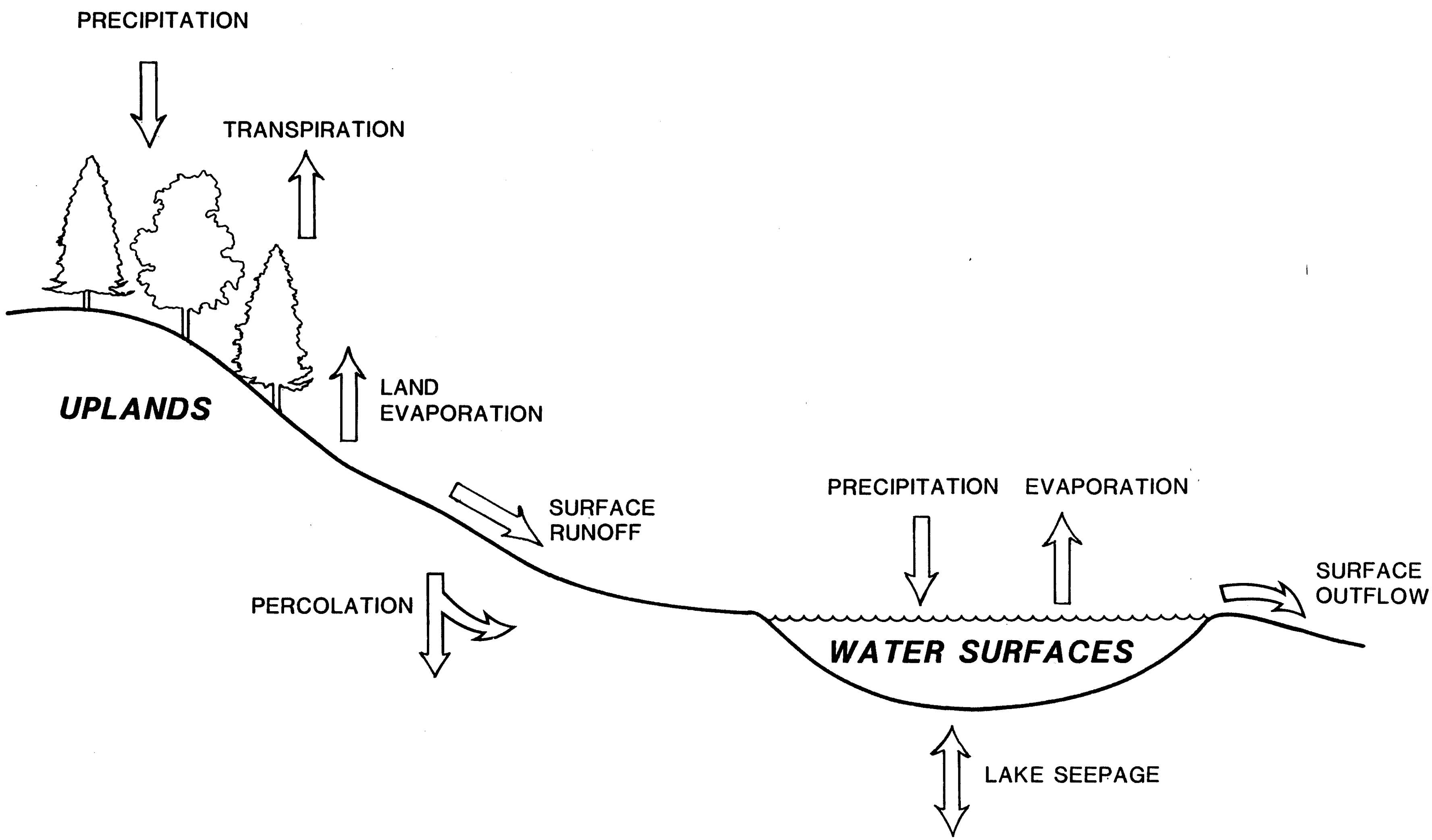


Figure 4.3

ELEMENTS OF THE WATER BUDGET MODELING

Water Budget Modeling

1. Yield Model

The following paragraphs briefly describe the calculations performed to estimate watershed yield. Yield is the sum of surface runoff and percolation to the groundwater. The model estimates the various elements of the water budget, which is illustrated in Figure 4.3.

Inputs to the yield model are historical monthly data on total precipitation, average temperature, average relative humidity, and average wind speed. Information on soils, topography, vegetation, and land use is used to estimate various adjustment factors in the model.

The yield model estimates monthly amounts of transpiration from plants, land surface evaporation, and water surface evaporation for the period of weather records used in the model. When these three atmospheric losses are subtracted from precipitation, the remainder is the watershed yield (surface runoff plus percolation to groundwater). The yield model was adjusted so that the sum of runoff and percolation approximately equals the measured discharges from the stream gaging records listed in Table 4.3.

A division of upland area yield between percolation and surface runoff was modeled to match the groundwater recharge (percolation) estimate for the area of 5 inches per year given in the Geological Survey Water-Supply Paper 2029-A. The modeled water budgets for forest/grassed areas, stockpiles, and surface waters are given in tables 4.4, 4.5, and 4.6, respectively.

2. Routing Model

A routing model was used to route the water yields through the four watersheds. The routing model input includes monthly precipitation, runoff, percolation, and lake evaporation data from the yield model. The routing model includes the relationships of discharge, surface area, and water storage volume to lake elevation.

TABLE 4.5

MONTHLY AVERAGE WATER BUDGET FOR STOCKPILE AREAS ESTIMATED BY MEYER MODEL (1933-1986)

Month	Precipitation (inches)	Land Evaporation (inches)	Transpiration (inches)	Surface Runoff (inches)	Percolation (inches)
Jan	0.93	0.17	0	0	0
Feb	0.64	0.27	0	0	0
Mar	1.21	0.59	0	0.25	0.24
Apr	2.13	0.93	0	2.05	1.91
May	2.84	1.41	0	0.44	0.99
Jun	4.13	2.15	0	1.45	0.52
Jul	3.77	2.18	0	1.29	0.30
Aug	3.73	1.89	0	1.27	0.56
Sep	3.18	1.34	0	0.55	1.29
Oct	2.26	0.76	0	0.32	1.19
Nov	1.52	0.39	0	0.02	0.29
Dec	0.92	0.22	0	0	0
ANNUAL*	27.24	12.28	0.00	7.64	7.30

* The summation of Land Evaporation, Transpiration, Surface Runoff, and Percolation does not equal Precipitation due to changes in soil moisture and surface storage.

TABLE 4.4

MONTHLY AVERAGE WATER BUDGET FOR FOREST/GRASS AREAS ESTIMATED BY MEYER MODEL (1933-1986)

Month	Precipitation (inches)	Land Evaporation (inches)	Transpiration (inches)	Surface Runoff (inches)	Percolation (inches)
Jan	0.93	0.15	0	0	0
Feb	0.64	0.24	0	0	0
Mar	1.21	0.54	0	0.19	0.31
Apr	2.13	0.84	0.10	1.74	2.20
May	2.84	1.28	0.92	0.23	0.53
Jun	4.13	1.95	1.42	0.75	0.22
Jul	3.77	1.98	1.67	0.67	0.04
Aug	3.73	1.72	1.34	0.66	0.08
Sep	3.18	1.22	0.74	0.28	0.47
Oct	2.26	0.69	0.14	0.16	0.98
Nov	1.52	0.35	0	0.01	0.20
Dec	0.92	0.20	0	0	0
ANNUAL*	27.24	11.16	6.33	4.68	5.03

* The summation of Land Evaporation, Transpiration, Surface Runoff, and Percolation does not equal Precipitation due to changes in soil moisture and surface storage.

The model also can include an estimated seepage rate (in inches/year over the lake surface) between the lakes and the groundwater.

Due to the many variables in the water budget and limitations on data availability, models are only an approximate representation of actual conditions. The intention is to model the major elements in the water budget and develop estimates of lake levels that approximate the average and range of actual lake levels. The primary purpose of developing a model is to be able to input proposed watershed changes and estimate the resulting changes in lake water levels. The accuracy of estimating these changes is more important than the ability of the model to precisely duplicate historical conditions.

Existing Conditions Modeling Results

Average monthly and annual results of the existing conditions water budget and routing are shown in tables 4.7, 4.8, 4.9, and 4.10 for the Corsica Pit, Mariska Pit, White Lake, and Leaf Lake, respectively. The following subsections describe the modeling for each pit or lake. These discussions of lake modeling also include the historical lake level records.

1. Corsica Pit

Surface runoff was routed through the Corsica Pit assuming no surface outflow and no change in water level. These are reasonable assumptions since the pit water level is significantly below the surrounding ground surface and it has had many years to rise to a level in balance with the groundwater. The modeling result shown on Table 4.7 is an estimate of the outflow from the pit to the groundwater. There is an outflow to groundwater from the Corsica Pit, despite the pumping for the McKinley water supply. This indicates that the pit recharges the groundwater.

There is likely some moderate fluctuation in the Corsica Pit's water levels, but no attempt was made to model it. The impacts of proposed mining would likely be caused by lowered groundwater levels, which in turn would lower the Corsica Pit's water levels, but no significant change in water level fluctuations would occur.

TABLE 4.6

MONTHLY AVERAGE WATER BUDGET FOR LAKES, WETLANDS, AND MINE PITS ESTIMATED BY MEYER MODEL (1933-1986) (DOES NOT INCLUDE SEEPAGE)

Month	Precipitation (inches)	Evaporation (inches)	Precipitation Minus Evaporation (inches)
Jan	0.93	0.20	0.73
Feb	0.64	0.29	0.35
Mar	1.21	0.59	0.62
Apr	2.13	1.32	0.81
May	2.84	2.05	0.79
Jun	4.13	2.52	1.61
Jul	3.77	3.63	0.14
Aug	3.73	4.17	-0.44
Sep	3.18	3.64	-0.46
Oct	2.26	2.15	0.11
Nov	1.52	0.76	0.76
Dec	0.92	0.22	0.70
ANNUAL	27.24	21.54	5.70

2. Mariska Pit

Surface runoff was routed through the Mariska Pit assuming no surface outflow and no change in water level. These are reasonable assumptions since the pit water level is significantly below the surrounding ground surface and it has had many years to rise to a level in balance with the groundwater. The modeling result shown on Table 4.8 is an estimate of the outflow from the pit to the groundwater. This indicates that the Mariska Pit recharges the groundwater. Impacts on the Mariska Pit need not be modeled since it would become part of the ultimate mine.

3. White Lake

Historical White Lake water levels are available from 1915 to 1978. A plot of these levels is shown in Figure 4.4. The lake has an outlet that leads to a 36-inch diameter concrete pipe with an invert elevation of 1,420.6. This pipe passes under the DM&IR railroad tracks east of the lake. The 400-foot long channel between the lake and the culvert is assumed to have higher elevations and also appears subject to beaver activity.

Groundwater information for the vicinity of White Lake indicates that the lake and its watershed are in a groundwater recharge area. This means that there will be seepage from the lake to the groundwater. It also means that only surface runoff from the watershed needs to be routed through the lake. Percolation to groundwater in the White Lake watershed is assumed to resurface beyond the lake to the southeast. An average seepage rate from the lake of 29 inches/year was estimated from observed wintertime water level drops. This represents seepage into the groundwater and/or seepage through the high ground and/or beaver dam between the lake and the culvert.

The lake's overflow elevation was assumed to be 1,423.2 feet above mean sea level, based on observed lake levels. The observed fluctuation in lake levels is typical of a lake whose level is below its overflow elevation much of the time. Examination of historical water level declines over winter when there is no inflow shows relatively constant rates of decline when the lake level is below Elevation 1423.2 (assumed to result from seepage only) but much greater declines when the lake level is above Elevation 1423.2 (assumed to result from seepage and outflow). Using this inferred

TABLE 4.7

EXISTING CONDITIONS
MONTHLY AVERAGE WATER BUDGET FOR CORSICA PIT
ESTIMATED BY MEYER MODEL (1933-1986)

Month	Surface Runoff (cfs)**	Precipitation Falling Onto Surface Water (cfs)**	Surface Water Evaporation (cfs)**	City of McKinley Pumping (cfs)**	Discharge to Groundwater* (cfs)**
Jan	0	0.05	0.01	0.05	-0.01
Feb	0	0.04	0.02	0.06	-0.04
Mar	0.11	0.07	0.03	0.05	0.10
Apr	0.97	0.12	0.07	0.06	0.96
May	0.14	0.16	0.11	0.06	0.13
Jun	0.45	0.23	0.14	0.07	0.47
Jul	0.40	0.21	0.20	0.08	0.33
Aug	0.40	0.21	0.23	0.08	0.30
Sep	0.17	0.18	0.20	0.07	0.08
Oct	0.10	0.13	0.12	0.06	0.05
Nov	0.01	0.09	0.04	0.06	0
Dec	0	0.05	0.01	0.05	0.01
ANNUAL	0.23	0.13	0.10	0.06	0.20

*Residual of Surface Runoff + Precipitation - Evaporation - Pumping.
Assumes no net change in water level.
**cfs -- cubic feet per second

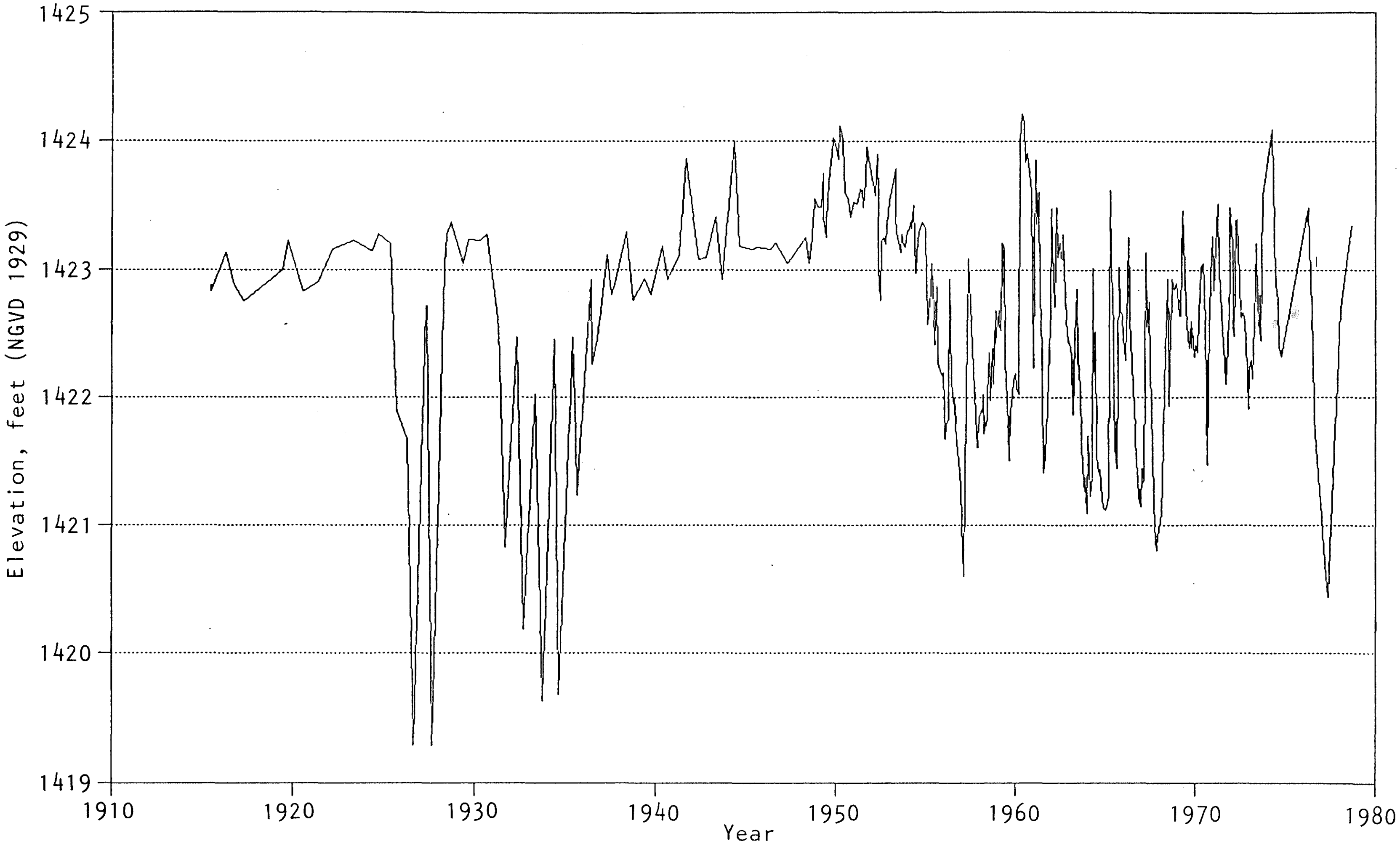


Figure 4.4

HISTORICAL WATER LEVELS
White Lake

overflow elevation in the model resulted in a good approximation of historical water levels. Table 4.9 shows the average results of the existing conditions water budget modeling for White Lake.

The White Lake historical water levels (Figure 4.4) suggest that watershed changes, outlet modifications, or pumping have occurred in the past. The Corsica Pit closed in 1954 and operated again briefly in 1961 and 1962. After 1954, White Lake levels were somewhat lower than in the previous 15 years and also showed more variation. Possibly White Lake received mine dewatering discharges prior to 1955. The water budget routing was done for the period 1955 to 1978 as representative of existing conditions. Figure 4.5 compares the modeled water levels to the historical water levels. The historical peaks during 1960-61 and 1974 may be due to beaver activity along the outlet channel which was not modeled. Figure 4.6 shows water level versus the percent of time during which the lake exceeds that level (elevation-duration curves) for both the historical and the modeled water levels between 1955 and 1978. Comparison of the historical and modeled lake levels and elevation-duration curves indicates that the White Lake model is accurate enough to provide a framework to predict impacts of the proposed mine.

4. Leaf Lake

A plot of the historical levels of Leaf Lake for the period of 1948 to 1980 is shown in Figure 4.7. It appears that the outlet may have been raised approximately 1 foot in approximately 1965.

The lake outlet was surveyed in March 1990. It is a 24-inch diameter corrugated metal culvert under Chestnut Drive approximately 800 feet downstream of Leaf Lake. The bottom of the culvert on the lake side is at Elevation 1,388.7 while the bottom on the downstream side is at 1,390.0. The upstream end is also partially plugged with sediment. The low point of the road at the culvert is approximately Elevation 1,392.7. The historical levels of Leaf Lake between 1948 and 1980 show the lake level exceeding Elevation 1,390 on only three occasions, all of which were after 1969. During the recent survey, the Leaf Lake water level was Elevation 1,391.1. This

TABLE 4.9

EXISTING CONDITIONS
MONTHLY AVERAGE WATER BUDGET FOR WHITE LAKE
ESTIMATED BY MEYER MODEL (1933-1986)

Month	Surface Runoff (cfs)*	Precipitation Falling Onto Surface Water (cfs)*	Surface Water Evaporation (cfs)*	Seepage (cfs)*	Surface Outflow (cfs)*	Lake Level (feet)
Jan	0.02	0.05	0.01	0.14	0	1422.4
Feb	0.01	0.04	0.02	0.14	0	1422.2
Mar	0.14	0.07	0.03	0.14	0.03	1422.2
Apr	1.20	0.12	0.08	0.14	0.56	1423.0
May	0.19	0.17	0.12	0.14	0.17	1422.9
Jun	0.57	0.24	0.15	0.14	0.38	1423.1
Jul	0.47	0.22	0.21	0.14	0.38	1423.1
Aug	0.45	0.22	0.24	0.14	0.31	1423.0
Sep	0.20	0.19	0.21	0.14	0.13	1422.9
Oct	0.13	0.13	0.12	0.14	0.08	1422.8
Nov	0.04	0.09	0.04	0.14	0.01	1422.7
Dec	0.02	0.05	0.01	0.14	0	1422.5
ANNUAL	0.29	0.13	0.10	0.14	0.17	1422.7

*cfs -- cubic feet per second

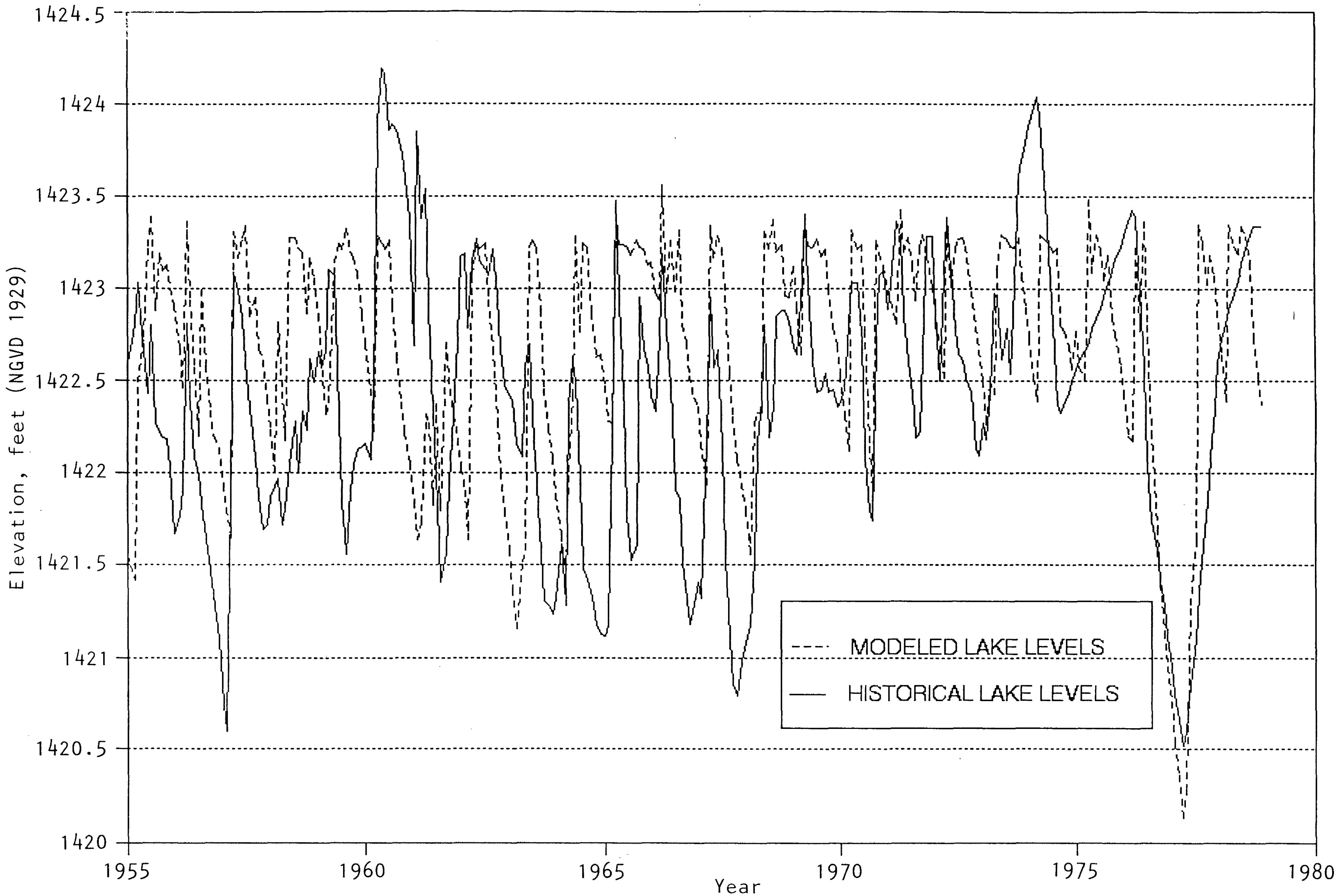


Figure 4.5

CALIBRATION OF MODELED LAKE LEVELS
White Lake

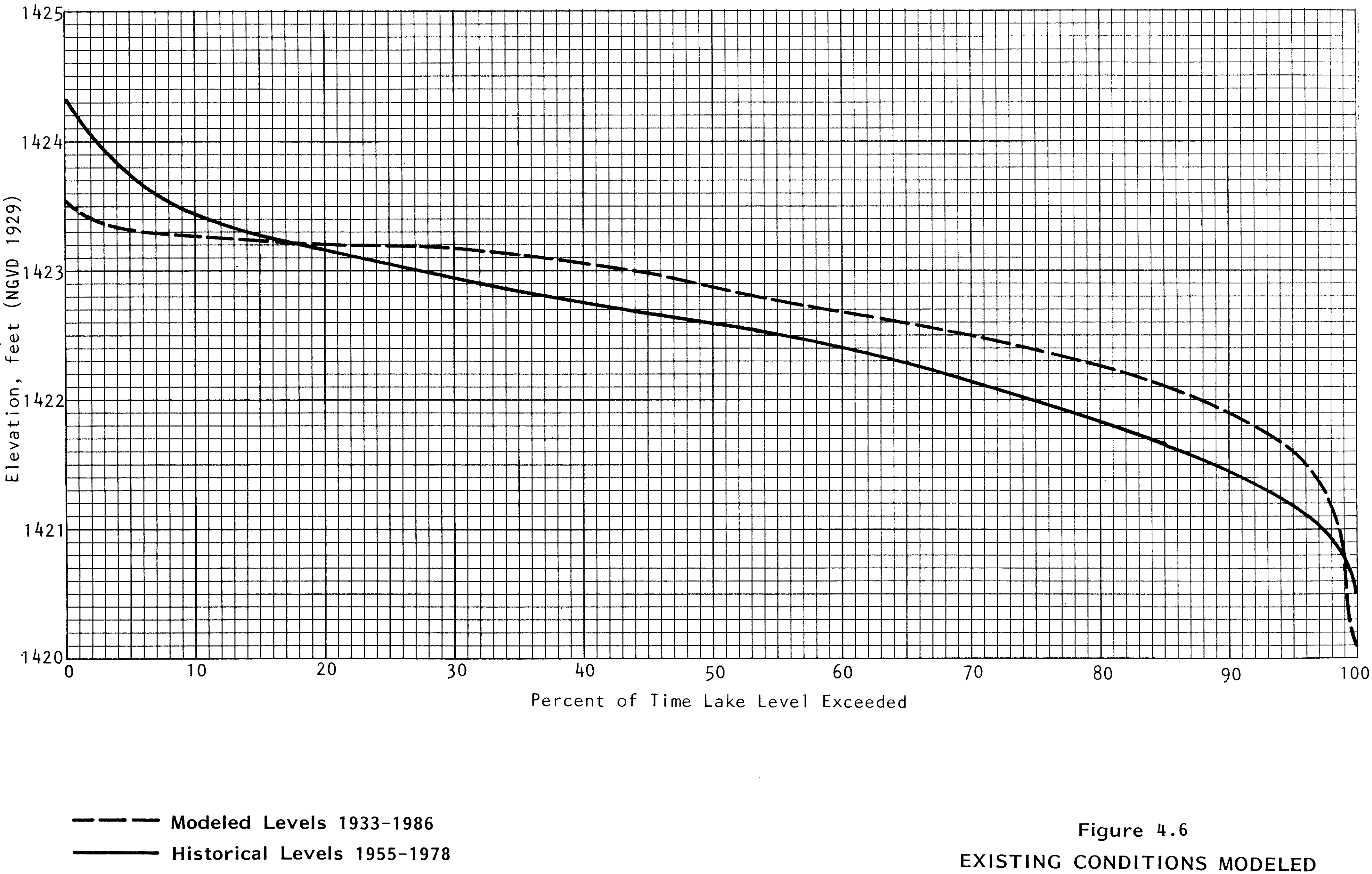


Figure 4.6

EXISTING CONDITIONS MODELED AND HISTORICAL WATER LEVEL-DURATION CURVES

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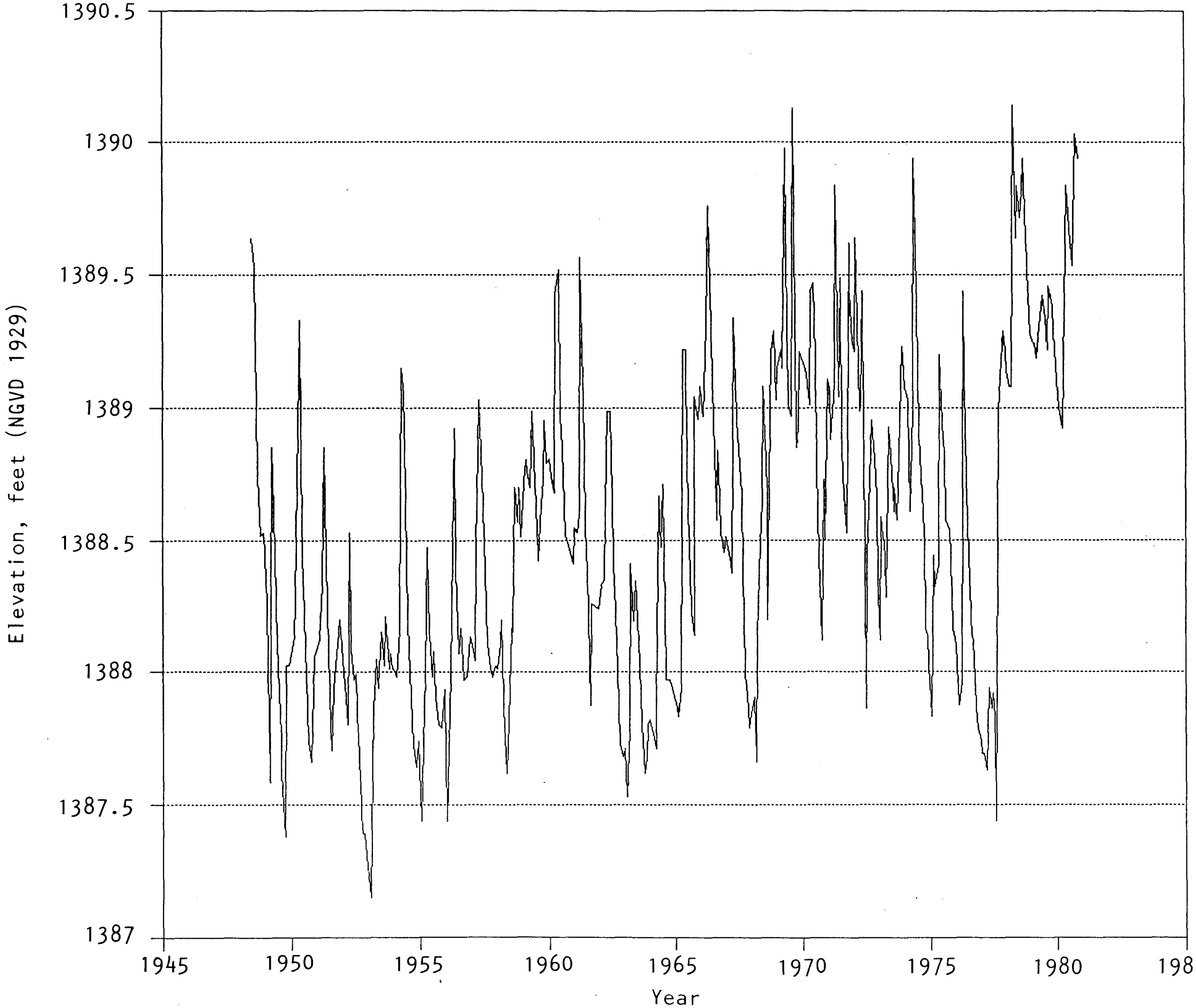


Figure 4.7
HISTORICAL WATER LEVELS
Leaf Lake

level is 1 foot higher than any value given in the historical record for the lake, which suggests that the culvert was altered or replaced between 1981 and 1990. The ordinary high water (OHW) level of the lake is at Elevation 1390.5.

A resident who lives along the lake said that the outlet culvert was replaced recently (probably within the last decade) because the former culvert often plugged, causing the lake to overflow the road. The resident also said present lake levels are 2 to 3 feet higher than they were in the 1950s. There has also been beaver activity between the lake and the culvert in the past. There is presently a beaver dam at the outlet with a 4-foot breach in it. The dam is located 535 feet upstream of Chestnut Drive on top of what was a field crossing during drier times. There are two culverts through the crossing, the upstream ends of which were plugged by the beavers when the dam was constructed. The breach in the dam is lower than the culvert under Chestnut Drive.

Leaf Lake is assumed to be approximately at the elevation of the local groundwater table. Therefore, both surface runoff and percolation to groundwater from its watershed were routed through the lake in the model. Because percolation is being routed through the lake, an adjustment for seepage to the groundwater, as used in modeling White Lake, was not included. Table 4.10 shows the average results of the existing conditions water budget modeling for Leaf Lake.

Because of the unknown outlet conditions at the time the historical lake level readings were taken, no attempt was made to match the observed lake levels. The elevation-duration curve for Leaf Lake's historical levels (1948-1980) is shown in Figure 4.8. An elevation-duration curve using modeled lake levels is shown in Figure 4.9. A comparison of the two shows that the modeled lake levels using the existing outlet are much higher than the historical levels. This is apparently due to increases in the culvert outlet elevation, as discussed previously.

The elevation-duration curve based on modeled lake levels is a more accurate representation of existing conditions than the curve developed from historical levels. It is therefore used as the base condition from which to estimate impacts of the proposed mining activities.

TABLE 4.10

EXISTING CONDITIONS
MONTHLY AVERAGE WATER BUDGET FOR LEAF LAKE
ESTIMATED BY MEYER MODEL (1933-1986)

Month	Surface Runoff (cfs)**	Precipitation Falling Onto Surface Water (cfs)**	Groundwater Inflow* (cfs)**	Surface Water Evaporation (cfs)**	Surface Outflow (cfs)**	Lake Level (feet)
Jan	0.04	0.08	0.01	0.02	0.09	1390.0
Feb	0.02	0.05	0	0.02	0.06	1390.0
Mar	0.08	0.10	0.23	0.05	0.26	1390.1
Apr	0.55	0.18	1.76	0.11	1.81	1390.6
May	0.13	0.24	0.47	0.17	1.11	1390.2
Jun	0.32	0.35	0.49	0.21	0.88	1390.3
Jul	0.22	0.32	0.34	0.31	0.69	1390.1
Aug	0.18	0.32	0.39	0.35	0.58	1390.1
Sep	0.08	0.27	0.50	0.30	0.56	1390.1
Oct	0.07	0.19	0.66	0.18	0.68	1390.1
Nov	0.06	0.13	0.14	0.06	0.37	1390.0
Dec	0.04	0.08	0.01	0.02	0.13	1390.0
ANNUAL	0.15	0.19	0.42	0.15	0.60	1390.1

*Includes surface water runoff and percolation from areas tributary to the old sedimentation pond plus percolation water from areas directly tributary to Leaf Lake.
**cfs -- cubic feet per second

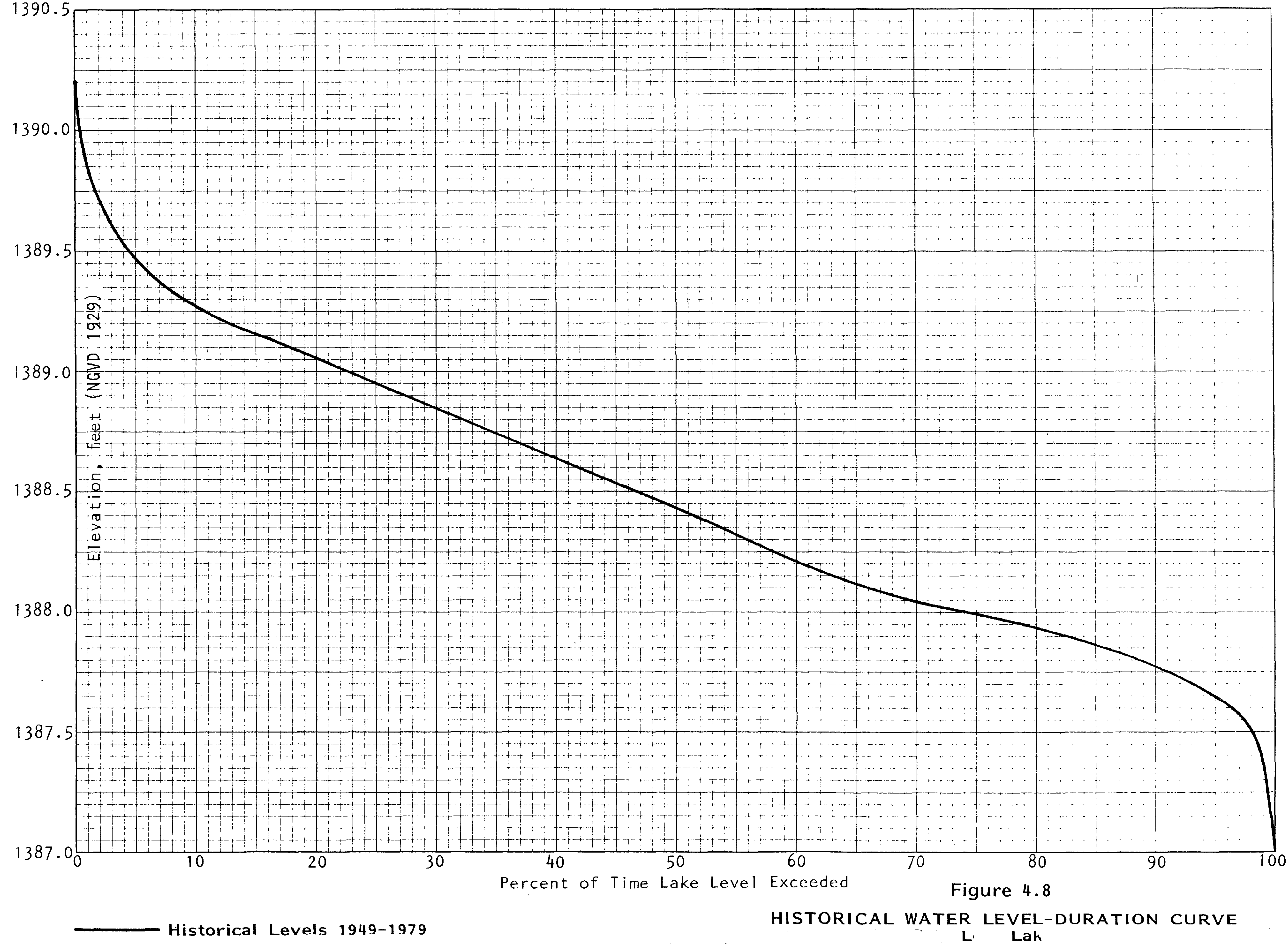


Figure 4.8

HISTORICAL WATER LEVEL-DURATION CURVE
L Lak

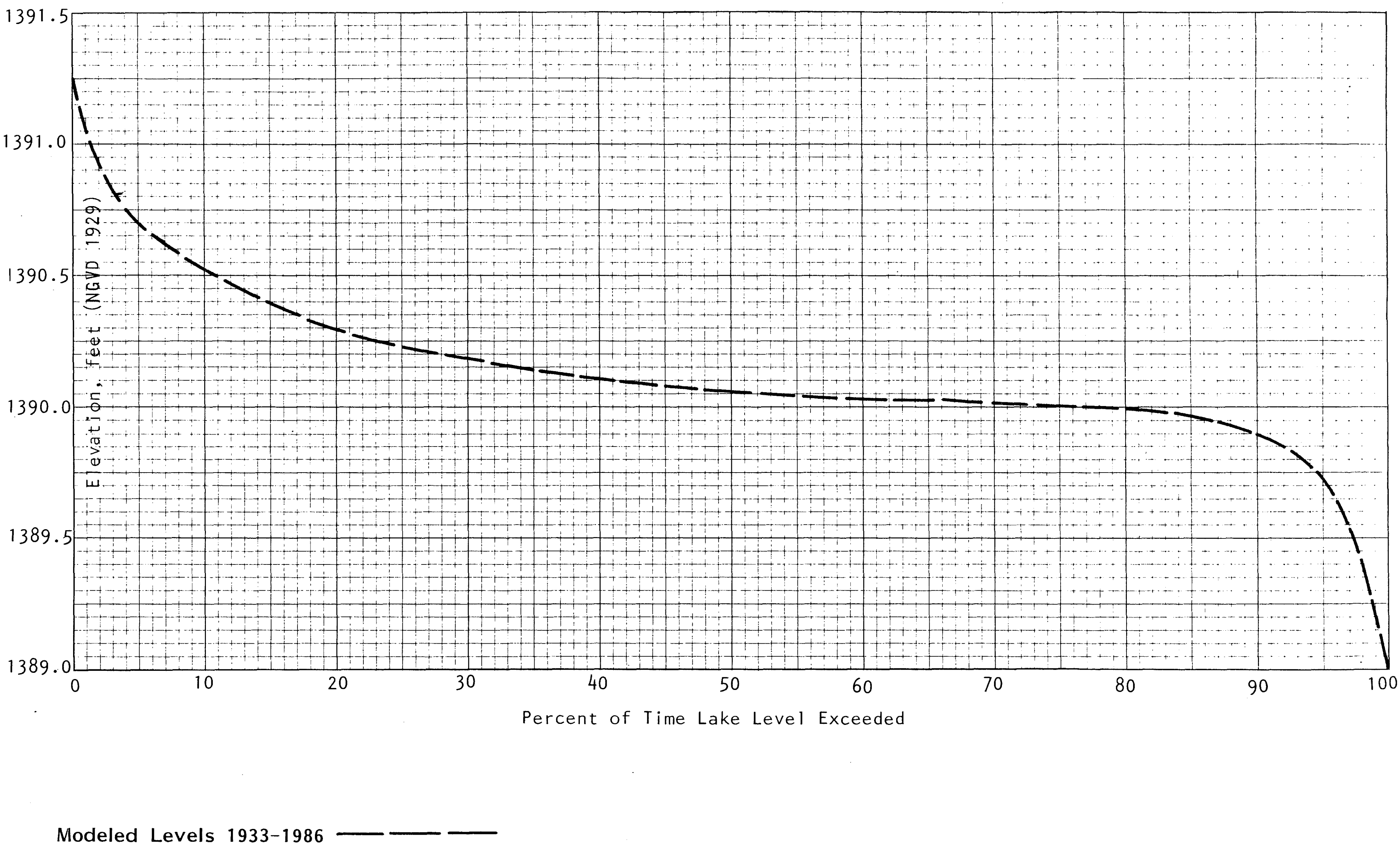


Figure 4.9

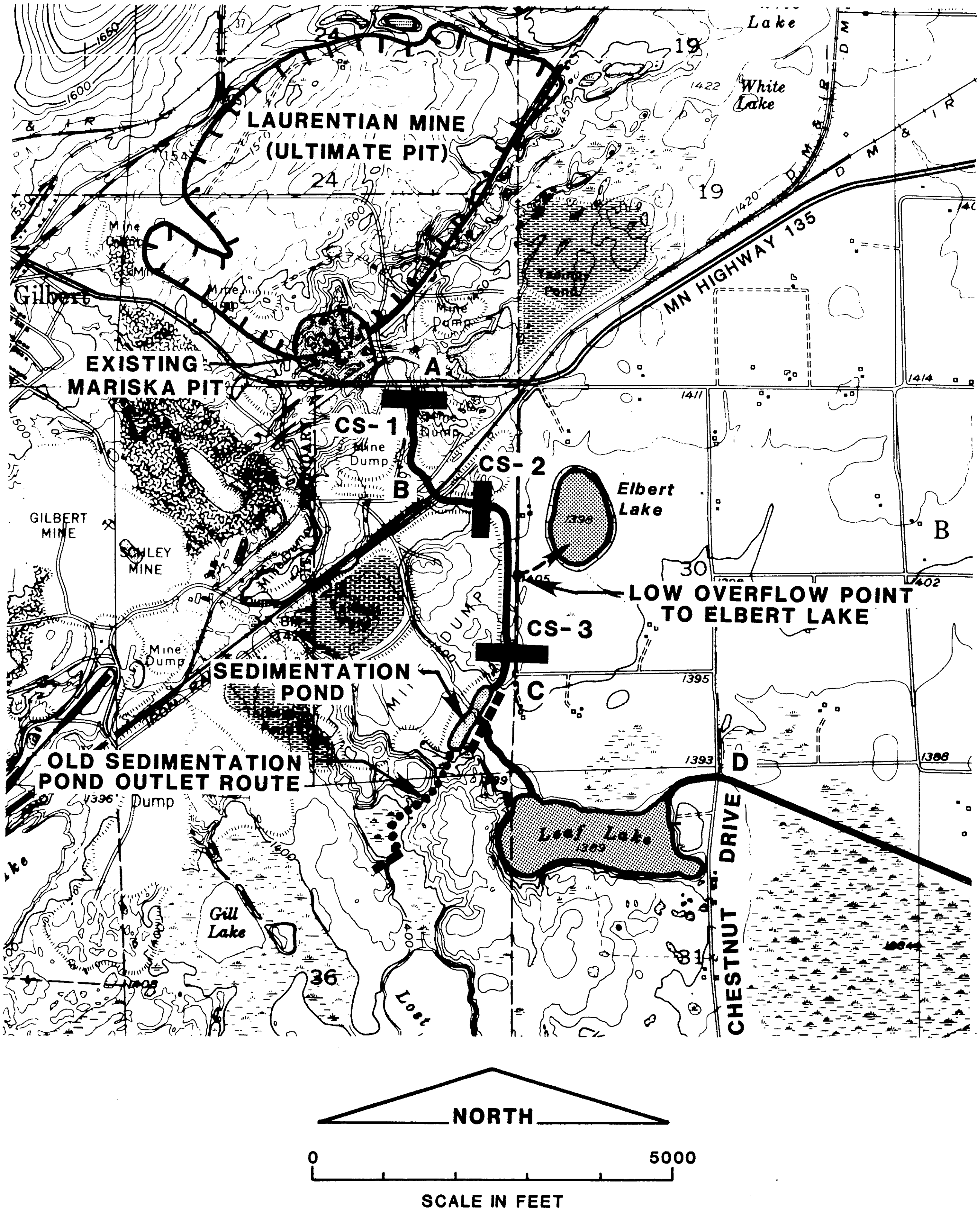
EXISTING CONDITIONS MODELED
WATER LEVEL-DURATION CURVE
Leaf Lake

Dewatering Route

The proposed route for water pumped from the proposed Laurentian Mine is shown on Figure 4.10. The route follows an existing ditch that flows south under TH 135 and then runs adjacent to a stockpile area to the DM&IR tracks. At the tracks the ditch turns east for approximately 1,000 feet where it again turns south and runs 2,600 feet to an old sedimentation pond located 1,200 feet northwest of Leaf Lake. The proposed dewatering route then flows from this basin through a wetland area to Leaf Lake. Downstream of Leaf Lake the dewatering route follows a ditch that flows approximately 3.2 miles southeast to the Embarrass River downstream of Esquagama Lake.

During a field trip in March 1990, the ditch upstream of the sedimentation pond had several feet of ice and standing water along most of its length. It was also observed that the dewatering route ditch is overgrown with trees and other vegetation along most of its length. Approximately 4,000 feet north of Leaf Lake, the ditch was overtopping its banks and flowing to a large pond (known locally as Elbert Lake). This overtopping was apparently caused by downstream culverts being plugged with ice and/or debris. From Elbert Lake, water flows to an intermittent stream and then to a ditch which joins the Leaf Lake outflow just downstream of the Leaf Lake outlet culvert.

The old sedimentation pond upstream of Leaf Lake was constructed at the foot of a mine dump. An old mining map (Great Northern Iron Ore Properties, 1959) identifies it as a sedimentation pond, a function it could still serve. The 1951 USGS 7.5-minute series quadrangle map indicates that an approximately 5-acre wetland was covered by construction of this mine dump. This wetland received runoff from surrounding upland areas and also likely historically received overflow from other wetlands north of the DM&IR tracks. Those wetlands have also been covered by mine dumps or drained. The sedimentation basin dike crosses the former stream channel from the covered wetland to Leaf Lake. However, no culvert could be found through the sedimentation basin dike allowing discharge to Leaf Lake.



Laurentian Taconite Mine

DRAFT ENVIRONMENTAL IMPACT STATEMENT

MINNESOTA DEPARTMENT OF NATURAL RESOURCES

Dewatering Flow

Existing Dike

A-D Existing Culverts

Surveyed Cross Section

Figure 4.10

MINE DEWATERING ROUTE

The old mining map also indicated a ditch connecting the sedimentation pond to wetlands tributary to Lost Lake. A recent survey was made of the basin and ditch overflow points to Lost Lake, Leaf Lake, and Elbert Lake. The survey indicates that under existing conditions water would overflow to Elbert Lake before it could overflow to Lost or Leaf lakes. A resident of the area stated that he does not think the sedimentation pond has ever overflowed to Lost Lake.

The culvert locations along the dewatering route between the proposed mine and the Leaf Lake outlet are shown in Figure 4.10. Table 4.11 lists the culvert sizes and bottom elevations. There are three locations along the dewatering route where culverts are needed but were not found. The roads that parallel the DM&IR tracks currently do not have culverts at the ditch crossings. The dam between the sedimentation pond and Leaf Lake also does not appear to have an outlet structure or culvert. Figure 4.11 shows a profile of the dewatering route from the proposed mine to downstream of Leaf Lake. Figures 4.12 shows typical cross sections of the ditch. The locations of the cross sections are shown on Figure 4.10.

TABLE 4.11

EXISTING CULVERTS ALONG DEWATERING PATH

Location	Type	Size	Invert Upstream	Invert Downstream	Capacity* (cfs)
Minnesota 135	RCPA	27 x 43	1415.9	1415.2	30
DM&IR RR	CMP	54 inch	1409.4	1408.1	95
Upstream of Sedimentation Pond	CMP	2-15 inch	1397.5	1397.0	8
Outlet to Leaf Lake	CMP	24 inch	1388.7	1390.0	11

* Assuming upstream water surface is at crown of pipe.

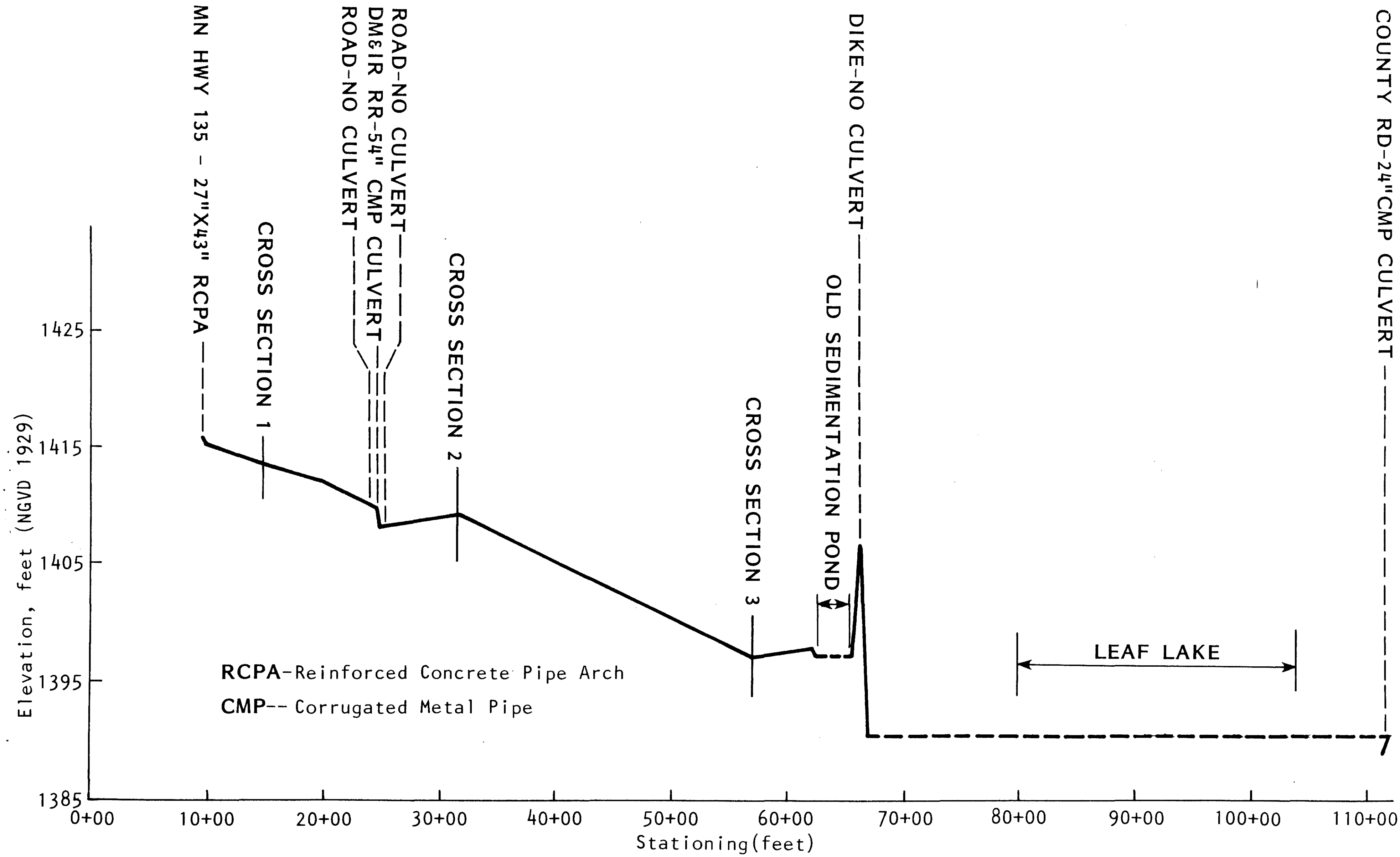
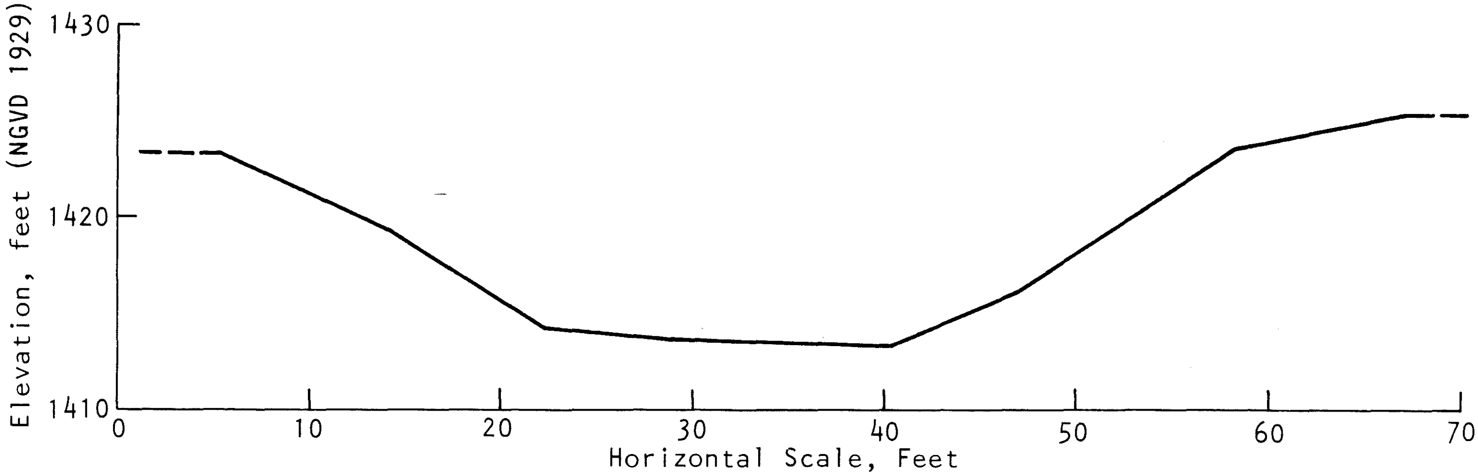
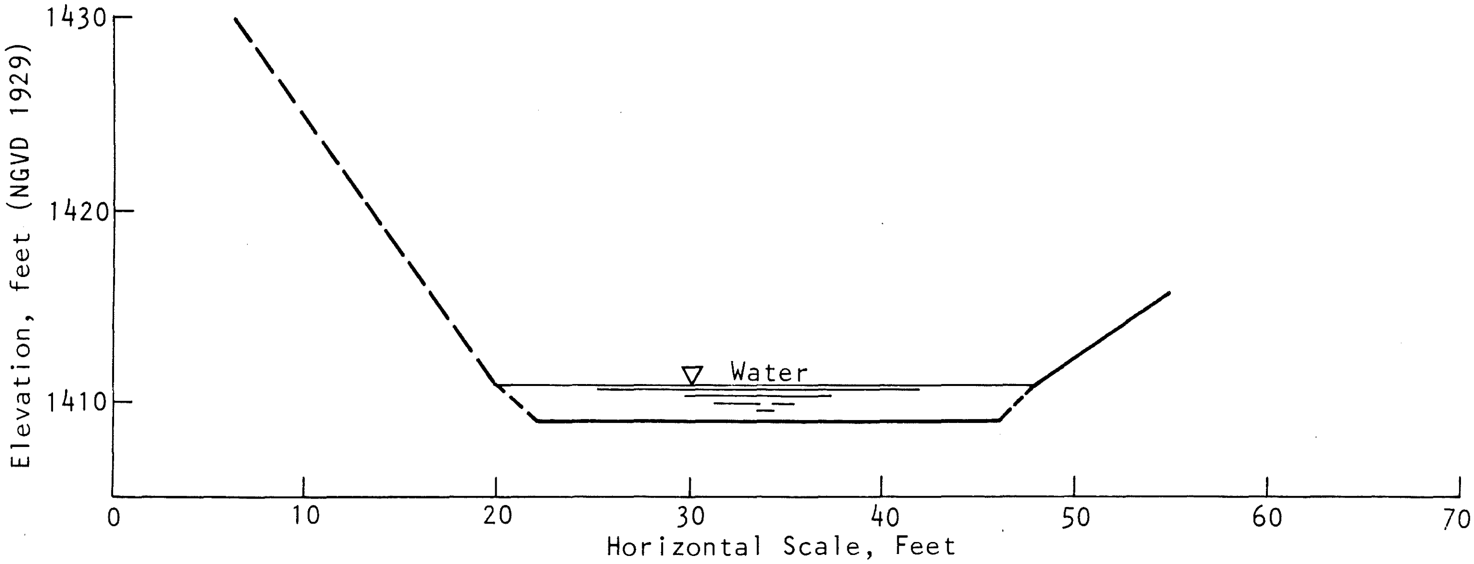


Figure 4.11

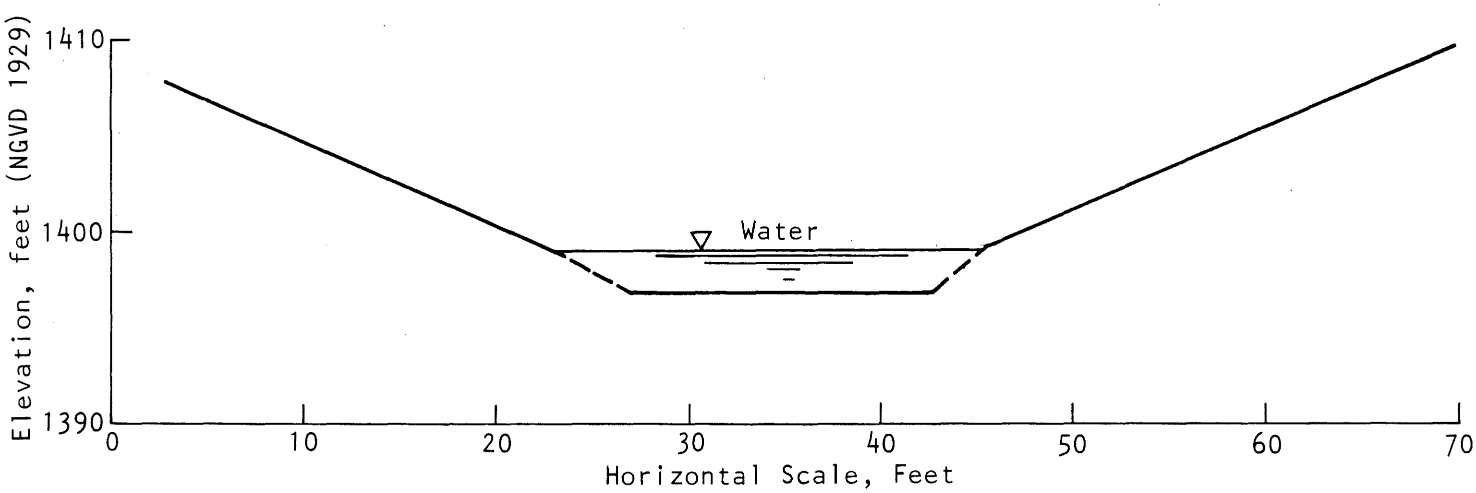
MINE DEWATERING ROUTE PROFILE
Existing Conditions



SECTION 1



SECTION 2



SECTION 3

Figure 4.12

MINE DEWATERING DITCH
TYPICAL CROSS SECTIONS

Groundwater

This section explains existing groundwater conditions in the vicinity of the proposed Laurentian Mine. Existing data and studies on the area's hydrogeology (groundwater) and geology were used. Existing conditions must be understood to determine how the proposed project might affect groundwater flow, groundwater levels, and lake levels. The information on existing groundwater conditions was used to prepare a computer model that simulates potential groundwater impacts.

Useable quantities of groundwater are available from both the local glacial drift and the Biwabik Iron Formation. Over most of the Mesabi Iron Range, the glacial drift is an important water supply tapped by most wells in the area. Because the Biwabik Iron Formation is deeper than the glacial drift, it is generally not used for domestic water supplies. However, several municipalities obtain water from the Biwabik Iron Formation using wells or pumping water from abandoned iron ore pits.

Regional Hydrogeology

1. Regional Geology

The Mesabi Iron Range is a 120-mile long and 3-mile wide band of northeast-southwest trending, Precambrian igneous and meta-sedimentary rocks dipping 5 to 15 degrees to the southeast and overlain by Pleistocene glacial drift deposits up to 300 feet thick (Figure 4.13). The Precambrian rocks form the southern margin of the Canadian Shield. The predominant physiographic feature is the Giants Range -- a long, linear ridge consisting largely of Precambrian granite, which is at an elevation 200 to 400 feet higher than the surrounding terrain. The Laurentian drainage divide follows the crest of the Giants Range (White, 1954).

The Giants Range has gentle slopes to the south and steeper slopes to the north, but on both sides these slopes grade into lowlands characterized by kettle holes, lakes, and swamps. The upper slopes and crest are notched by many drainage channels. The "Virginia Horn" in T57N, R17W is a Z-shaped bend in the crest, which parallels

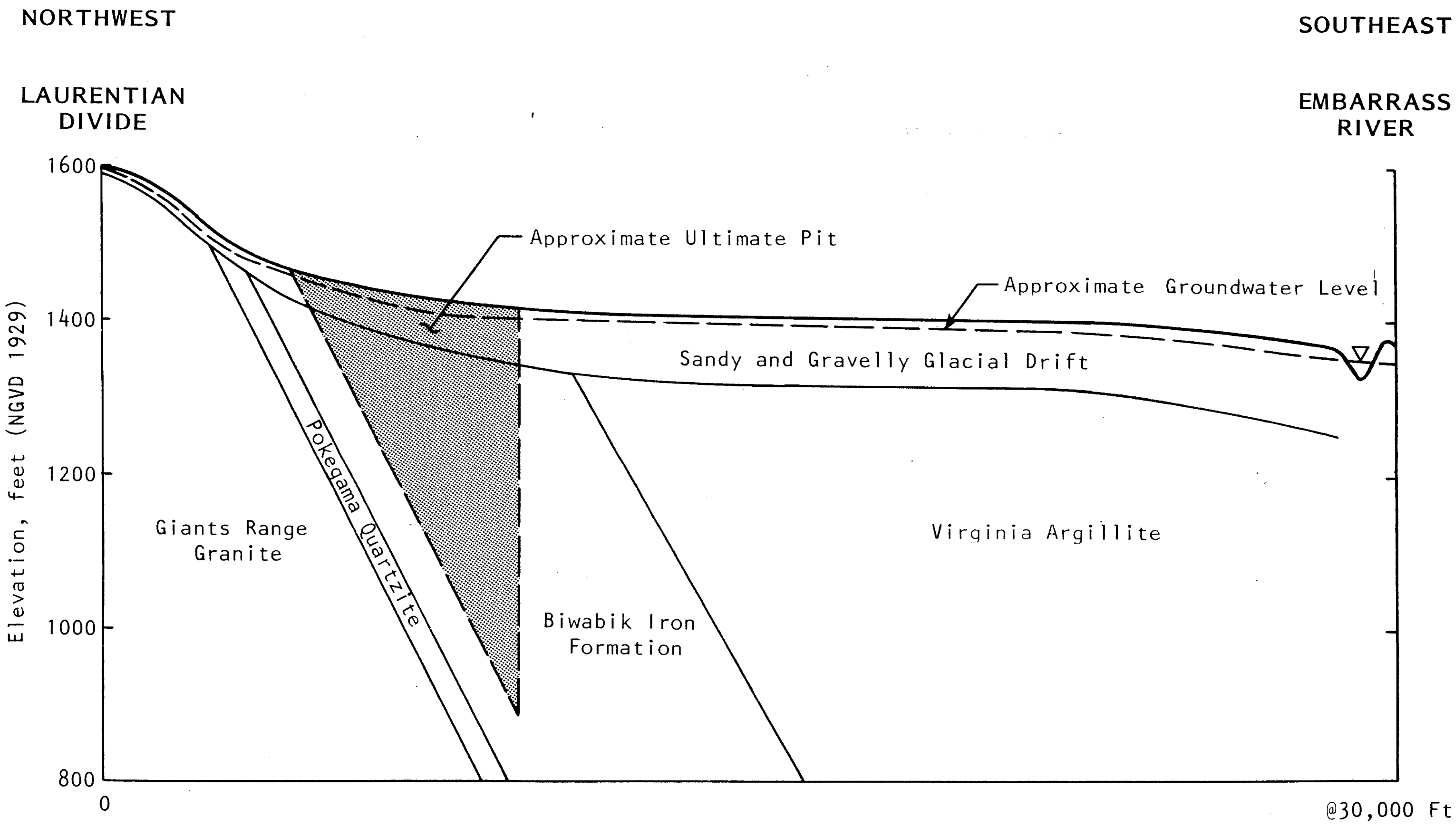


Figure 4.13

GENERALIZED GEOLOGIC CROSS SECTION
(Vertical Scale Exaggerated Greatly)

the fold pattern of the Mesabi Iron Range (White, 1954; Winter, et al., 1973). The proposed Laurentian Mine is to be located along the eastern arm of the "Virginia Horn."

Paralleling the Giants Range to the south is the Biwabik Iron Formation, from which iron ore has been extensively mined for the past 100 years. The Biwabik Iron Formation is characterized by iron silicate minerals, chert, magnetite, and iron-carbonate minerals. Weathering processes of oxidation, hydration, and leaching have concentrated iron-bearing ore minerals to produce lenses of "natural ores" that have been almost completely mined from the Mesabi Range. The thickness of the Biwabik Iron Formation ranges between 350 and 850 feet (White, 1954). The proposed Laurentian project would mine the magnetite-rich rock (taconite) of the Biwabik Formation. Rock with lower magnetite content would also be removed from the pit and separated into waste rock and lean ore. The waste rock would have a very low sulfur content.

Underlying the Biwabik Iron Formation is the Pokegama Quartzite, a micaceous meta-sedimentary rock unit ranging in thickness between 30 and 150 feet. Overlying the Biwabik Iron Formation is the Virginia Argillite, consisting mostly of argillite (a rock somewhat similar to slate) with a thickness greater than 2,000 feet (White, 1954). Figure 4.13 is a geologic cross section illustrating the association of the Pokegama Quartzite and the Virginia Argillite with respect to the Biwabik Iron Formation. It should be noted that the vertical scale in Figure 4.13 exaggerates the dip or slope of the rock layers. As the figure indicates, all three rock layers intercept the bedrock surface near the proposed mine because of the dip. The terms "overlying" and "underlying" are still used, however, to indicate the relative positions in which the rock layers would be intercepted by vertical drill holes.

Overlying the Precambrian bedrock surface are gravelly sands, silts, and clays deposited by meltwater streams from nearby glaciers roughly 20,000 to 100,000 years ago. Many long, linear, east-west trending glacial end moraines traverse the area. Also in the region are eskers, which are long, sandy ridges formed by streams flowing under glacial ice. Several outwash plains (sand and gravel deposits formed by streams running off glacial ice) of limited areal extent are present in the region. Former glacial lake basins occupy a large part of the region north and south of the Giants Range (Winter, et al., 1973).

The glacial drift deposit consists of three major till units and associated glaciofluvial deposits, informally called (1) basal till, (2) bouldery till, and (3) surficial till. The total thickness of the combined drift units ranges from non-existent along the base of the Giants Range to 300 feet in some bedrock valleys. A very prominent bedrock valley occurs between Gilbert and Biwabik, where the Embarrass River cuts through the Giants Range. Within this bedrock valley, unusually thick glacial deposits are present. Throughout most of the region the drift is typically about 100 feet thick (Winter et al., 1973).

2. Regional Occurrence of Groundwater

Bedrock Aquifers

Except for some altered zones within the Biwabik Iron Formation, the regional bedrock yields little groundwater (Cotter, et al., 1965a).

The altered zones within the Biwabik Iron Formation that can yield water are zones where the taconite has been oxidized, hydrated, and leached -- mainly in areas where the taconite was previously broken by folding and faulting, thus exposing it to these processes. Slatey taconites, found mainly in the upper and lower slatey members of the Biwabik Iron Formation, commonly alter to "paint rock," which is a sticky, clayey rock of low permeability. The cherty members of the Biwabik Iron Formation alter to a more permeable rock. On the central and eastern Mesabi Iron Range, oxidation is less widespread than in the area to the west, around Hibbing and Grand Rapids, but leaching is more complete where oxidation has taken place (Cotter, et al., 1965a). The Biwabik Iron Formation is overlain by the low-permeability Virginia Argillite and is underlain by the low-permeability Pokegama Quartzite.

Over much of the Mesabi Iron Range, the Biwabik Iron Formation laps against the south flank of the Giants Range and dips approximately 5 to 20 degrees to the south-southeast. The recharge area for groundwater in the Biwabik Iron Formation is limited to that zone south of the crest of the Giants Range and north of the southern limit of the Biwabik formation subcrop (where the

Biwabik formation is overlain by the Virginia Argillite) (Cotter, et al., 1965a). Recharge occurs from the overlying glacial drift and in some of the open pit mines and lakes on the Mesabi Iron Range. The rate of groundwater recharge is estimated to be about 5 inches/year (Winter, et al., 1973). Recharge to the Biwabik Iron Formation in the vicinity of Virginia is probably somewhat greater than in other areas bounded by the Laurentian Divide because of the funneling effect produced by the arc-like shape of the "Virginia Horn" (Cotter, et al., 1965b).

Groundwater likely flows south-southeast along the dip of the Biwabik Iron Formation, but there are no wells through the Virginia Argillite into the Biwabik Iron Formation to verify a south-southeast flow direction. Typically, however, groundwater usually flows away from the recharge areas in a down-dip direction. Unconfined to semi-confined conditions probably prevail where the Biwabik Iron Formation crops out or subcrops below glacial drift. Confined conditions probably occur south of the contact between the Biwabik Iron Formation and the Virginia Argillite.

In the vicinity of the "Virginia Horn," there are some wells that tap groundwater in the Biwabik Iron Formation. The communities of Biwabik and McKinley have in the past used wells finished in the Biwabik Iron Formation to augment water supplies. In addition, the communities of Aurora and Virginia have obtained water, in part, from wells finished in both the Biwabik Iron Formation and glacial drift aquifers (Cotter, et al., 1965a). These communities are almost certainly far enough removed from the vicinity of the proposed Laurentian Mine so that they will not experience any adverse effects on groundwater supplies due to mine dewatering. Their inclusion in this discussion serves to illustrate the point that the Biwabik Iron Formation can be a productive groundwater source.

Glacial Drift Aquifers

Delineating aquifers within the drift is difficult because glacial deposits are characteristically highly variable in thickness and areal extent. In general, the major sand and gravel deposits (aquifers) occur between the till units (confining beds) or at the ground surface. Internal characteristics of glacial units, such as grain size, porosity, and lithology, are also highly variable.

The basal till unit, which rests on bedrock in the western portion of the Mesabi Iron Range, probably does not exist in the vicinity of the proposed Laurentian Mine. East of Hibbing, the basal till unit has been identified in only two test holes and in the Embarrass Mine near Aurora. In the vicinity of the proposed Laurentian Mine, the bouldery till unit, approximately 25 feet thick, rests on top of bedrock. The bouldery till unit is characterized by many cobbles and boulders in a sandy to silty matrix. The bouldery till unit has moderate to low permeability (Winter, et al., 1973).

Above the bouldery till unit, glaciofluvial deposits of fine-grained sand approximately 50 to 100 feet thick are commonly present. Lense-shaped bodies of coarser sand and gravel occur within the glaciofluvial deposits. These deposits were probably formed when the Rainy ice lobe retreated north of the Giants Range and sediment-laden meltwaters poured southward through bedrock valley notches in the Giants Range. One such bedrock valley notch is present between Gilbert and Biwabik. Glacial sediments within the bedrock valleys tend to be thicker than in other locations. The permeability of the glaciofluvial deposits is generally moderate to high (Winter, et al., 1973).

A surficial till unit overlies glaciofluvial sediments in areas south of the Giants Range. These sediments are typically reddish brown clayey silt. The surficial till unit is generally continuous but less than 25 feet thick. The unit typically has a low permeability and, where present, retards infiltration to the underlying glaciofluvial sediments (Winter, et al., 1973).

In the bedrock valley between Gilbert and Biwabik, a surficial glaciofluvial unit is present. Generally, this unit is less than 25 feet thick but may reach a thickness in excess of 100 feet. This deposit is characteristically moderately to highly permeable (Winter, et al., 1973).

The water table within the drift aquifers is generally less than 10 feet below the ground surface and rarely greater than 25 feet below (Winter, et al. 1973).

Local Hydrogeology

1. Bedrock Aquifers

Cotter, et al. (1965b) note that there are very few data on wells in the Biwabik Iron Formation near Gilbert and McKinley, but the Biwabik formation probably represents a potential source for groundwater because a considerable part of the formation has been altered to ore in the area. In order for the Biwabik Iron Formation to yield groundwater in large quantities, it must be altered by oxidation, hydration, and leaching to increase the permeability. The formation of natural iron-ore deposits in the Biwabik formation requires such alteration mechanisms.

Estimates of the specific capacity for wells in unfractured and unaltered portions of the Biwabik Iron Formation range from 0.02 to 0.11 gallons/minute per foot of drawdown (Siegel and Ericson, 1980). Specific capacity is a measure of an aquifer's ability to provide well water. In order to use these data to prepare the computer model that would simulate groundwater impacts, the specific capacity values must be converted to transmissivity values. Transmissivity is an aquifer's permeability multiplied by the aquifer's thickness and is a measure of how much groundwater can flow through the aquifer. Using a modified form of the Thiem equation, the specific capacity values of 0.02 to 0.11 gallons/minute per foot of drawdown translate into a transmissivity for unaltered portions of the Biwabik Iron Formation of 35 to 190 gallons/day per foot.

For altered portions of the Biwabik Iron Formation, specific capacities and transmissivity values are estimated to be considerably higher. A mine dewatering well in the ore body in the Corsica Pit, near McKinley, was formerly pumped continuously at 860 gallons/minute and the specific capacity was determined to be about 20 gallons/minute per foot of drawdown (Cotter, et al., 1965b). Siegel and Ericson (1980) found a specific capacity range of 0.24 to 6.44 gallons/minute per foot of drawdown for wells completed in altered portions of the Biwabik Iron Formation. Using a modified form of the Thiem equation, these specific capacities can be translated to an estimated range of transmissivity values of 400 to 11,000 gallons/day per foot for the altered portions of the Biwabik Iron Formation. A possible extreme transmissivity value of about 35,000 gallons/day per foot is estimated based on the specific capacity of 20 gallons/minute per foot of drawdown observed in the Corsica Pit dewatering well.

In summary, the Biwabik Iron Formation is sufficiently permeable to yield useable quantities of groundwater for domestic and some municipal uses. However, the overlying glacial drift is a much more productive source of groundwater in the area.

2. Glacial Drift Aquifers

Cotter, et al. (1965b) delineated an area of glacial drift between the communities of Gilbert and McKinley that is largely composed of ice-contact derived sediments of sand and gravel overlying bedrock along the front of the Giants Range. There is a groundwater recharge area bounded on the north and west by the Laurentian drainage divide.

A map of glacial deposits published by Winter, et al. (1973, Plate 1A) indicates that the glacial deposits in the vicinity of the proposed Laurentian Mine are largely the result of ice-contact deposits and ground moraine deposits. Two linear northeast-trending esker deposits are shown to exist south and east of the Mariska Pit. Cotter, et al. (1965b) also makes reference to esker features in this area.

Winter, et al. (1973) indicate that there are about 90 feet of glacial drift overlying the Biwabik Iron Formation at the Mariska Pit, which is in the southern corner of the proposed Laurentian Mine. At the Mariska Pit, the top 1 foot of glacial drift is red clay till. From depths of 1 to 17 feet, silty to cobbly sand and gravel comprise the glacial drift. From a depth of 17 feet to the top of the Biwabik Iron Formation, at a depth of 92 feet, the drift is composed of sand and medium-sized gravel. These descriptions of the composition of the glacial drift near the location of the proposed Laurentian Mine suggest that there are about 90 feet of relatively permeable sand and gravel overlying the Biwabik Iron Formation. The estimated hydraulic conductivity of these sediments, based on their grain-size distributions, is between 40 and 270 feet/day (Winter, et al., 1973).

Winter, et al. (1973, Plate 2B) indicate that a test hole installed about 1 mile east of Gilbert yielded an estimated transmissivity for the glacial drift of 100,000 gallons/day per foot and a percentage of sand in the glacial drift of about 100 percent. Using this value of transmissivity and a saturated thickness of 90 feet for the glacial drift near the proposed Laurentian Mine, a hydraulic conductivity value of 150 feet/day is calculated. This falls well within the range of hydraulic conductivity values of 40 and 270 feet/day predicted from the grain-size distribution used by Winter, et al. (1973).

Groundwater in the glacial drift in the vicinity of the proposed Laurentian Mine generally flows to the southeast. Groundwater flow directions near lakes and open pit mines deviate from this southeast trend due to the hydraulic effects of these surface features.

Water Quality

The water quality of lakes and streams in the vicinity of the proposed Laurentian Mine is typical of lakes and streams in northern Minnesota. This section describes current water quality for comparison with estimated future water quality to assess the potential project impacts. This discussion centers on phosphorus and dissolved oxygen concentrations since mining activities are most likely to affect these parameters in area lakes.

Only a small amount of historical water quality data for area lakes and streams was available from local, state, and federal resource management agencies. These data were supplemented by a limited program of water quality sampling and analysis conducted for this Draft EIS.

The natural lakes in the vicinity of the proposed project (Leaf Lake and White Lake) are both eutrophic (nutrient-rich) lakes that exhibit seasonal water quality problems, including winter oxygen depletion (which can result in fish kills) and summer algal blooms. Leaf Lake has had winter fish kills in the past. On the other hand, the abandoned mine pit lakes (Corsica Pit, Mariska Pit, and Lake Orebegone) all have good water quality and are classified as oligotrophic (nutrient-poor) lakes. No water quality data are available for the Pike River in the vicinity of the proposed haul road, but the river is presumed to have relatively good water quality because of the undisturbed character of its watershed.

Nature of Water Quality Problems

1. Eutrophication

The process of lake degradation is called eutrophication. It is the process whereby lakes accumulate nutrients from their watersheds. Over time, a lake naturally becomes more fertile, and is converted from oligotrophic (nutrient-poor) to eutrophic (nutrient-rich) status as it is progressively enriched by nutrients from its watershed. As sediment and internal biological production fill the lake's basin, the lake successively becomes a pond, a marsh and, ultimately, a terrestrial site.

The process of eutrophication is a natural one, resulting from the environmental forces that influence a lake. Cultural eutrophication, however, is an acceleration of the natural process caused by human activities. This acceleration may result from point-source nutrient loadings, such as effluent from wastewater treatment plants, or it may be caused by diffuse (i.e., non-point) sources of nutrients, such as stormwater runoff. Runoff from the proposed Laurentian Mine and associated stockpiles would contribute non-point source pollutants to area lakes. The consequence of eutrophication is often profuse and unsightly growths of algae (algal blooms) and/or rooted aquatic macrophytes (weeds).

The quantity or biomass of algae in a lake or pond is usually limited by the concentration of an essential element or nutrient (the "limiting nutrient" concept). Aquatic weeds, on the other hand, derive most of their nutrients from lake or pond sediments. The limiting nutrient concept is a widely applied principle in the study of eutrophication. It is based on the concept that, in considering all of the substances needed for biological growth, one will be present in limited quantity and will be the "limiting" nutrient, thereby controlling the rate of biological growth. This is an oversimplification, but serves to point out the importance of nutrient concentrations in determining biological growth.

Nitrogen (N) and phosphorus (P) are generally the two growth-limiting nutrients for algae in most natural waters. Analysis of the nutrient content of both water and algae provides ratios of N:P that tend to indicate whether one or the other of these elements is growth-limiting. These ratios are based on the average elemental composition of algae. An average stoichiometric formula for algae is $C_{106}H_{181}O_{145}N_{16}P$. By comparing the tissue concentrations of important nutrients in algae to the concentrations of the same nutrients in the ambient waters, one can estimate whether a particular nutrient may be limiting.

Algal growth is generally phosphorus-limited in waters within N:P ratios greater than 12. It has been amply demonstrated, in experiments ranging from laboratory bioassays to fertilization of in-situ enclosures to whole-lake experiments, that most often phosphorus is the nutrient that limits algal growth. Lakes in the vicinity of the proposed Laurentian Mine all have N:P ratios greater than 12. For this reason, algal abundances there depend on phosphorus concentrations.

2. Structure of Lakes and Ponds

Certain physical phenomena occur in lakes and ponds that can profoundly influence their chemistry and biology. Probably the most important phenomenon is thermal stratification. Because water varies in density according to its temperature, lakes and ponds in temperate regions tend to stratify, or form layers, especially during the summer.

Water is most dense at 4°C (~39°F), and becomes less dense as it becomes warmer or colder. Consequently, cooler, denser water accumulates in the bottom strata of lakes and ponds during the spring and autumn of the year following mixing periods called "overturns." This difference in water temperature, from surface to bottom, increases during the summer as surface waters warm and the lake stratifies into three layers. The warm surface stratum of a lake or pond is called the epilimnion. Below the epilimnion is a transitional layer of water, the metalimnion, in which the temperature declines rapidly. This steep temperature gradient is termed a thermocline. The bottom stratum of a lake is the hypolimnion and contains the coldest, densest waters.

The significance of summer thermal stratification in lakes is that the density change across the thermocline provides a real physical barrier to circulation. While water above the thermocline may circulate as a result of wind action, hypolimnetic waters at the bottom are isolated and do not mix. Consequently, very little transfer of gases (including oxygen) occurs from the atmosphere to the hypolimnion. If the lake or pond sediments are rich in organic matter, microbial decomposition and respiration can deplete hypolimnetic waters of their dissolved oxygen. Nutrients contained in the sediment may then be released into the water column as a result of changes in the oxidation-reduction (REDOX) potential of the system caused by oxygen depletion. These nutrients will contribute to the growth of algae in surface waters when the lake or pond mixes. If dissolved oxygen concentrations are depressed below 3.5 mg/L, game fish will not survive in the water. Rough fish require at least 2.0 mg/L dissolved oxygen.

Shallow ponds (generally $\leq$ 10-foot depth) stratify weakly and may circulate many times during the summer as a result of wind mixing. They are termed polymictic (multiple mixing). Deeper lakes and ponds generally circulate only twice each year, in the spring and fall, when surface waters warm or cool sufficiently to allow wind-driven circulation to occur. These lakes and ponds are designated dimictic (twice mixing). The water columns of lakes and ponds become isothermal (same temperature) whenever they circulate.

Recycling of nutrients from anoxic (no oxygen) sediments to the surface waters of a lake or pond is most often a problem in highly fertile water bodies. Leaf Lake and White Lake are both relatively fertile water bodies that are subject to hypolimnetic oxygen depletion and recycling of phosphorus from their sediments. The Corsica Pit lake, on the other hand, is a relatively infertile water body that does not exhibit these problems.

Lake Water Quality

Lakes in the vicinity of the proposed mine include two natural lakes (Leaf and White lakes), and three water-filled, abandoned mine pits (Lake Orebegone, the Mariska Pit, and Corsica Pit). Area lakes and their watersheds are shown in Figure 4.2.

This Draft EIS focuses on the water quality of Leaf Lake, White Lake, and the Corsica Pit. The morphologic and watershed land use characteristics of these three lakes are summarized in tables 4.12 and 4.13, respectively. Because it was determined that its water quality would not be affected by the proposed mine, Lake Orebegone is not addressed in great detail in this section. Also, the water quality impacts on the Mariska Pit lake were not assessed because the lake eventually would be incorporated into the Laurentian Mine.

In 1989, Inland Steel sampled area lakes in anticipation of the need for background water quality data for this Draft EIS. The results of sample analyses are reported in tables 4.14 and 4.15. These results indicate that the lakes have reasonably good water quality and all meet the Class 2(b) water quality standards (Table 4.16) prescribed for them by the Minnesota Pollution Control Agency. Total phosphorus concentrations in all four lakes were less than 0.020 mg/L, indicating oligotrophic (low

TABLE 4.12

MORPHOLOGIC CHARACTERISTICS OF LAKES IN THE VICINITY OF THE PROPOSED LAURENTIAN TACONITE MINE

Lake	Elevation (feet)	Surface Area (acres)	Maximum Depth [m (ft)]	Mean Depth [m (ft)]	Volume (acre-feet)	Watershed Area (acres)	Mean Hydraulic Residence Time (years)
Leaf	1390.0	49.6	6.1 (20.0)	2.86 (9.4)	465.5	528.1	1.07
White	1422.3	45.4	6.1 (20.0)	3.16 (10.4)	470.5	550.9	3.82
Corsica Pit	1417.7	40.4	55 (180.4)	34 (111.5)	4500	437.9	100.2

Source: MDNR bathymetric maps and USGS topographic maps

TABLE 4.13

WATERSHED LAND USE DATA FOR LAKES IN THE VICINITY OF THE PROPOSED LAURENTIAN TACONITE MINE

	Lake		
Parameter	Leaf	White	Corsica Pit
Watershed Area (acres)	528.1	550.9	437.9
Land Use In Watershed (acres):			
Stockpile	100.3	11.5	39.0
Forest/Open	325.7	471.8	357.1
Wetland	48.8	17.3	1.4
Open Water	53.3	50.3	40.4

TABLE 4.14

LAKE WATER QUALITY ON MAY 18, 1989
(Surface Water Samples)

	Water Body			
Parameter, units	Lake Orebegone	Mariska Pit	White Lake	Leaf Lake
Total Coliform, colonies/100ml	20	18	11	4
Fecal Coliform, colonies/100ml	2	<1	2	2
Acidity as $CaCO_3$, mg/L	4.5	5.5	4.0	5.5
Total Alkalinity, mg/L	156	148	16	167
Hardness, mg/L	193	162	22	92
Nitrate as N, mg/L	0.47	0.22	<0.10	0.14
Nitrite as N, mg/L	<0.01	<0.01	<0.01	<0.01
Turbidity, NTU	0.40	0.36	0.90	0.65
Sulfate, mg/L	59	29	9	42
Sulfide, mg/L	<0.2	<0.2	<0.2	<0.2
Color, Pt/Co units	<1	<1	25	3
Ammonia as N, mg/L	<0.1	<0.1	<0.1	<0.1
Sulfite, mg/L	<2.0	<2.0	<2.0	<2.0
Bromide, mg/L	<0.10	<0.10	<0.10	<0.10
Chloride, mg/L	8.6	2.6	1.9	5.0
Cyanide, mg/L	<0.10	<0.10	<0.10	<0.10
Fluoride, mg/L	0.12	0.05	0.05	0.13
Surfactants, mg/L	<0.10	<0.10	<0.10	<0.10
Oil & Grease, mg/L	3.16	<2.0	3.07	<2.0
Phenols, mg/L	<0.01	<0.01	<0.01	<0.01
Aluminum, total, mg/L	0.04	0.03	0.07	<0.01
Cadmium, total, ug/L	<0.2	<0.2	<0.2	<0.2
Calcium, total, mg/L	36	35	5.5	44
Cobalt, total, mg/L	<0.05	<0.05	<0.05	<0.05
Chromium, total, ug/L	<10	<10	<10	<10
Copper, total, ug/L	<5	<5	<5	<5
Lead, total, ug/L	<1	<1	<1	<1
Magnesium, total, mg/L	25	18	1.9	20
Mercury, total, ug/L	<0.4	<0.4	<0.4	<0.4
Molybdenum, total, mg/L	<0.1	<0.1	<0.1	<0.1
Nickel, total, mg/L	<0.05	<0.05	<0.05	<0.05
Potassium, total, mg/L	3.78	2.13	0.85	2.77
Sodium, total, mg/L	8.59	4.08	1.79	6.59
Zinc, total, ug/L	<10	<10	<10	<10
Manganese, total, mg/L	<0.01	0.01	0.14	0.32
Phosphorus, total, mg/L	<0.02	<0.02	<0.02	<0.02

Samples collected and analyzed by Northeast Technical Services, Inc.
(<) = less than

TABLE 4.15

CORSICA PIT WATER QUALITY ON SEPTEMBER 13, 1989
(Surface Water Samples)

Parameter, Units	Results
Total Coliform Bacteria/100ml	<1
Fecal Coliform Bacteria/100ml	<1
Acidity, mg/L	6.6
Total Alkalinity as $CaCO_3$, mg/L	92.0
Total Hardness as $CaCO_3$, mg/L	104
Nitrate Nitrogen:N, mg/L	<0.10
Nitrite Nitrogen:N, mg/L	<0.01
Turbidity, NTU	0.28
Sulfate, mg/L	25.0
Sulfide, mg/L	<0.2
Sulfite, mg/L	<2.0
Ammonia Nitrogen:N	<0.10
Color, Pt/Co	<5
Bromide, mg/L	<0.10
Chloride, mg/L	4.5
Cyanide, mg/L	<0.01
Fluoride, mg/L	0.08
Surfactants, MBAS, mg/L	<0.10
Oil & Grease, mg/L	<2.0
Total Phenols, mg/L	<0.01
Total Phosphorus, mg/L	<0.02
Ortho-Phosphorus, mg/L	<0.02
Total Aluminum, mg/L	0.07
Total Cadmium, ug/L	<0.20
Total Calcium, ug/L	23.3
Total Cobalt, mg/L	<0.05
Total Chromium, ug/L	2.6
Total Copper, ug/L	4.5
Total Lead, ug/L	<2.0
Total Manganese, mg/L	<0.01
Total Magnesium, mg/L	12.1
Total Mercury, ug/L	<0.4
Total Molybdenum, mg/L	<0.10
Total Nickel, ug/L	<10
Total Potassium, mg/L	3.0
Total Sodium, mg/L	1.9
Total Zinc, ug/L	<10

Samples collected by and analyzed by Northeast Technical Services, Inc.
(<) = less than

fertility) or mesotrophic (medium fertility) conditions. The Corsica Pit lake serves as the drinking water supply for the City of McKinley. Although not classified as a Class 1 (Domestic Consumption) water body, this lake does currently meet Minnesota drinking water quality standards.

However, this interpretation that the lakes have reasonably good water quality is based only on the results of surface water quality sample analysis, and is inconsistent with reports of significant hypolimnetic oxygen depletion and moderate algal blooms during the summer months in Leaf and White lakes. This is presumably due to the high oxygen demand of organic lake sediments and the subsequent release and recycling of phosphorus from anoxic sediments. Therefore, both Leaf and White lakes are probably eutrophic (highly fertile) water bodies. This interpretation is supported by reports of fish kill conditions during winter months in Leaf Lake. The Corsica Pit, on the other hand, is a relatively infertile lake that exhibits little or no hypolimnetic oxygen depletion.

To further assess the degree of dissolved oxygen depletion in the bottom hypolimnion of area lakes, water quality sampling was conducted during mid-March of 1990. Dissolved oxygen concentrations, total phosphorus concentrations, and specific conductances were monitored along a 1-meter (3.28-foot) interval depth profile at the center (deep hole) of each lake. The following results confirm that Leaf and White lakes have significant oxygen depletion and eutrophic conditions, while the infertile mine pits have little oxygen depletion.

1. Leaf Lake

On March 15, 1990, Leaf Lake had very little dissolved oxygen in its water column below a depth of 4 meters (13.1 feet, Table 4.17). Specific conductance levels (indicative of ions released from the lake's sediment) and total phosphorus concentrations were both elevated in the anoxic zone of the lake. Even the dissolved oxygen concentrations in the upper stratum of the lake were low, with the maximum concentration observed only 3.5 mg/L, just beneath the ice-cap. These data correspond well with reports of previous winter fish kills in Leaf Lake. Low dissolved oxygen concentrations are probably the cause of previous fish kills.

TABLE 4.16

MINNESOTA CLASS 2B (FISHERIES AND RECREATION) WATER QUALITY STANDARDS[1]

Substance or Characteristics	Limit or Range
Dissolved oxygen	Not less than 5 milligrams per liter at all times (instantaneous minimum concentration)***
Temperature	5°F above natural in streams and 3°F above natural in lakes, based on monthly average of the maximum daily temperature, except in no case shall it exceed the daily average temperature of 86°F.
Ammonia nitrogen (N)*	0.04 milligram per liter (un-ionized as N)
Chromium (Cr)	0.05 milligram per liter
Copper (Cu)	0.01 milligram per liter or not greater than 1/10 the 96 hour TLM value.
Cyanide (CN)	0.02 milligram per liter
Oil	0.5 milligram per liter
pH value	6.5-9.0
Phenols	0.01 milligram per liter and none that could impart odor or taste to fish flesh or other freshwater edible products such as crayfish, clams, prawns and like creatures. Where it seems probable that a discharge may result in tainting of edible aquatic products, bioassays and taste panels will be required to determine whether tainting is likely or present.
Turbidity	25 NTU
Fecal coliform organisms	200 organisms per 100 milliliters as a logarithmic mean measured in not less than five samples in any calendar month, nor shall more than 10% of all samples taken during any calendar month individually exceed 400 organisms per 100 milliliters.

TABLE 4.16 (continued)

MINNESOTA CLASS 2B (FISHERIES AND RECREATION) WATER QUALITY STANDARDS[1]

Substance or Characteristics	Limit or Range
Fecal coliform organisms (cont'd.)	(Applies only between May 1 and October 31.)
Radioactive materials	Not to exceed the lowest concentration permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.
Total residual chlorine**	0.003 milligrams per liter

*The percent un-ionized ammonia can be calculated for any temperature and pH by using the following formula taken from Thurston, R.V., R.C. Russo, and K. Emerson, 1974. Aqueous ammonia equilibrium calculations. Technical Report Number 74-1. Fisheries Bioassay Laboratory, Montana State University, Bozeman, MT. 18 p.

$$f = \frac{1}{10^{(pK_a - pH)} + 1} \times 100$$

where:
f = the percent of total ammonia in the un-ionized state,
$pK_a = 0.0901821 + \frac{2729.92}{T}$, dissociation constant for ammonia, and
T = temperature in degrees Kelvin (273.16° Kelvin=0° Celsius)

**Applies to conditions of continuous exposure, where continuous exposure refers to chlorinated effluents which are discharged for more than a total of two hours in any 24-hour period.

***This dissolved oxygen standard shall be construed to require compliance with the standard 50 percent of the days at which the flow of the receiving water is equal to the lowest weekly flow with a once in 10-year recurrence interval (7Q10).

Source: Minnesota Pollution Control Agency
TLM = median tolerance limit
NTU = nephelometric turbidity units

TABLE 4.17

LEAF LAKE WATER QUALITY ON MARCH 15, 1990

Sample Depth [m (ft)]	Parameter (units)			
	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (umhos/cm)	Total Phosphorus (mg/L)
2 (6.6)	3.0	3.5	260	0.01
3 (9.8)	3.0	2.6	280	0.02
4 (13.1)	3.0	1.7	290	0.02
5 (16.4)	3.0	0.2	310	0.02
6 (19.7)	3.0	0.2	340	0.15
7 (23.0)	3.0	0.2	350	--

Samples collected and analyzed by Barr Engineering Co.

-- = sample not collected
umhos/cm = micromhos per centimeter
mg/L = milligrams per liter
°C = degrees, Centigrade
m = meters

2. White Lake

Similar to Leaf Lake, the dissolved oxygen concentrations of White Lake on March 15, 1990, were depleted to low levels below a depth of 3 meters (9.8 feet, Table 4.18). Elevated specific conductance levels and total phosphorus concentrations, presumably related to ion release from anoxic lake sediments, were found to correspond to low dissolved oxygen concentrations. A maximum dissolved oxygen concentration of 6.3 mg/L was observed just beneath the ice, but only 2.7 mg/L was noted at 3 meters (9.8 feet). The water column had dissolved oxygen concentrations below 2 mg/L (the level generally accepted as necessary to support rough fish) below a depth of 3 meters (9.8 feet). Thus, fish were probably confined to the lake's upper stratum. Although reports of winter fish kills did not appear in the MDNR records, it seems that White Lake will be susceptible to fish kills during winters with deep snow or opaque ice. Under such conditions, sunlight is prevented from penetrating the lake ice and, consequently, algae do not photosynthesize and add oxygen to the water column.

3. Corsica Pit

Corsica Pit water quality data collected on March 15, 1990, show plentiful dissolved oxygen supplies throughout its depth of 55 meters (180.4 feet, Table 4.19). Concentrations ranged from 9.8 mg/L in the upper stratum of the lake to 4.4 mg/L at the bottom. No evidence of ion release from the lake sediments could be detected in either the specific conductance or total phosphorus data. Phosphorus concentrations were less than 0.010 mg/L throughout the water column, indicating that the Corsica Pit is an oligotrophic water body.

TABLE 4.18

WHITE LAKE WATER QUALITY ON MARCH 15, 1990

Sample Depth [m (ft)]	Parameter (units) Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (umhos/cm)	Total Phosphorus (mg/L)
2 (6.6)	2.5	6.3	40	0.02
3 (9.8)	3.0	2.7	45	0.02
4 (13.1)	3.0	0.5	50	0.02
5 (16.4)	4.0	0.5	55	0.01
6 (19.7)	4.0	0.1	60	0.03
7 (23.0)	4.0	0.1	80	0.03

Samples collected and analyzed by Barr Engineering Co.

m = meters
°C = degrees, Centigrade
mg/L = milligrams per liter
umhos/cm = micromhos per centimeter

TABLE 4.19

CORSICA PIT WATER QUALITY ON MARCH 15, 1990

Sample Depth [m (ft)]	Parameter (units) Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (umhos/cm)	Total Phosphorus (mg/L)
2 (6.6)	3.0	--	130	<0.01
10 (32.8)	3.0	--	140	<0.01
18 (59.1)	3.0	9.8	140	<0.01
27 (88.6)	3.0	9.6	140	<0.01
36 (118.1)	4.0	4.5	150	<0.01
45 (147.6)	4.0	4.3	150	<0.01
55 (180.4)	4.0	4.4	150	0.04

Samples collected and analyzed by Barr Engineering Co.

m = meters
°C = degrees, Centigrade
mg/L = milligrams per liter
umhos/cm = micromhos per centimeter
< = less than
-- = sample not collected

4. Lake Orebegone and the Mariska Pit

Both Lake Orebegone and the Mariska Pit exhibited high concentrations of dissolved oxygen throughout their water columns (tables 4.20 and 4.21). Both lakes had generally low phosphorus concentrations. Hypolimnetic increases in specific conductance and total phosphorus concentrations were absent, corroborating the observed high dissolved oxygen concentrations. These data suggest that both lakes are mesotrophic water bodies. The observed good water quality in these abandoned ore pits is understandable given their great depths, relatively small (and undeveloped) watersheds, and the short period of time over which lake sediments have accumulated nutrients from watershed runoff.

Pike River Water Quality

The Pike River is a first order stream (no tributaries) at one of the proposed haul road crossings, and a second order stream (two tributaries) at the other crossing. As a headwater stream, its flows are extremely variable and highly influenced by the quality of runoff from its watershed. A thorough search of the files of local, state, and federal resource management agencies failed to disclose any historical water quality data for the Pike River near the planned crossings. Sample collection was planned for mid-March 1990, but the streams were swollen with rain and snowmelt. Samples were not collected because conditions were not indicative of normal, background water quality. It can be inferred, however, that background water quality of the Pike River in this area is probably quite good, given the undisturbed character of its watershed.

TABLE 4.20

LAKE OREBEGONE WATER QUALITY ON MARCH 16, 1990

Sample Depth [m (ft)]	Parameter (units)			
	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (umhos/cm)	Total Phosphorus (mg/L)
2 (6.6)	2.0	11.0	245	<0.01
12 (39.4)	3.0	10.6	260	<0.01
24 (78.7)	3.0	10.2	250	0.02
36 (118.1)	3.0	7.5	260	0.01
48 (157.5)	3.0	7.2	260	<0.01
60 (196.9)	3.0	7.2	260	0.02
70 (229.7)	3.0	5.4	270	<0.01

Samples collected and analyzed by Barr Engineering Co.

m = meters
°C = degrees, Centigrade
mg/L = milligrams per liter
umhos/cm = micromhos per centimeter
< = less than

TABLE 4.21

MARISKA PIT WATER QUALITY ON MARCH 16, 1990

	Parameter (units)			
Sample Depth [m (ft)]	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (umhos/cm)	Total Phosphorus (mg/L)
2 (6.6)	2.0	10.2	210	0.01
10 (32.8)	3.0	9.4	210	0.03
18 (59.1)	3.0	9.0	200	0.01
26 (85.3)	3.0	7.8	210	0.01
34 (111.5)	3.0	3.2	210	0.02
42 (137.8)	3.0	3.2	210	0.02
50 (164.0)	3.0	--	210	0.01

Samples collected and analyzed by Barr Engineering Co.

m = meters
°C = degrees, Centigrade
mg/L = milligrams per liter
umhos/cm = micromhos per centimeter
-- = sample not collected

Noise and Vibration

The noise and vibration caused by blasting and other mine operations are concern in mining. This section discusses existing noise and vibration conditions in the vicinity of the proposed Laurentian Mine. Existing conditions are discussed in terms of ambient (background) noise levels in Gilbert and along the proposed haul road. This section also identifies existing structures that are more sensitive to the effects of noise and vibration in the area.

The background noise level near Gilbert's northern limit and along old TH 135 was found to be representative of a rural environment and within the MPCA standard. Other noise levels were found to be lower than the MPCA standards. The only main source of noise is TH 135. Noise levels along the proposed haul road were not measured but were assumed to be lower than those measured in Gilbert because that area has little, if any, human activity.

Structures that are sensitive to noise and vibration are the wastewater treatment plant, the residence nearest the proposed mine, and 18 storage tanks (13 contain fuel oil or gasoline and the rest are empty). The treatment plant is of the greatest concern. Currently there is no excessive noise or vibration affecting these or other structures.

Ambient Noise Levels in Gilbert

Background noise measurements were taken in Gilbert on old TH 135, approximately 700 feet north of the new TH 135. This location is on the town side of the proposed sound attenuation berm, near the edge of proposed mining-related activities. Two sets of readings were taken during one 15-minute period (2:15 to 2:30) on a Monday afternoon. The readings were made with a Larson-Davis 700 sound level meter. About one hour after the readings were made, the Hibbing Flight Service reported a temperature of 26 degrees Fahrenheit and a 15 mph wind with gusts. These readings are shown in Figure 4.14.

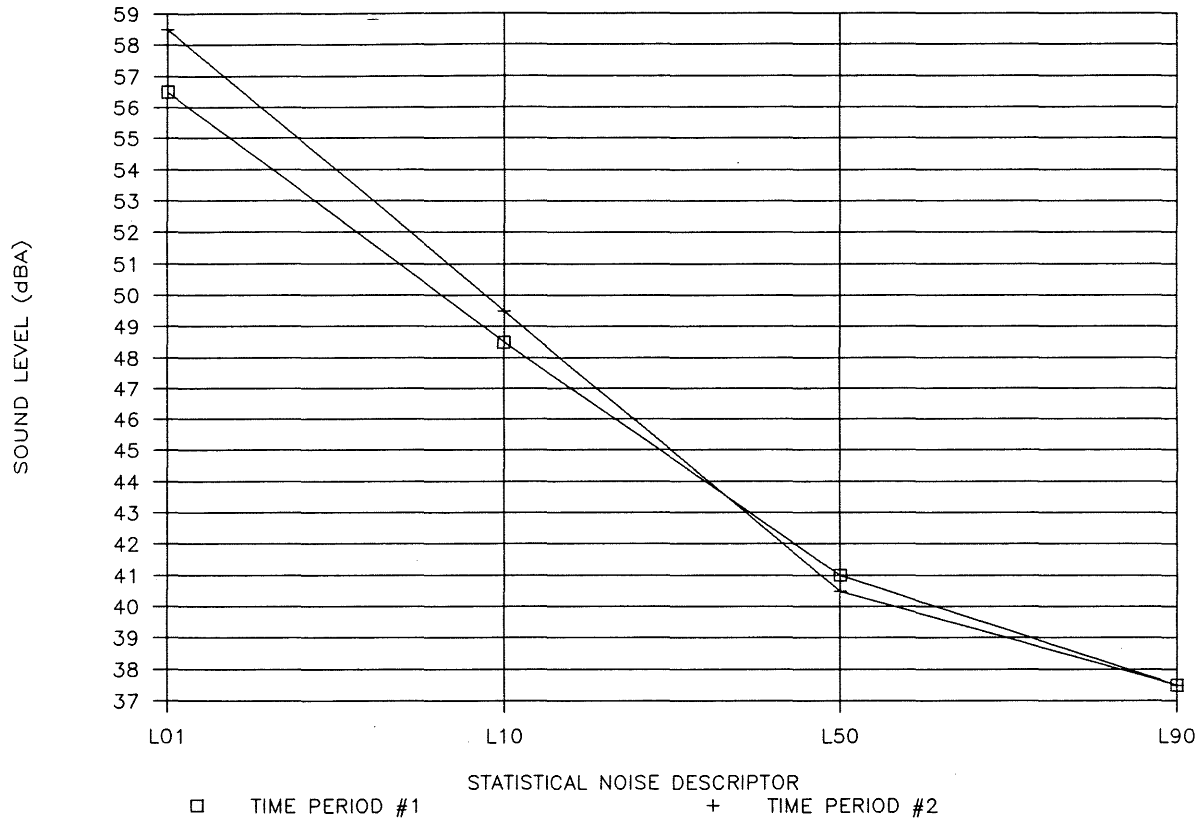


Figure 4.14

BACKGROUND SOUND LEVELS

IN GILBERT, MINNESOTA

During the noise measurement, there appeared to be little variation in the background noise level over time. Noise levels are classified as L90, L50, and L10, signifying levels that are exceeded 90, 50, and 10 percent of the time, respectively, during a 24-hour period. The L90 level was just over 37 dBA, which is representative of a rural environment. The L50 level was a low 41 dBA, compared with the MPCA daytime L50 maximum acceptable standard of 60 dBA. The L10 level was 49 dBA, compared with the MPCA daytime standard of 65 dBA. These measurements appear in the table below.

Current traffic volume on TH 135 is approximately 4,000 ADT (Average Daily Traffic). Assuming that 7.5 percent of this volume passed the monitoring site during the early afternoon and assuming a hard surface between the roadway and the monitoring site, the following noise levels are projected for traffic on TH 135:

Level	Projected	Measured
L10	49.9	49
L50	42.4	41

Since actual noise measurements at the monitoring site did not exceed projected noise levels from traffic on TH 135, it appears that the existing noise levels at the monitoring site north of TH 135 can be attributed to highway traffic. No other major sources of noise could be identified.

Ambient Noise Levels in Proposed Haul Road Area

No ambient noise readings were taken along the proposed haul road right-of-way north of Gilbert. Since the proposed road passes through uninhabited property where there is little human activity, it is expected that the sound levels in this area are 2 to 5 dBA lower than those observed in Gilbert.

Sensitive Structures Near Proposed Mine

In the immediate vicinity of the proposed mine pit are several structures that would be most sensitive to noise and vibration from the mine. These structures are:

- Wastewater treatment plant (south of TH 135)

- Residence nearest the proposed mine
  (north of new TH 135 and west of old TH 135)

- Storage tanks:

  - four tanks at the residence closest to the proposed sound berm, two empty and two containing fuel oil, owned by Kim's Oil
  - four tanks 400 feet west, all containing fuel oil, owned by Kohler Fuel
  - three tanks 400 feet northwest, all empty, formerly containing gasoline, owned by Inter-City Oil
  - one gasoline tank and six gasoline or fuel oil tanks, owned by Inter-City Oil, near the intersection of new TH 135 and old TH 135

Of greatest concern to the City of Gilbert is the potential impact of the mine and mine blasting on the wastewater treatment plant. Figure 4.15 is a cross-section of the plant showing the footings and relative ground elevation. A detail of the internal footing is shown in Figure 4.16. The design shows normal ties between the vertical and horizontal components, which are important to minimize vibration effects on the structure. Figure 4.17 shows two cross-sections of sewage tanks indicating that the tanks are depressed to optimize the structural design of the tanks. This information is useful in developing estimated vibration levels within the structure due to blasting from the adjacent mine.

There are no existing uses or conditions in the proposed project area that cause excessive vibrations for these or other structures.

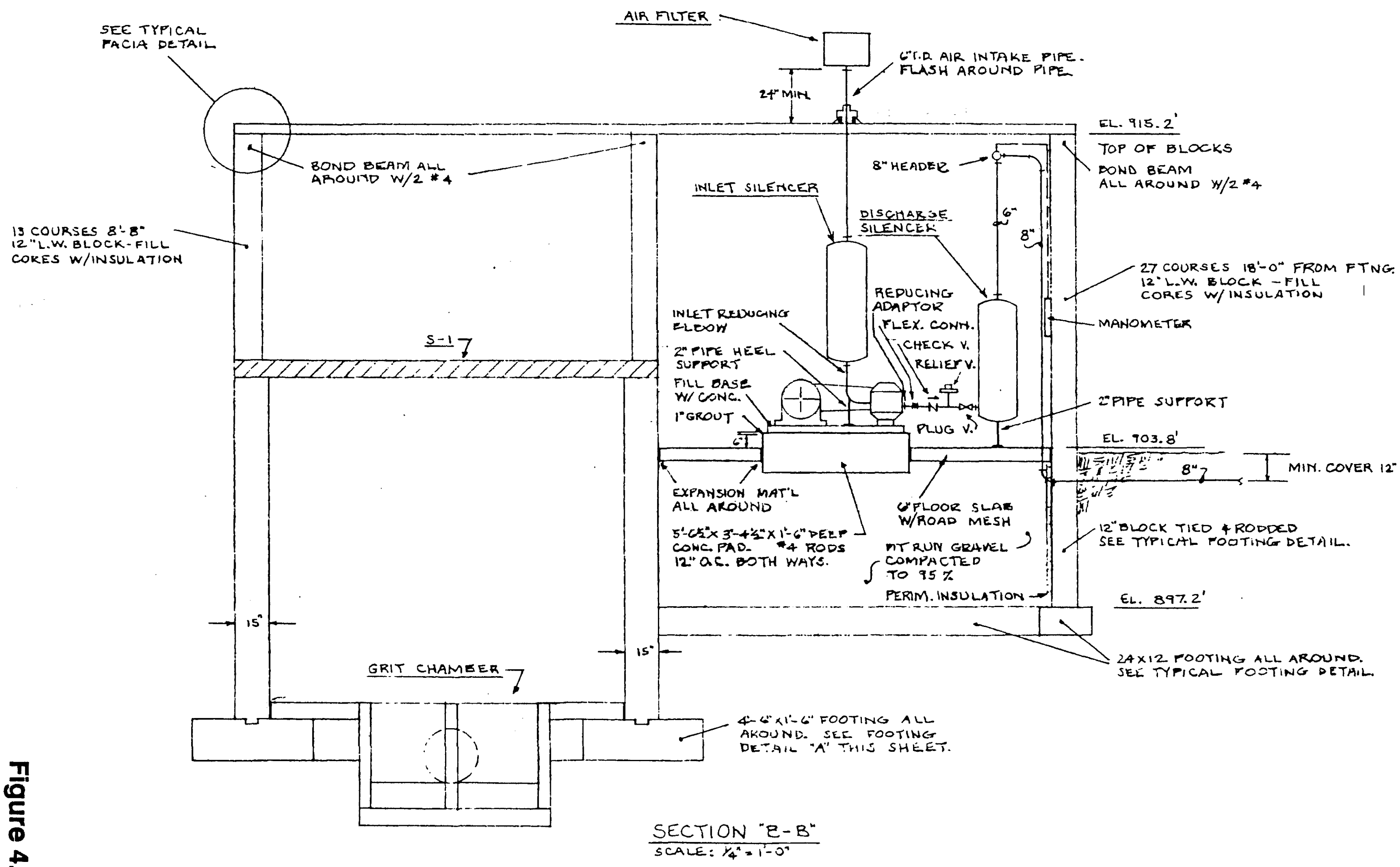


Figure 4.15
WASTEWATER TREATMENT PLANT CROSS SECTION

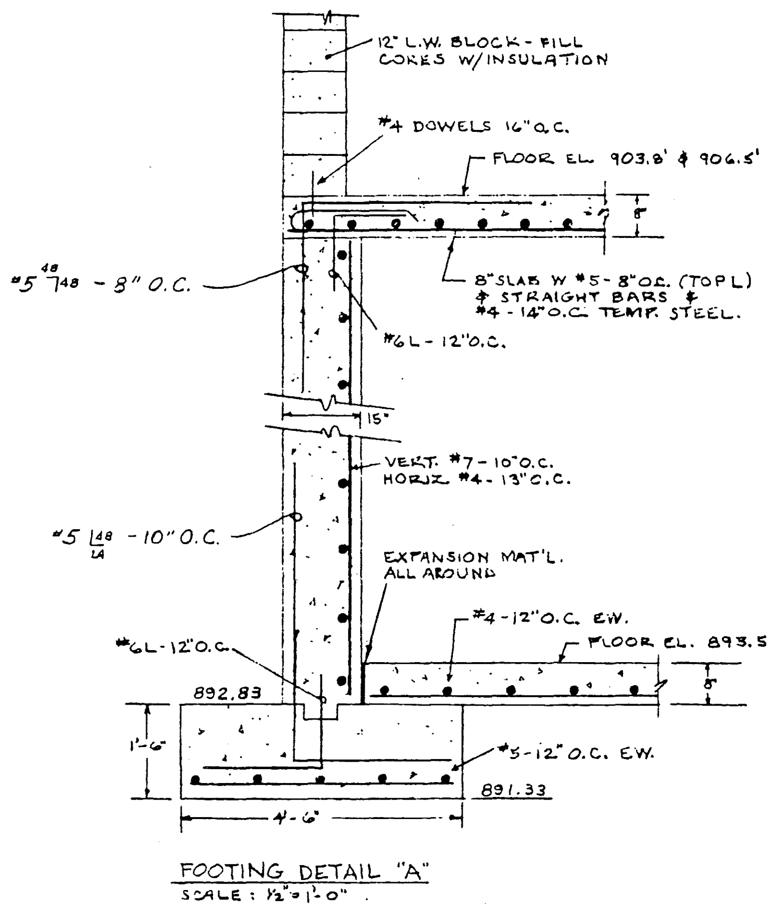


Figure 4.16

WASTEWATER TREATMENT PLANT

FOOTING DETAIL

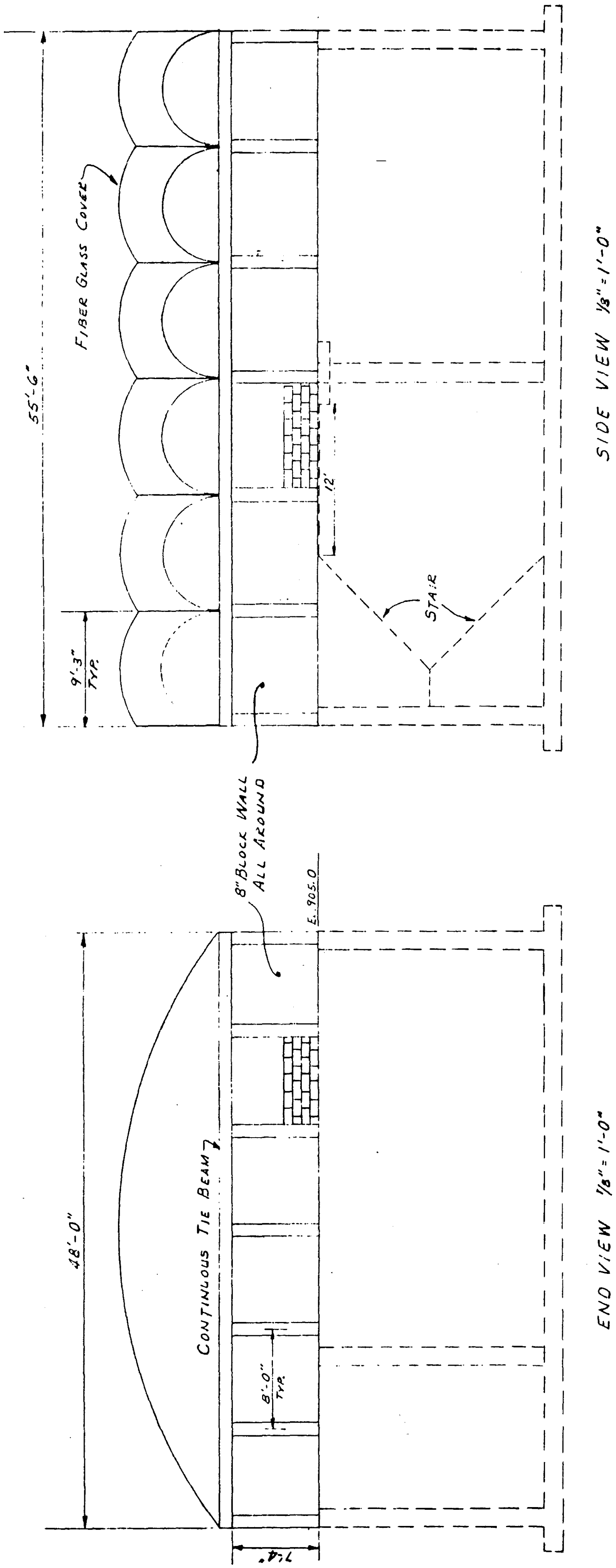


Figure 4.17

WASTEWATER TREATMENT PLANT

SEWAGE TANK CROSS SECTIONS

Air Quality

The proposed Laurentian Mine would impact air quality through fugitive dust emissions from haul road truck traffic, stockpile wind erosion, materials handling, and blasting. This section describes existing background air quality conditions.

In order to establish the existing air quality in and around the proposed project area, two topics need to be discussed: 1) the climatology/meteorology of the area, and 2) air quality monitoring in the area. The first subsection describes the region's climate and, where applicable, focuses on air quality considerations. The second subsection examines the region's existing air quality by evaluating air quality monitoring data relative to state and federal air quality standards.

In summary, the existing air quality in the vicinity of the proposed Laurentian Mine is good, with only one exceedence of a State air quality standard in five years, and no exceedences of Federal air quality standards. Annual concentrations of total suspended particulates have increased over the past four years, but they remain well below the acceptable ambient air concentration levels. These good air quality conditions are supported by a climate with substantial precipitation and cold weather, both of which reduce fugitive dust emissions.

Climatology

It is important to establish the climatology/meteorology of an area because the climate determines pollutant transport and dispersal. Also, in the case of fugitive dust, the climate has a direct bearing on the amount of particulates generated. A region's climate is most easily expressed in terms of recorded meteorological parameters, such as temperature, precipitation, wind speed, and wind direction. Other factors that influence a regional climate include topography, land use, and vegetation. For the purposes of this Draft EIS, the description of climatologic conditions is limited to a synopsis of the recorded meteorologic parameters and does not include an analysis of other contributing factors.

The climate of the Virginia-Hibbing Iron Range region was extensively documented in the Copper-Nickel Study of 1979 and by Watson (1978) for that same study. A synopsis of Virginia's climate was prepared for this Draft EIS. These data were used in compiling the following paragraphs and are summarized in a 1951-1980 climatological summary for Virginia, Minnesota (NOAA, 1982). Weather observation data are recorded at the Virginia Weather Station. Wind data are collected at the Hibbing airport.

The climate of the area under study is typically continental, characterized by warm summers and cold winters. In general, continental climates experience a great degree of variability in weather regimes over periods ranging from hours to years. Frontal passages can bring temperature changes of 40°F or more in a matter of hours. During the same month over the years, recorded temperatures at Virginia have spanned 100°F or more (for example, February has experienced a high of 61°F and a low of -43°F). Precipitation from thunderstorms can be intense; more than 4 inches of rain have fallen in a 24-hour period on more than one occasion at Virginia. Wind speed and wind direction can also undergo dramatic shifts during the passage of a weather system.

Temperatures at Virginia ranged from -46°F to 97°F during 1951-1980. The average monthly high and low temperatures in January are 15.9°F and -6.1°F, respectively. During the warmest month, July, the average monthly high and low temperatures are 79.3°F and 53.9°F, respectively. The region typically experiences approximately 150 consecutive days where the daily mean temperature is 32°F or below. On average, there are 115 days between the latest and earliest freezing temperatures (from May 16 to September 18). The surface soil is frozen throughout the winter months. The extent of freezing conditions is important when considering fugitive dust because frozen soil does not easily erode.

Virginia is located far enough east to receive appreciable amounts of precipitation resulting from Gulf Stream moisture. The average amount of precipitation is 27 inches per year with approximately 120 days receiving .01 inches or more. Approximately 75 percent of the precipitation is received between March and September with the greatest mean monthly precipitation (4.19 inches) occurring in June. Average snowfall is 62 inches per year. The mean duration of snow at least 1 inch deep is 140 days (Kuehnast, et al., 1982).

Precipitation is very important for dust suppression. Snowfall is important because it covers what otherwise may be an erodible surface soil. Snowfall also virtually eliminates dust emissions from vehicle traffic; the vehicle traffic packs the snow onto the road surface, thereby creating a surface without erodible particles. Rain adds moisture to the various erodible surfaces (e.g., storage piles and roads). On storage piles, for example, moisture causes temporary adhesion of fines to the surfaces of larger particles. Road dust is suppressed by cohesive moisture films formed among the discrete grains of road surface material (EPA, 1985).

Along with temperature and precipitation data, wind data are important in establishing a region's climate. "Wind roses" are a convenient way of presenting the joint frequency and direction of the wind. Figure 4.18 contains annual and monthly averaged wind roses for Hibbing for the ten years of 1964-1973. Winds greater than 8 miles per hour are included. These wind roses are adapted from the Climate of Minnesota, Part XIV: Wind Climatology and Wind Power (Baker, 1983).

As can be seen from the wind roses, the characteristic feature of the wind in this region is a bimodal distribution. Winds are predominantly from the northwest with a secondary maximum from the south-southeast. Hibbing has about 75 percent of its winds from the directions between 300° and 360° (northwest to north) and from between 120° and 190° (southeast to south). The winter months show the most consistent northwest wind. During April and May, a more pronounced easterly component of the wind is present. By the time summer sets in, southwesterly winds are not uncommon. In autumn, the bimodal distribution of the wind is again apparent.

Average wind speed is greatest in May at 10.8 mph. Winds are calmest in the summer with a minimum monthly average of 7.9 mph in August.

Air Quality

For the purposes of this Draft EIS, the air quality is defined by the amount of particulates in the air. Particulates are defined as either TSP (total suspended particulates) or PM-10 (particulate matter less than 10 microns in diameter). One

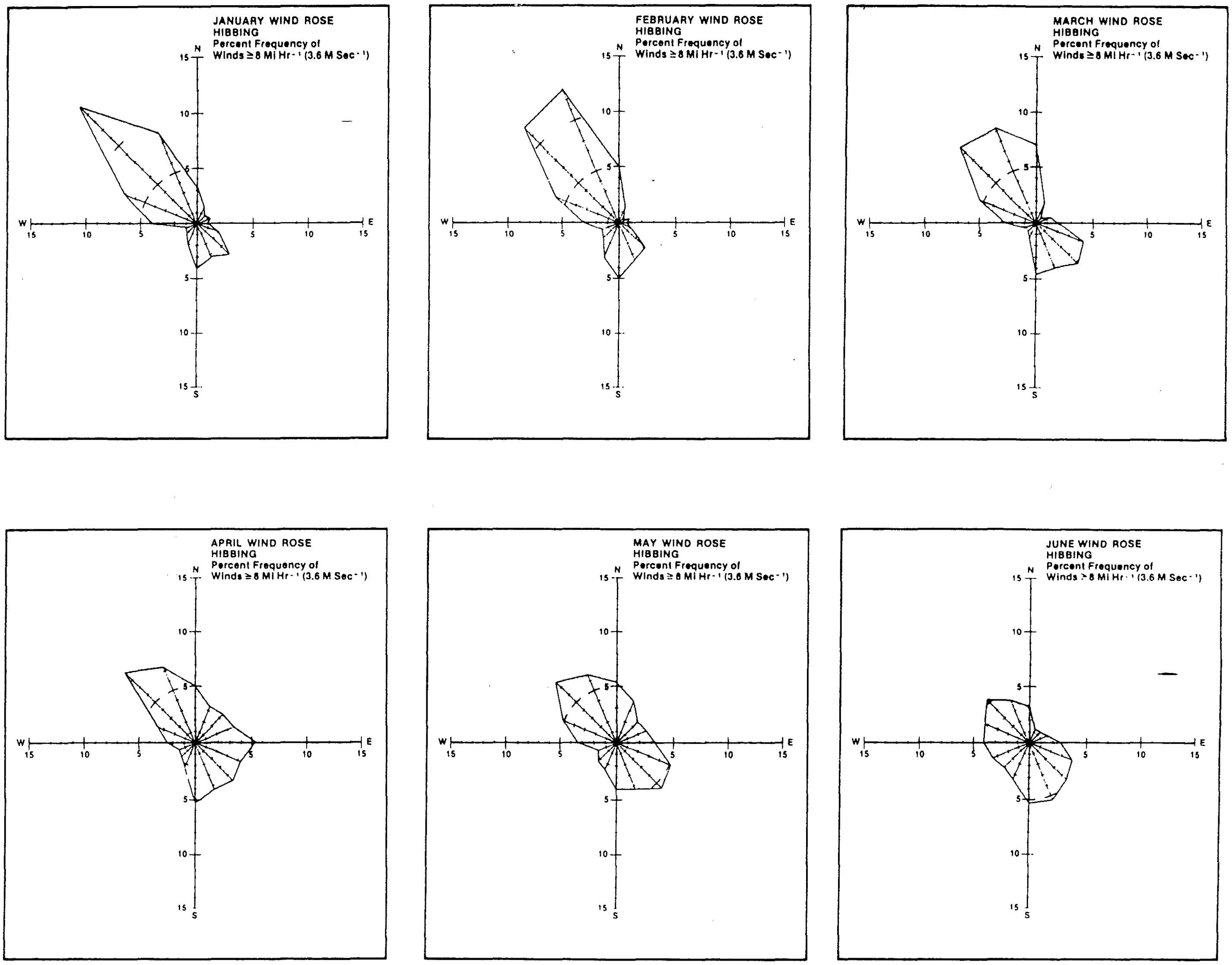


Figure 4.18

MONTHLY AND ANNUAL WIND ROSES AT HIBBING FOR WINDS OF AT LEAST 8 mi/hr

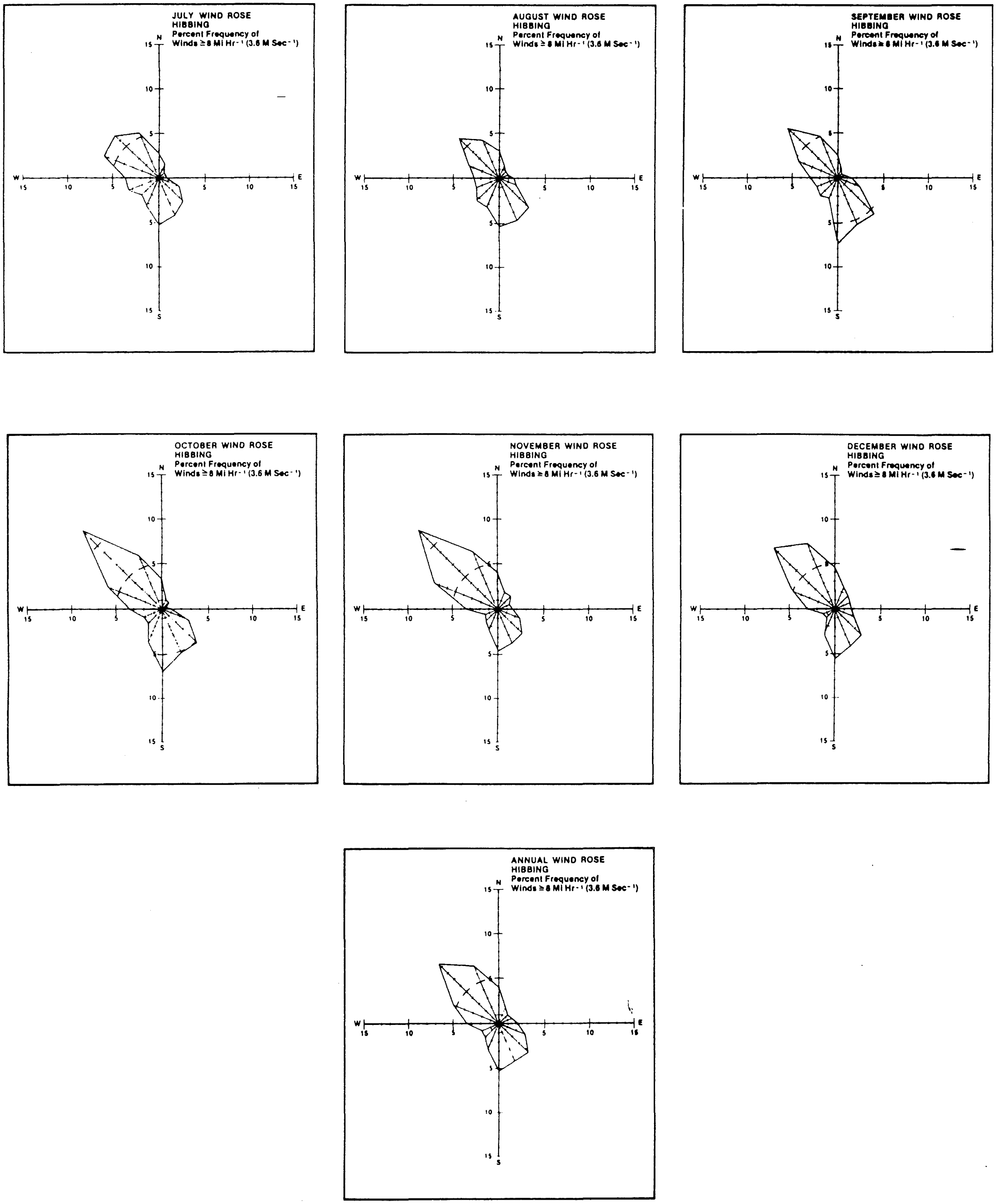


Figure 4.18 (Cont.)

MONTHLY AND ANNUAL WIND ROSES
AT HIBBING FOR WINDS OF AT
LEAST 8 mi/hr

micron is about .000039 of an inch. Because total suspended particulates have an diameter of 30 microns or less, PM-10 is a subset of TSP. PM-10 is also known as inhalable particulate matter, particles that can lodge in the cilia of the lungs and not be exhaled. Evaluation of other air pollutants normally covered by air quality permits (such as SO_2 and CO) is outside of the scope of this Draft EIS, as determined by the Scoping EAW.

The criteria used to evaluate the existing air quality are the state and federal ambient air quality standards. There are primary and secondary ambient air quality standards, based on annual and 24-hour averages, for both PM-10 and TSP. Primary standards define levels of air quality that protect people's health. Secondary standards define levels of air quality that protect property (including crops and livestock) from damage or deterioration, and prevent annoyances, nuisances, and transportation hazards (Minnesota Standards Section 7005.0010, Ambient Air Quality Standards). Current federal air quality standards are concerned with PM-10 (Code of Federal Regulations, Title 40, Part 50). Minnesota's air quality standards for mineland reclamation govern TSP (Minnesota Rules 7005, 1989). The state and federal guidelines allow for one exceedence per year of the 24-hour particulate standard. Table 4.22 lists the allowable ambient air concentrations for TSP and PM-10.

The Minnesota Pollution Control Agency maintains an ambient air quality monitoring station on the roof of Virginia's City Hall (MPCA Site 1300). While the station was established to evaluate regional air quality, the proximity of the station to the proposed mine site provides for an adequate assessment of the site's air quality.

Table 4.23 contains the TSP and PM-10 concentrations reported from the Virginia monitoring station for the years 1985-1989 (MPCA, 1989). Over the past five years, there has only been one exceedence of the State secondary standard for 24-hour TSP concentrations. During this same period, there have been no exceedences of the federal PM-10 standard. The annual TSP concentrations have increased over the past four years; however, they remain well below the acceptable ambient air concentration levels.

TABLE 4.22

AMBIENT AIR QUALITY STANDARDS FOR PARTICULATE MATTER
(microns per cubic meter)

Pollutant	Averaging Period	Primary Standard	Secondary Standard	Regulation and Reference
PM-10	24-Hr.	150	150	Federal Standard
	Annual	50	50	40 CFR 50.6
TSP	24-Hr.	260	150	State Standard
	Annual	75	60	Minnesota Rules 7005.0080

PM-10 = particulate matter less than 10 microns in diameter
TSP = total suspended particulates
CFR = Code of Federal Regulations

TABLE 4.23

TSP AND PM-10 AMBIENT AIR CONCENTRATIONS
VIRGINIA, MN 1985-1989
(microns per cubic meter)

Pollutant	Year	Annual	24-Hr. Maximum	24-Hr. Second High
TSP	1985	31.8	132	98
	1986	23.7	88	70
	1987	31.0	112	102
	1988	38.4	163 SS	74
	1989	39.0	107	95
PM-10	1985	17.9	28	27
	1986	18.2	41	34
	1987	16.6	57	46
	1988	18.9	51	38
	1989	17.5	47	33

PM-10 = particulate matter less than 10 microns in diameter
TSP = total suspended particulates
SS = violation of the State secondary standard

Vegetation and Wetlands

Vegetation and wetland types identified in the project area are those typically found in northeastern Minnesota. The forested areas consist of tree species such as aspen, paper birch, jack pine, and balsam fir. White cedar is also present in some upland areas. All of the tree species are commonly associated with disturbed conditions or areas that have been logged in the past. The most common wetland present was alder swamp. A small (4-acre) bog containing sphagnum moss and leatherleaf is also present.

There are no known occurrences of threatened or endangered plant species.

Habitat Types

Color aerial photographs (scale 1:24,000; October 1988) were used to delineate the various vegetative patterns and habitat types within the proposed mine, stockpile area, and haul road. These areas were field-checked to verify the pattern, color, and texture of the vegetation represented on the aerial photos. A habitat type map (Figure 4.19) was prepared by comparing the photographs to actual vegetation observed in the field.

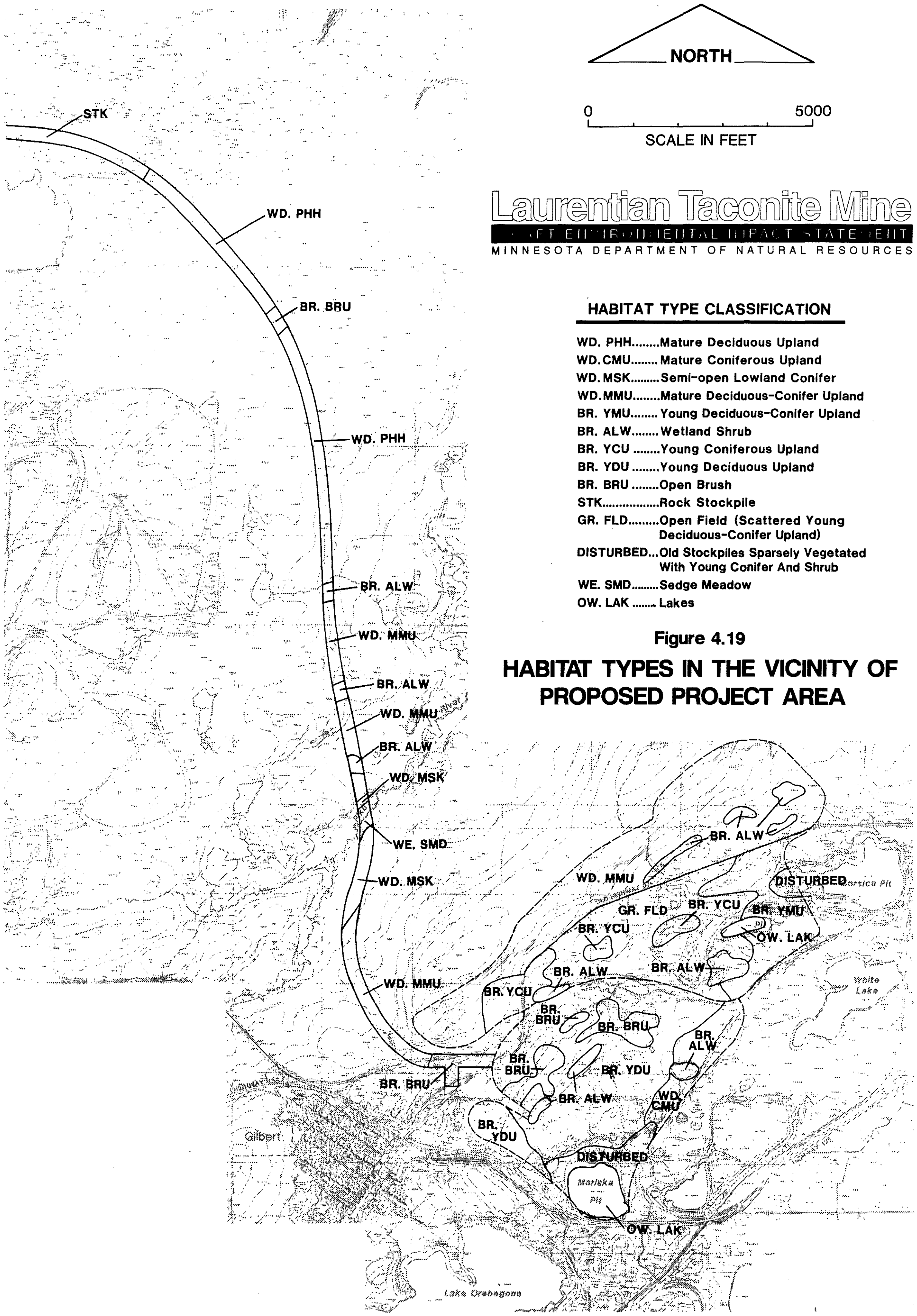
Table 4.24 lists the approximate acreage and percentage of each habitat type within the proposed mine, stockpile area, and haul road. The acreages of each habitat type were proportionally adjusted to compensate for differences between the project area outlined on the aerial photos and the actual project area measured from 1" = 400' scale mine plans. The scale differences between the photos and plans and slight scale variations of the photos resulted in slightly different project area totals. The area measured from the 400' scale mine plans was used as the project area acreage.

The classification system used to identify habitat types is based on plant communities rather than particular species. The MDNR developed this ecological community classification system to inventory plant communities within state parks (Svoboda, 1977).

Laurentian Taconite Mine

DRAFT ENVIRONMENTAL IMPACT STATEMENT

MINNESOTA DEPARTMENT OF NATURAL RESOURCES



HABITAT TYPE CLASSIFICATION

WD. PHH........Mature Deciduous Upland
WD. CMU........Mature Coniferous Upland
WD. MSK.........Semi-open Lowland Conifer
WD. MMU........Mature Deciduous-Conifer Upland
BR. YMU........Young Deciduous-Conifer Upland
BR. ALW........Wetland Shrub
BR. YCU........Young Coniferous Upland
BR. YDU........Young Deciduous Upland
BR. BRU........Open Brush
STK.................Rock Stockpile
GR. FLD.........Open Field (Scattered Young Deciduous-Conifer Upland)
DISTURBED...Old Stockpiles Sparsely Vegetated With Young Conifer And Shrub
WE. SMD........Sedge Meadow
OW. LAK.......Lakes

Figure 4.19

HABITAT TYPES IN THE VICINITY OF PROPOSED PROJECT AREA

TABLE 4.24

EXISTING HABITAT TYPES IN PROJECT AREA

	Habitat Type Abbreviations	Habitat Type Description	Area (Acres)	Percent of Total Area
Mine Pit	BR.YDU	Young Deciduous Upland	265	60
	BR.ALW	Wetland Shrub	15	3
	BR.BRU	Open Brush	35	8
	WD.CMU	Mature Conifer Upland	60	14
	OW.LAK	Lake	25	6
	Disturbed	Old Stockpiles	40	9
		SUBTOTAL	440	
Stockpiles	WD.MMU	Mature Deciduous - Conifer Upland	285	47
	BR.YMU	Young Deciduous-Conifer Upland	80	13
	BR.ALW	Wetland Shrub	30	5
	BR.YCU	Young Coniferous Upland	45	7
	GR.FLD	Open Field (scattered BR.YMU)	150	25
	OW.LAK	Lake	5	1
	Disturbed	Old Stockpiles	10	2
		SUBTOTAL	600	
Haul Road	BR.BRU	Open Brush	10	5
	BR.ALW	Wetland Shrub	5	3
	WD.MMU	Mature Deciduous-Conifer Upland	55	30
	WD.MSK	Semi-Open Lowland Conifer	10	5
	WD.PHH	Mature Deciduous Upland	70	38
	STK	Rock Stockpile	30	16
	WE.SMO	Wet Meadow	5	3
		SUBTOTAL	185	
		TOTAL	1,225	

In the proposed mine (440 acres), 60 percent of the area is open grassland with young deciduous upland species consisting mostly of young aspen mixed with small areas of paper birch. Lowland vegetation consists of tag alder. A small area near the Mariska Pit (labeled "disturbed" on the Figure 4.19) was covered by past mine stockpiling. Vegetation in this section consists of young aspen, jack pine, and paper birch. Northeast of the disturbed area lies a section of mature coniferous upland species that includes a closed canopy stand of balsam fir, white cedar, and white pine.

In the proposed stockpile area (600 acres), habitat types in the northern half are primarily mature deciduous-conifer uplands with small areas of wetland shrubs. The northeast portion of this northern half has predominantly balsam fir mixed with young aspen in the uplands and black spruce, tag alder, and white cedar in the lowlands. In the southwest portion of the northern half, the dominant vegetation is aspen-birch mixed with balsam fir which gradually changes to dense balsam fir mixed with aspen-birch along the southwest perimeter. The remaining half of the proposed stockpile area consist of open field with scattered patches of aspen, paper birch, and balsam fir in the uplands and tag alder in the lowlands. A small portion of the proposed stockpile area near the Corsica Pit was disturbed by past mine stockpiling. The disturbed area is sparsely vegetated with young growths of jack pine, balsam fir, and paper birch in the uplands, and tag alder in the ditches along the abandoned roadways.

Near the southern end, the proposed haul road would pass through a small area of open brush consisting of tag alder. Further north along the proposed road, the vegetation changes to mature deciduous-conifer uplands consisting of balsam fir mixed with paper birch and aspen. As the proposed road nears the Pike River, the vegetative community changes to black spruce and sedges in the lowlands. Black spruce and a few jack pine are found in the area immediately north of the Pike River. The next 3,000 feet of the proposed road leading to the intermittent stream is primarily mature deciduous-conifer uplands with aspen, paper birch, and balsam fir. North of the intermittent stream to the rock stockpile is an area that consists of mature deciduous upland comprised of an equal mix of aspen and paper birch with a few balsam fir interspersed. The remaining section of the proposed road passes through a rock stockpile on its route to the taconite plant.

Wetland Types

Wetlands in the proposed project area were identified, classified, and delineated through the use of National Wetland Inventory (NWI) maps that were field-verified in March 1990. The NWI maps were produced by the U.S. Fish and Wildlife Service using aerial photographs from 1977 and published on a topographical base at a scale of 1:24,000. During field verification, wetlands within the primary impact zone of the Laurentian Mine and haul road were examined for the dominant vegetation and water regime.

Figure 4.20 shows wetlands within the proposed mine, stockpile area, and haul road as well as wetlands within 1,000 feet of those areas. Figure 4.20 does not include open water areas more than 6 feet deep because they are primarily borrow pits and abandoned mine pits that generally do not support emergent vegetation. Table 4.25 lists wetland types that are within the boundaries of the proposed mine, stockpile area, and haul road.

Wetlands were classified according to the system described in Cowardin, et al. (1979). This system classifies wetlands according to ecological communities and may include descriptive modifiers such as water regime, water chemistry, and soils.

All wetlands in the project area are classified in the palustrine system, which includes all non-tidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and open water areas less than 20 acres in size and less than 2 meters deep (Cowardin, et al., 1979). These wetlands are commonly referred to as marshes, swamps, bogs and fens. The palustrine system also includes small, shallow, permanent or intermittent water bodies, commonly referred to as ponds.

The proposed project area contains a total of 71 acres of wetland, 60 percent of which consists of alder swamps (see Figure 4.20).

The proposed mine pit contains 20 acres of wetland (Figure 4.20). There the predominant wetland types are alder swamp and a mixture of alder swamp and sedge meadow. The dominant vegetation types in these wetlands are tag alder, bluejoint grass, and sedges. On the western side of the mine area is a 4-acre bog dominated by sphagnum moss and leatherleaf.

Laurentian Taconite Mine

DRAFT ENVIRONMENTAL IMPACT STATEMENT

MINNESOTA DEPARTMENT OF NATURAL RESOURCES

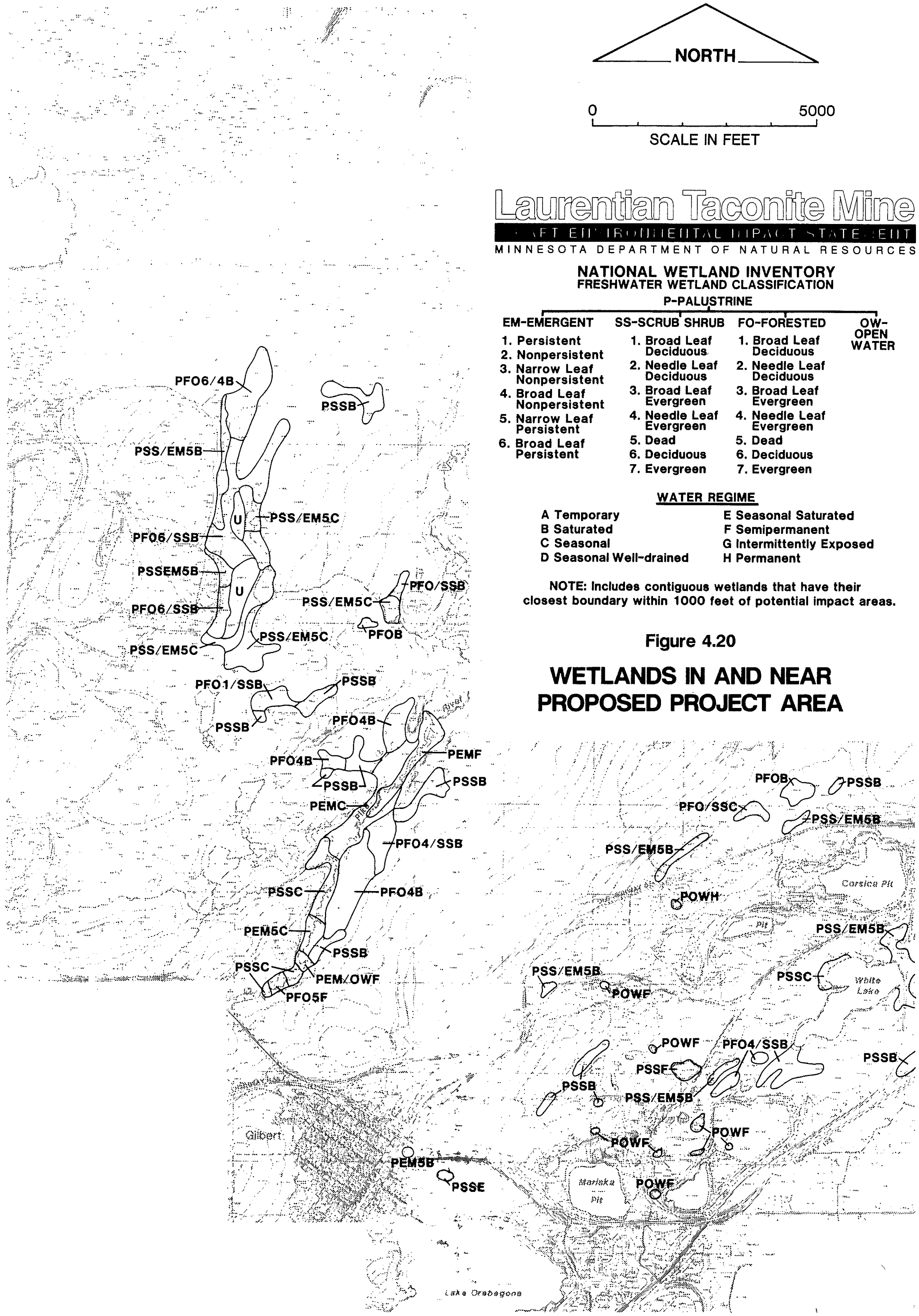


Figure 4.20

WETLANDS IN AND NEAR PROPOSED PROJECT AREA

TABLE 4.25
EXISTING WETLANDS IN PROJECT AREA

Project Area	Wetland Classification[1]	Dominant Vegetation	Water Regime[1]	Area (acres)
Mine	Alder swamp (PSS1)	Alder	Saturated (B)	9
	Bog (PSS3)	Leatherleaf, sphagnum moss	Semi-permanently flooded (F)	4
	Alder swamp/sedge meadow (PSS1/EM5)	Alder, bluejoint grass, sedge	Saturated (B)	4
	Open water pond (POW)	--	Semi-permanently flooded (F)	3
Stockpile Area	Alder swamp (PSS1)	Alder	Saturated (B)	10
	Alder swamp/sedge meadow (PSS1/EM5)	Alder, bluejoint grass, sedge	Saturated (B)	11
	Coniferous swamp/alder swamp (PFO7/SS1)	White cedar, alder	Seasonally flooded (C)	4
	Coniferous swamp (PFO7)	White cedar	Saturated (B)	5
	Open water pond (POW)	--	Permanently flooded (H)	1
Haul Road	Sedge meadow (PEM5)	Sedge, bluejoint grass, cattail	Semi-permanently flooded (F)	3
	Alder swamp (PSS1)	Alder	Seasonally flooded (C)	6
	Coniferous swamp (PFO4)	Black spruce, sedge	Saturated (B)	11
			TOTAL WETLAND AREA	71

[1]Letters in parentheses represent U.S. Fish and Wildlife Service classification system.

The proposed stockpile area contains 31 acres of wetland, predominantly alder swamp and a mixture of alder swamp and sedge meadow (Figure 4.20). Two coniferous swamps dominated by white cedar and tag alder are present north of old Highway 135.

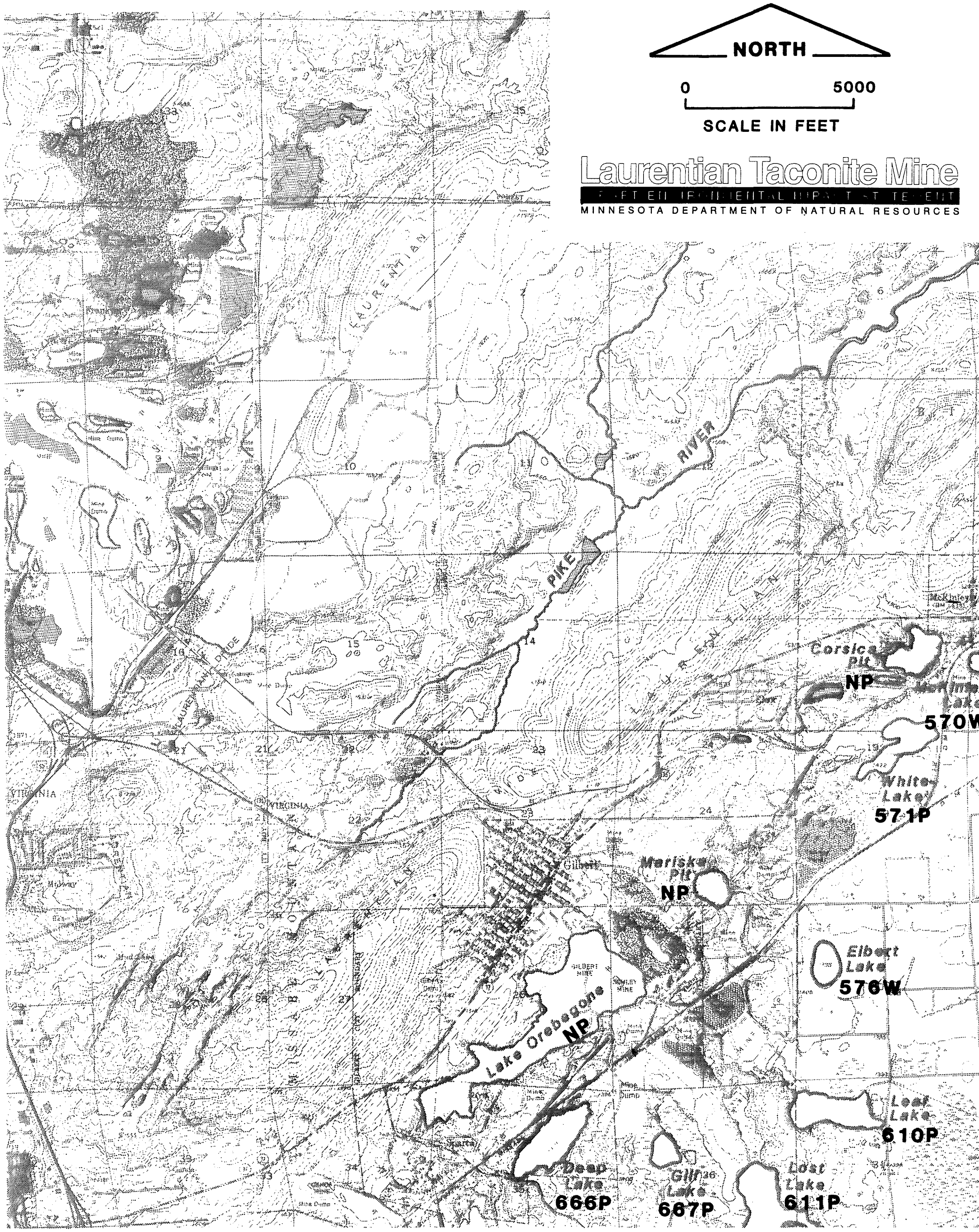
The 300-foot wide zone of the proposed haul road includes 20 acres of wetland (Figure 4.20). The proposed road would cross a major wetland complex associated with the Pike River headwaters. At the proposed crossing, the wetland types are coniferous swamp and sedge meadow. Dominant vegetation in the coniferous swamp is black spruce and sedges. Much of the black spruce in the vicinity of the proposed road has been logged. Sedge meadow lies on both sides of the Pike River and the dominant vegetation is sedge and cattail. The proposed road alignment also includes scattered areas of alder swamp.

According to the MDNR Protected Waters and Wetlands Inventory, two state-protected wetlands are within the vicinity of the proposed project. These wetlands include McKinley Lake, located approximately 0.5 miles east of the proposed stockpile area, and Elbert Lake, located 0.5 miles south of the proposed mine pit (Figure 4.21). State-protected waters within the area include the Pike River, White Lake, Leaf Lake, Lost (Horseshoe) Lake, Gill Lake, and Deep Lake. Wetlands that are adjacent to these lakes and river and within the ordinary high water mark would be classified as state-protected.

Threatened and Endangered Plant Species

State endangered, threatened, and special-concern plant species recorded in St. Louis County are listed in Table 4.26. There are no federally threatened plant species reported for St. Louis County.

The Minnesota Natural Heritage Program data base contains no reported occurrences of threatened or endangered plant species in the vicinity of the proposed project. However, a biological survey of the area has not been conducted. According to the MDNR, suitable habitat is available in the area to support two plant species of special concern: barren strawberry (*Waldsteinia fragariodes*) and *Poa sylvestris*.



610P Protected Waters Number

576W Protected Wetlands Number

NP Not Protected

Figure 4.21

STATE PROTECTED WATERS AND WETLANDS

TABLE 4.26

STATE ENDANGERED, THREATENED, AND SPECIAL CONCERN PLANT SPECIES IN ST. LOUIS COUNTY

	Status
Adoxa moschatellina; Moschatel	S
Allium schoenoprasum var. *sibiricum*; Wild Chives	S
Ammophila breviligulata; Beach Grass	T
Arethusa bulbosa; Dragon's-mouth	S
Calamagrostis lacustris; Marsh Reedgrass	E(P)
Caltha natans; Floating Marsh Marigold	E(P)
Carex exilis; a species of Sedge	S
Carex garberi; Garber's Sedge	E(P)
Carex katahdinensis; Mount Katahdin Sedge	E(P)
Carex pallescens; Pale Sedge	E(P)
Cetraria aurescens; a species of Lichen	S
Cladonia pseudorangiformis; a species of Lichen	S
Claytonia caroliniana; Carolina Spring-beauty	S
Deschampsia flexuosa; Slender Hairgrass	S
Eleocharis nitida; Neat Spike-rush	E(P)
Eleocharis pauciflora var. *fernaldii*; Few-flowered Spike-rush	S
Euphrasia hudsoniana; Hudson Bay Eyebright	S
Juncus stygius var. *americanus*; Bog Rush	S
Listera auriculata; Auricled Twayblade	E(P)
Littorella americana; American Shore-plantain	E
Lobaria quericizans; a species of Lichen	T
Muhlenbergia uniflora; One-flowered Muhly	T(P)
Phacelia franklinii; Wild Heliotrope	T(P)
Platanthera clavellata; Club-spur Orchid	S
Poa sylvestris	S
Polygonum viviparum; Alpine Bistort	S
Potamogeton vaseyi; Vasey's Pondweed	S
Pseudocyphellaria crocata; a species of Lichen	E
Pyrola minor; Small Shinleaf	S(P)
Ranunculus lapponicus; Lapland Buttercup	S
Rhynchospora fusca; Sooty-colored Beak-rush	S
Salix pellita; Satiny Willow	S(P)
Sparganium glomeratum; Clustered Bur Reed	E
Sticta fuliginosa; a species of Lichen	S
Subularia aquatica; Awlwort	E
Tillaea aquatica; Pigmyweed	E
Tomenthypnum falcifolium; a species of Moss	S
Triglochin palustris; Marsh Arrow-grass	S
Tsuga canadensis; Eastern Hemlock	S
Utricularia gibba; Humped Bladderwort	S
Viola novae-angliae; New England Violet	S
Waldsteinia fragariodes; Barren Strawberry	S
Xyris montana; Yellow-eyed Grass	S

E Endangered
T Threatened
S Special Concern
(P) Proposed for listing
Source: Coffin and Pfannmuller, 1988.

Fish and Wildlife

Two natural lakes, three water-filled mine pits, and one shallow stream are present in the vicinity of the proposed project. However, fisheries survey data were not available for two of the mine pits (Corsica and Mariska). Common fish species in the two lakes include white sucker, two species of bullheads, northern pike, and panfish. The Lake Orebegone pit has been stocked with trout and has naturally occurring populations of white sucker and bluegill along with a few other species. The Pike River, because of its shallowness at the proposed haul road, is populated mostly by minnows, chubs, and dace.

Wildlife species present are those commonly occurring in second-growth forests in northeastern Minnesota. The most familiar species include ruffed grouse, white-tailed deer, and snowshoe hare. A habitat database called SPECLIST was used to estimate total species present. The proposed project area could be inhabited by up to 131 species of birds, 43 species of mammals, nine species of amphibians, and two species of reptiles.

Two federally protected threatened and endangered species were observed within 2 to 4 miles of the proposed project area: the eastern timber wolf and the peregrine falcon. The peregrine falcon is being re-established in the area by the Minnesota Department of Natural Resources.

Fish

In the vicinity of the proposed Laurentian Mine are two naturally-occurring lakes (White Lake and Leaf Lake), three water-filled mine pits (Corsica Pit, Mariska Pit, and Lake Orebegone), and the Pike River (Figure 4.22). Fisheries data are available for only White Lake, Leaf Lake, Lake Orebegone, and the Pike River Flowage (approximately 35 miles downstream of the proposed project area). Additional fisheries data could not be collected during the EIS investigation because of ice cover. Based on an evaluation of the existing fisheries data, it was concluded that these data are adequate to assess potential project-related fisheries impacts.

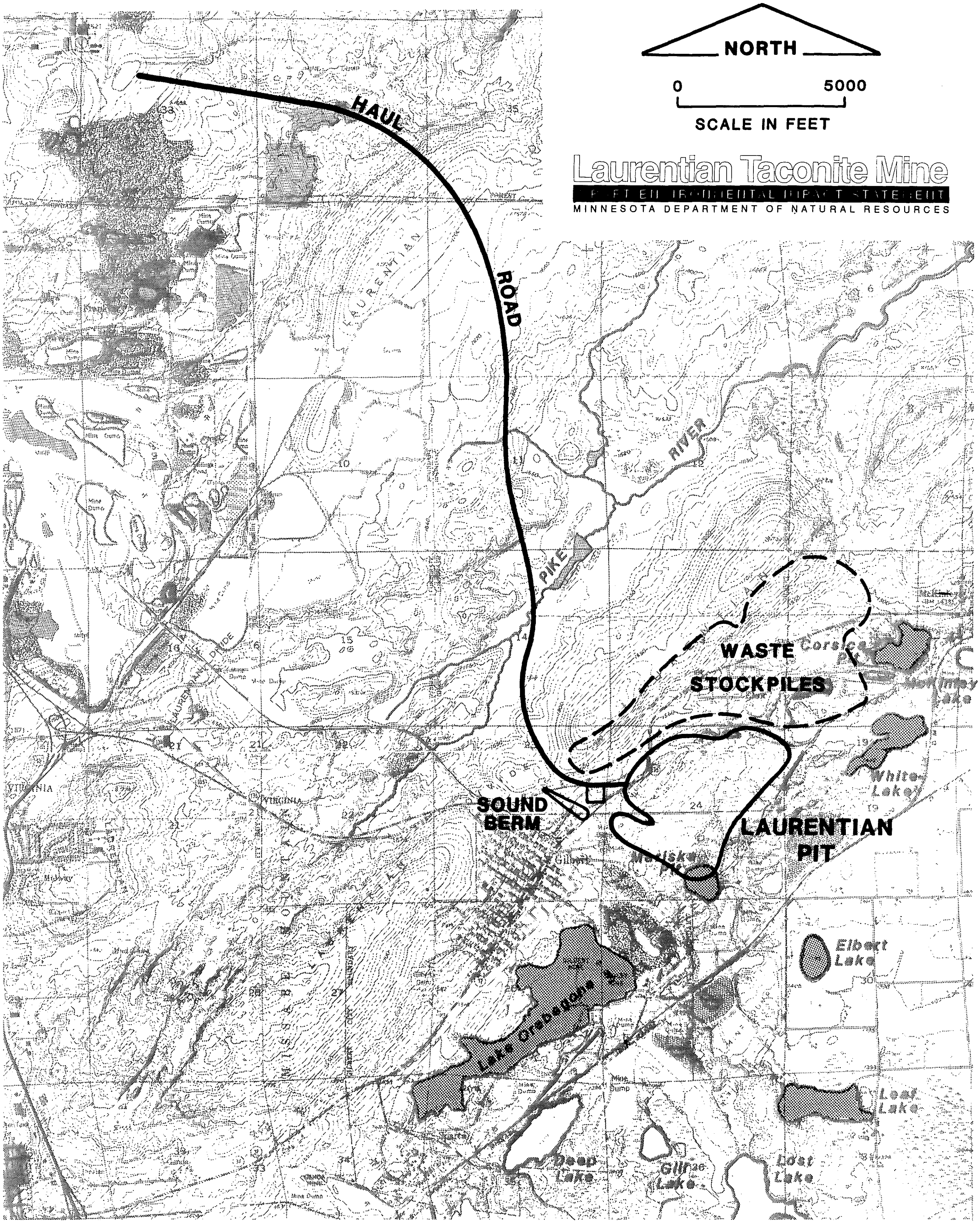


Figure 4.22

LAKES AND RIVERS THAT MAY BE AFFECTED BY PROPOSED PROJECT

The Minnesota Department of Natural Resources (MDNR) conducted fisheries surveys on White Lake and Leaf Lake in 1987 and 1981, respectively. Results of those fisheries surveys are summarized in Table 4.27. White Lake is a soft water lake (total alkalinity = 12.5 ppm) and stratifies in summer with anoxic (no oxygen) conditions below 10 feet (MDNR, 1987). Leaf Lake is a hard water lake (total alkalinity = 131 ppm) and stratifies in the summer with oxygen-poor conditions below 13 feet (MDNR, 1981). Barr Engineering measured profiles in both of these lakes in March 1990 under ice cover conditions. These lakes contained adequate oxygen levels (i.e., >2 ppm) in the upper 10 feet for the survival of most fish species in those lakes.

The MDNR conducted fisheries surveys on Lake Orebegone in 1983, 1986, and 1988. Results of the most recent survey are shown in Table 4.27. Lake Orebegone was stocked in 1984 through 1988 with lake, rainbow, brook, and splake trout by the MDNR in an attempt to establish a trout fisheries (MDNR, 1989).

All three abandoned mine pits are over 150 feet deep. The oxygen profile sampling completed in March 1990 indicated adequate oxygen levels for fish species at all depths.

Although no fisheries data are available for the Pike River, the MDNR conducted a 1986 fish survey of the Pike River Flowage. The survey identified the fish species listed in Table 4.27. Fish from the Pike River Flowage may migrate upstream to the proposed haul road crossing during periods of high water. Other fish species expected in the river are shown in Table 4.28. These species were found in the Dunka River and Langley Creek near Babbitt during an MDNR fish survey in 1975 (Barr, 1976). The Dunka River and Langley Creek flow through an area similar to the proposed Laurentian Mine area.

The proposed haul road crossing is near the headwaters of the Pike River (Figure 4.23). A field reconnaissance of the river at the proposed crossing was done in March 1990. Due to spring snowmelt, river conditions were not representative of normal or base flow conditions. Approximately 2 feet of surface runoff was flowing over the frozen river. Therefore, the field reconnaissance was limited to a cursory examination of fish habitat.

TABLE 4.27

FISH SPECIES ABUNDANCE IN AREA LAKES

	Leaf Lake[1]	White Lake[2]	Lake Orebegone[3]	Pike River Flowage[4]
White sucker	+	-	+	+
Black bullhead	+	-	--	--
Yellow bullhead	--	+	--	--
Northern pike	+	o	-	o
Yellow perch	-	-	-	+
Walleye	-	--	-	o
Pumpkinseed	o	o	--	-
Bluegill	o	o	o	-
Black crappie	o	-	--	--
Rock bass	--	--	--	+
Largemouth bass	--	-	--	--
Rainbow Trout	--	--	-	--
Brook Trout	--	--	-	--
Lake Trout	--	--	-	--

+ Species present in above-average numbers compared to state-wide population
o Species present in average numbers compared to state-wide population
- Species present in below-average numbers compared to state-wide population
-- Species not present

1 Based on MDNR fisheries survey conducted in 1982
2 Based on MDNR fisheries survey conducted in 1987
3 Based on MDNR fisheries survey conducted in 1989
4 Based on MDNR fisheries survey conducted in 1986

TABLE 4.28

FISH SPECIES COMPOSITION[1] IN TYPICAL REGIONAL STREAM[2]

Common Shiner
Blacknose Dace
White Sucker
Central Mudminnow
Northern Redbelly Dace
Brook Stickleback
Creek Chub
Pearl Dace
Johnny Darter
Fathead Minnow
Iowa Darter
Blacknose Shiner

[1]Fish species listed in order of relative abundance with the first species representing the most abundant.

[2]Composition based on a fisheries survey of Dunka River and Langley Creek near Babbitt conducted by the MDNR in 1975 (Barr Engineering Co., 1976).

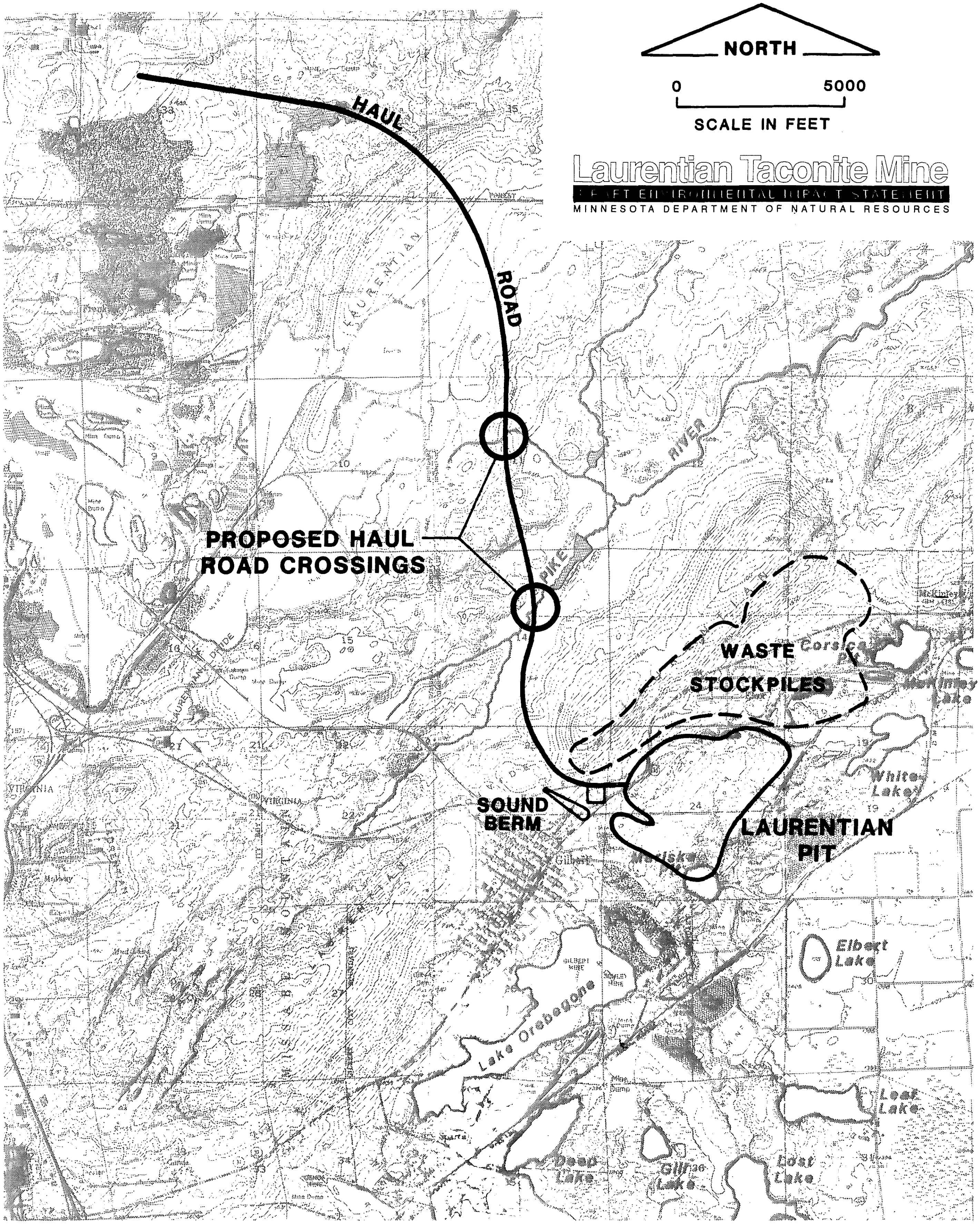


Figure 4.23

LOCATIONS OF PROPOSED HAUL ROAD CROSSINGS

At the proposed crossing, the river meanders through a sedge meadow and appears to be very shallow (i.e., 1 to 2 feet) during base flow conditions. Only 3 to 5 inches of water was found flowing under the 1-foot ice layer during the field reconnaissance. The maximum width of the river under normal conditions would be approximately 15 to 20 feet. The river bottom consists of a soft muck. Beaver dams have been reported downstream of the area.

The proposed haul road also crosses an intermittent stream that flows into the Pike River (Figure 4.23). The stream has a very steep gradient and appears to dry out during certain periods of the year. It is unlikely that the stream supports a fishery in the reach that the haul road would cross.

Wildlife

Wildlife species inhabiting the proposed project area were inferred based on their association with identified habitat types. Habitat types were identified using aerial photographs, as discussed in the section on vegetation and wetlands. A data base program called SPECLIST (see Appendix C) was used to provide information on wildlife species potentially present in the dominant habitat types. A field reconnaissance was done in March 1990 to verify habitat types and to observe any wildlife using the area.

Selected wildlife species were further evaluated through consultation with the MDNR's area wildlife manager, research biologist, and non-game specialist. These species include eastern timber wolf, bald eagle, osprey, peregrine falcon, sharp-tailed grouse, and Canada goose. Information on sightings and habitat preference was provided by MDNR biologists. This information was used to assess the use of the proposed project area by the wildlife species listed above.

Wildlife species that could be present in the proposed project area are listed in Tables 4.29 through 4.31. Approximately 131 species of birds, 43 species of mammals, nine species of amphibians, and two species of reptiles may occur in the habitat types within the proposed project area. The majority of these species have a territorial range that would most likely encompass the entire site or parts of it.

Table 4.32 summarizes the sightings of eastern timber wolves, peregrine falcons, sharp-tailed grouse, and Canada geese in the vicinity of the project area. The majority of the sightings were more than 2 miles from the site. Sharp-tailed grouse have been observed in the western portion of the proposed mine pit. This area does not contain a dancing ground for the sharp-tailed grouse (Lightfoot, 1990). The MDNR did not have any recorded sightings or nest observations of eagles or osprey in the vicinity of the project area (Lightfoot, 1990).

Threatened and Endangered Fish and Wildlife Species

Table 4.33 lists state endangered, threatened, and special concern fish and wildlife species recorded in St. Louis County. In addition, the eastern timber wolf, bald eagle, and piping plover are federally threatened species and the peregrine falcon is a federally endangered species, all of which are known to occur in St. Louis County.

As shown in Table 4.32, the eastern timber wolf and peregrine falcon have been sighted within 2 to 4 miles of the project area. A total of 28 young peregrine falcons were released over a three-year period (1987-1989) by the MDNR in the Rouchleau mine pit near Virginia (Hines, 1990). The MDNR is attempting to establish nesting pairs of peregrine falcons in the cliffs of the old mine pits. During the field reconnaissance completed in March 1990, a peregrine falcon was observed soaring over the proposed pit and a timber wolf was observed on a logging road on the northern boundary of the proposed stockpile area. At that time, tracks of two other wolves were observed in the same area. Bald eagle and osprey nests have not been recorded in the project area.

TABLE 4.29

POTENTIAL AVIAN SPECIES IN PROJECT AREA

Common Name	Scientific Name
Double-crested Cormorant	*Phalacrocorax auritus*
Great Blue Heron	*Ardea herodias*
Least Bittern	*Ixobrychus exilis*
American Bittern	*Botaurus lentiginosus*
Mallard	*Anas platyrhynchos*
Blue-winged Teal	*Anas discors*
Common Goldeneye	*Bucephala clangula*
American Widgeon	*Mareca americana*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Red-breasted Merganser	*Mergus serrator*
Turkey Vulture	*Cathartes aura*
Osprey	*Pandion haliaetus*
Bald Eagle	*Haliaeetus leucocephalus*
Marsh Hawk	*Circus cyaneus*
Goshawk	*Accipiter gentilis*
Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipiter cooperii*
Broad-winged Hawk	*Buteo platypterus*
Red-tailed Hawk	*Buteo jamaicensis*
Merlin	*Falco columbarius*
Peregrine Falcon	*Falco peregrinus*
Spruce Grouse	*Canachites canadensis*
Sharp-tailed Grouse	*Pedioecetes phasianellus*
Ruffed Grouse	*Bonasa umbellus*
Spotted Sandpiper	*Actitis macularia*
American Woodcock	*Philohela minor*
Common Snipe	*Capella gallinago*
Herring Gull	*Larus argentatus*

TABLE 4.29 (cont.)
POTENTIAL AVIAN SPECIES IN PROJECT AREA

Common Name	Scientific Name
Common Tern	*Sterna hirundo*
Rock Dove	*Columba livia*
Mourning Dove	*Zenaida macroura*
Yellow-billed Cuckoo	*Coccyzus americanus*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Great Horned Owl	*Bubo virginianus*
Barred Owl	*Strix varia*
Long-eared Owl	*Asio otus*
Short-eared Owl	*Asio flammeus*
Saw-whet Owl	*Aegolius acadicus*
Snowy Owl	*Nyctea scandiaca*
Great Gray Owl	*Strix nebulosa*
Common Nighthawk	*Chordeiles minor*
Ruby-throated Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Megaceryle alcyon*
Common Flicker	*Colaptes auratus*
Pileated Woodpecker	*Dryocopus pileatus*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Yellow-bellied Sapsucker	*Melanerpes erythrocephalus*
Hairy Woodpecker	*Dendrocopus villosus*
Northern Three-toed Woodpecker	*Picoides tridactylus*
Great Crested Flycatcher	*Myiarchus crinitus*
Eastern Phoebe	*Sayornis phoebe*
Downy Woodpecker	*Dendrocopus pubescens*
Black-backed Three-toed Woodpecker	*Picoides articus*
Eastern Kingbird	*Tyrannus tyrannus*
Yellow-bellied Flycatcher	*Empidonax flaviventris*
Alder Flycatcher	*Empidonax alnorum*
Least Flycatcher	*Empidonax minimus*

TABLE 4.29 (cont.)
POTENTIAL AVIAN SPECIES IN PROJECT AREA

Common Name	Scientific Name
Eastern Wood Peewee	*Contopus virens*
Olive-sided Flycatcher	*Nuttallornis borealis*
Tree Swallow	*Iridoprocne bicolor*
Cliff Swallow	*Petrochelidon pyrrhonota*
Gray Jay	*Perisoreus canadensis*
Blue Jay	*Cyanocitta cristata*
Common Raven	*Corvus corax*
Common Crow	*Corvus brachyrhynchos*
Black-capped Chickadee	*Parus atricapillus*
Boreal Chickadee	*Parus hudsonicus*
Red-breasted Nuthatch	*Sitta canadensis*
Brown Creeper	*Certhia familiaris*
House Wren	*Troglodytes aedon*
Winter Wren	*Troglodytes troglodytes*
Gray Catbird	*Dumetella carolinensis*
Brown Thrasher	*Toxostoma rufum*
Wood Thrush	*Hylocichla mustelina*
Hermit Thrush	*Catharus guttatus*
Swainson's Thrush	*Catharus ustulatus*
Veery	*Catharus fuscescens*
Golden-crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*
Bohemian Waxwing	*Bombycilla garrulus*
Starling	*Sturnus vulgaris*
Solitary Vireo	*Vireo solitarius*
Red-eyed Vireo	*Vireo olivaceus*
Philadelphia Vireo	*Vireo philadelphicus*
Black-and-white Warbler	*Mniotilta varia*
Golden-winged Warbler	*Vermivora chrysoptera*

TABLE 4.29 (cont.)
POTENTIAL AVIAN SPECIES IN PROJECT AREA

Common Name	Scientific Name
Tennessee Warbler	*Vermivora peregrina*
Nashville Warbler	*Vermivora ruficapilla*
Yellow Warbler	*Dendroica petechia*
Magnolia Warbler	*Dendroica magnolia*
Black-throated Blue Warbler	*Dendroica caerulescens*
Yellow-rumped Warbler	*Dendroica coronata*
Black-throated Green Warbler	*Dendroica virens*
Blackburnian Warbler	*Dendroica fusca*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Bay-breasted Warbler	*Dendroica castanea*
Palm Warbler	*Dendroica palmarum*
Ovenbird	*Seiurus aurocapillus*
Northern Waterthrush	*Seiurus noveboracensis*
Connecticut Warbler	*Oporornis agilis*
Mourning Warbler	*Oporornis philadelphia*
Common Yellowthroat	*Geothlypis trichas*
Canada Warbler	*Wilsonia canadensis*
American Redstart	*Setophaga ruticilla*
Bobolink	*Dolichonyx oryzivorus*
Eastern Meadowlark	*Sturnella magna*
Red-winged Blackbird	*Agelaius phoeniceus*
Brewer's Blackbird	*Euphagus cyanocephalus*
Common Grackle	*Quiscalus quiscalus*
Scarlet Tanager	*Piranga olivacea*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Indigo Bunting	*Passerina cyanea*
Evening Grosbeak	*Hesperiphona vespertina*
Purple Finch	*Carpodacus purpureus*
Pine Grosbeak	*Pinicola enucleator*

TABLE 4.29 (cont.)
POTENTIAL AVIAN SPECIES IN PROJECT AREA

Common Name	Scientific Name
Common Redpoll	*Acanthis flammea*
Pine Siskin	*Spinus pinus*
American Goldfinch	*Spinus tristis*
Red Crossbill	*Loxia curvirostra*
White-winged Crossbill	*Loxia leucoptera*
Savannah Sparrow	*Passerculus sandwichensis*
Le Conte's Sparrow	*Ammospiza leconteii*
Vesper Sparrow	*Pooecetes gramineus*
Dark-eyed Junco	*Junco hyemalis*
Chipping Sparrow	*Spizella passerina*
Clay-colored Sparrow	*Spizella pallida*
White-throated Sparrow	*Zonotrichia albicollis*
Lincoln's Sparrow	*Melospiza lincolnii*
Swamp Sparrow	*Melospiza georgiana*
Song Sparrow	*Melospiza melodia*

TABLE 4.30

POTENTIAL REPTILIAN AND AMPHIBIAN SPECIES IN PROJECT AREA

Common Name	Scientific Name
Redbelly Snake	*Storeria occipitomaculata*
Common Garter Snake	*Thamnophis sirtalis*
Eastern Newt	*Notophthalmus viridescens*
Blue-spotted Salamander	*Ambystoma laterale*
Redback Salamander	*Plethodon cinereus*
American Toad	*Bufo americanus*
Spring Peeper	*Hyla crucifer*
Gray Treefrog	*Hyla versicolor*
Striped Chorus Frog	*Pseudacris triseriata*
Northern Leopard Frog	*Rana pipiens*
Wood Frog	*Rana sylvatica*

TABLE 4.31

POTENTIAL MAMMALIAN SPECIES IN PROJECT AREA

Common Name	Scientific Name
Star-nose Mole	*Condylura cristata*
Cinerous Shrew	*Sorex cinereus*
Richardson Shrew	*Sorex arcticus*
Northern Water Shrew	*Sorex palustris*
Pygmy Shrew	*Microsorex hoyi*
Short-tailed Shrew	*Blarina brevicauda*
Little Brown Bat	*Myotis lucifugus*
Keens' Myotis	*Myotis keenii*
Big Brown Bat	*Eptesicus fuscus*
Silver-haired Bat	*Lasionycteris noctivagans*
Snowshoe Hare	*Lepus americanus*
Woodchuck	*Marmota monax*
Least Chipmunk	*Eutamias minimus*
Eastern Chipmunk	*Tamias striatus*
Red Squirrel	*Tamiasciurus hudsonicus*
Eastern Gray Squirrel	*Sciurus carolinensis*
Northern Flying Squirrel	*Glaucomys sabrinus*
Beaver	*Castor canadensis*
Woodland Deer Mouse	*Peromyscus maniculatus gracili*
Bog Lemming	*Synaptomys cooperi*
Northern Bog Lemming	*Synaptomys borealis*
Boreal Redback Vole	*Clethrionomys gapperi*
Meadow Vole	*Microtus pennsylvanicus*
Rock Vole	*Microtus chrotorrhinus*
Meadow Jumping Mouse	*Zapus hudsonius*
Woodland Jumping Mouse	*Napaeozapus insignis*
Porcupine	*Erethizon dorsatum*
Black Bear	*Ursus americanus*
Raccoon	*Procyon lotor*

TABLE 4.31 (cont.)
POTENTIAL MAMMALIAN SPECIES IN PROJECT AREA

Common Name	Scientific Name
Fisher	*Martes pennanti*
Marten	*Martes americana*
Short-tailed Weasel	*Mustela erminea*
Long-tailed Weasel	*Mustela frenata*
Least Weasel	*Mustela rixosa*
Mink	*Mustela vison*
Striped Skunk	*Mephitis mephitis*
Red Fox	*Vulpes fulva*
Coyote	*Canis latrans*
Eastern Timber Wolf	*Canis lupus*
Canada Lynx	*Lynx canadensis*
Bobcat	*Lynx rufus*
White-tailed Deer	*Odocoileus virginianus*
Moose	*Alces alces*

TABLE 4.32

WILDLIFE SIGHTINGS IN VICINITY OF PROJECT AREA[1]
WILDLIFE SPECIES OF REGIONAL INTEREST

Species	Location of Sighting	Distance from Project Area[2]
Peregrine Falcon *(Falco peregrinus)*	NE ¼, Sec. 8, T58N, R17W	3.7 miles
Eastern Timber Wolf *(Canis lupus)*	NE ¼, Sec. 9, T58N, R17W	3.0 miles
	SE ¼, Sec. 4, T58N, R17W	3.2 miles
	SE ¼, Sec. 34, T59N, R17W	3.3 miles
	NE ¼, Sec. 2, T58N, R17W	2.8 miles
	SE ¼, Sec. 3, T58N, R17W	2.5 miles
	NW ¼, Sec. 10, T58N, R17W	2.7 miles
	NE ¼, Sec. 14, T58N, R17W	0.8 miles
Sharp-Tailed Grouse *(Pedioecetes phasianellus)*	SE ¼, Sec. 3, T58N, R17W	2.5 miles
	NW ¼, Sec. 10, T58N, R17W	2.7 miles
	SW ¼, Sec. 25, T58N, R17W	1.0 mile
	NW ¼, Sec. 25, T58N, R17W	0.4 mile
	SE ¼, Sec. 23, T58N, R17W	On mine pit area
Canada Goose *(Branta canadensis)*	NE ¼, Sec. 7, T58N, R17W	4.2 miles
	NW ¼, Sec. 8, T58N, R17W	4.1 miles
	SE ¼, Sec. 35, T58N, R17W	1.6 miles
	SE ¼, Sec. 18, T58N, R16W	0.2 miles

[1]Locations of wildlife sightings provided by Jeff Lightfoot, Area Wildlife Manager, for the MDNR.

[2]Distance from project area is based on the shortest distance from the proposed mine pit or stockpile area boundaries (does not include haul road).

TABLE 4.33

STATE ENDANGERED, THREATENED, AND SPECIAL CONCERN FISH AND WILDLIFE SPECIES IN ST. LOUIS COUNTY

	Status
Birds	
Bartramia longicauda; Upland Sandpiper	S
Botaurus lentiginosus; American Bittern	S
Charadrius melodus; Piping Plover	E
Haliaeetus leucocephalus; Bald Eagle	T
Lanius ludovicianus; Loggerhead Shrike	T
Pandion haliaetus; Osprey	S
Sterna hirundo; Common Tern	S
Mammals	
Canis lupus; Gray (Timber) Wolf	T(P)
Martes americana; Marten	S
Microtus chrotorrhinus; Rock Vole	S
Myotis septentrionalis; Nothern Myotis	S
Phenacomys intermedius; Heather Vole	S
Pipistrellus subflavus; Eastern Pipistrelle	S
Rangifer tarandus; Caribou	S
Spilogale putorius; Eastern Spotted Skunk	S
Amphibians and Reptiles	
Chelydra serpentina; Snapping Turtle	S
Clemmys insculpta; Wood Turtle	T
Fish	
Acipenser fulvescens; Lake Sturgeon	S

E Endangered
T Threatened
S Special Concern
P Present in Project Vicinity
Source: Coffin and Pfannmuller, 1988.

Socio-Economics

The existing socio-economic conditions in the vicinity of the proposed Laurentian Mine primarily involve the Minorca Mine and Plant and the communities of Gilbert and McKinley. Other considerations are mineral leases, old Trunk Highway 135 (which is still used for traffic), and economic conditions in St. Louis County. Highlights of the existing conditions are given below, followed by a detailed discussion.

The Minorca Mine and Plant paid $12 million in wages to 328 employees in 1989. In addition, the facility paid nearly $5 million in taxes in 1989, most of which was a production tax distributed to communities in northeastern Minnesota. It is anticipated that the facility will produce 16 percent of Minnesota's estimated 1990 iron ore industry output.

The City of Gilbert is a small town with a population below 3,000. This population has been declining. Revenues have remained steady on the whole, although intergovernmental revenues undergo greater fluctuation. The city's main business is eating and drinking establishments. The City of McKinley, with a population below 250, is nearby.

Minorca Taconite Mine and Plant

The Inland Steel Minorca Taconite Mine and Plant currently employs 328 workers and paid more than $12 million in wages and salaries in 1989, amounting to an average of $36,600 per employee.

The Minorca facility produced 2.5 millions tons of taconite pellets per year with a market value of $71.8 million at current prices ($28.72/ton, Skillings Mining Review, 1990). This represents approximately 16 percent of the estimated $443 million in output from Minnesota's iron ore industry for 1990.

In 1989, Inland Steel paid the following taxes for the Minorca facility:

Real Estate and Personal Property	$ 139,700	
Unemployment Compensation	340,100	
Sales and Use Tax	515,300	
Production Tax	3,778,300 *	
Royalty Tax		191,300
Total Taxes	$4,964,700	

* This tax is distributed among local communities in northeastern Minnesota.

City of Gilbert

The City of Gilbert lies immediately to the southwest of the proposed Laurentian Mine.

The city had a 1989 population of 2,721. With reduced mining employment, the city's population has continually decreased, although this has slowed over the past several years (Figure 4.24). Corresponding with the population decline has been the closure of some businesses in the city, as well as a gradual decrease in Indicated Market Value. (See the top graph in Figure 4.25.) However, there has been a steady flow of net property taxes collected (see bottom graph of Figure 4.25). The peak in 1988 was due to payment of previously held taxes and other accounting measures.

The primary businesses in Gilbert are eating and drinking establishments. The community constructed a wastewater treatment plant just south of the new Trunk Highway 135, and operates its own profitable electrical utility (see Figure 4.26).

The City of Gilbert has enjoyed relative stability in local government aid, but undergoes greater fluctuation in intergovernmental revenues -- primarily homestead credit (including the Taconite Homestead Credit) and Taconite Municipal Aid (Figure 4.27). As a result, changes in taconite production throughout the Iron Range could have significant impacts on Gilbert. In 1988, Taconite Municipal Aid revenue to Gilbert was

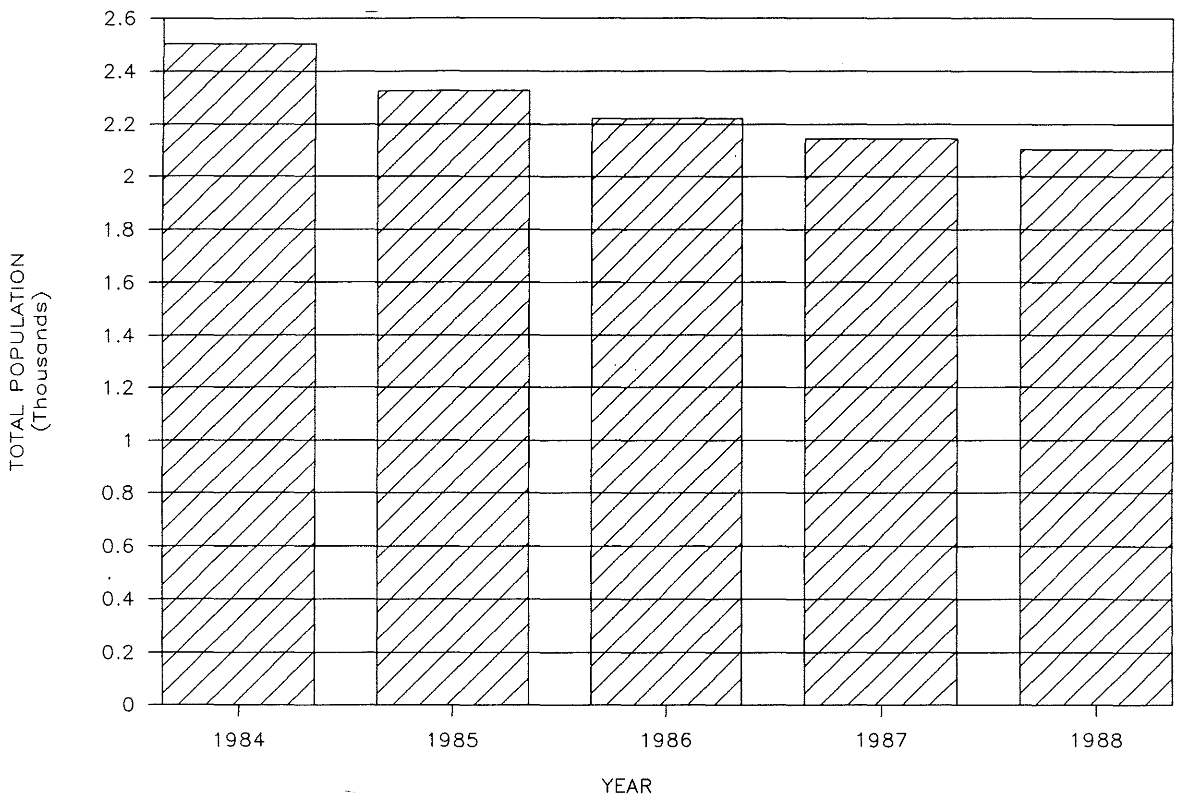
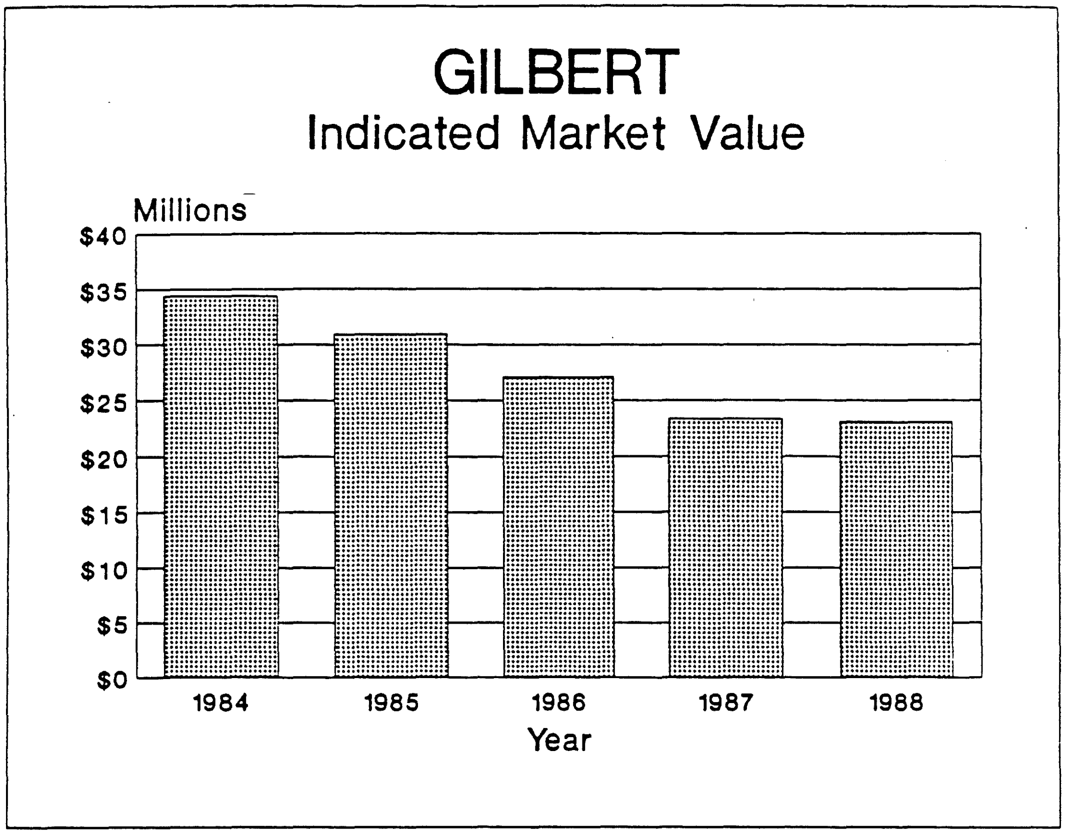


Figure 4.24

TOTAL POPULATION

CITY OF GILBERT, MINNESOTA



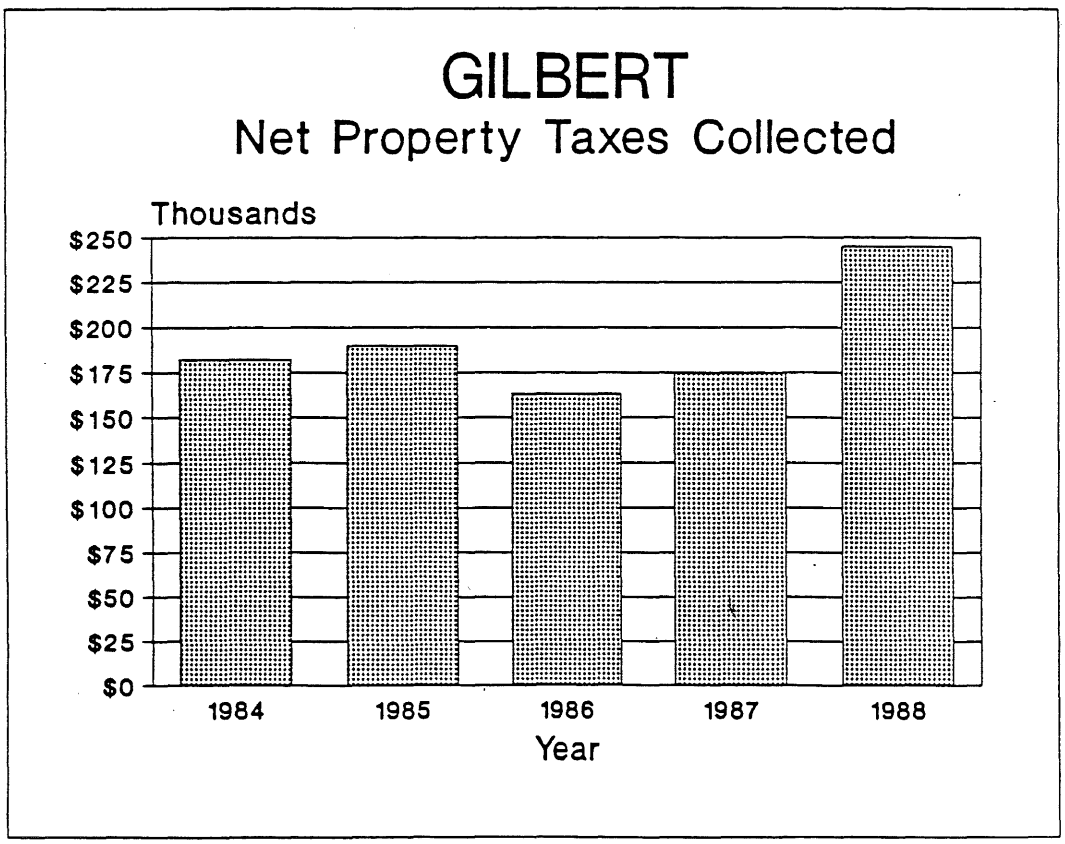


Figure 4.25

MARKET VALUE AND PROPERTY TAXES

CITY OF GILBERT, MINNESOTA

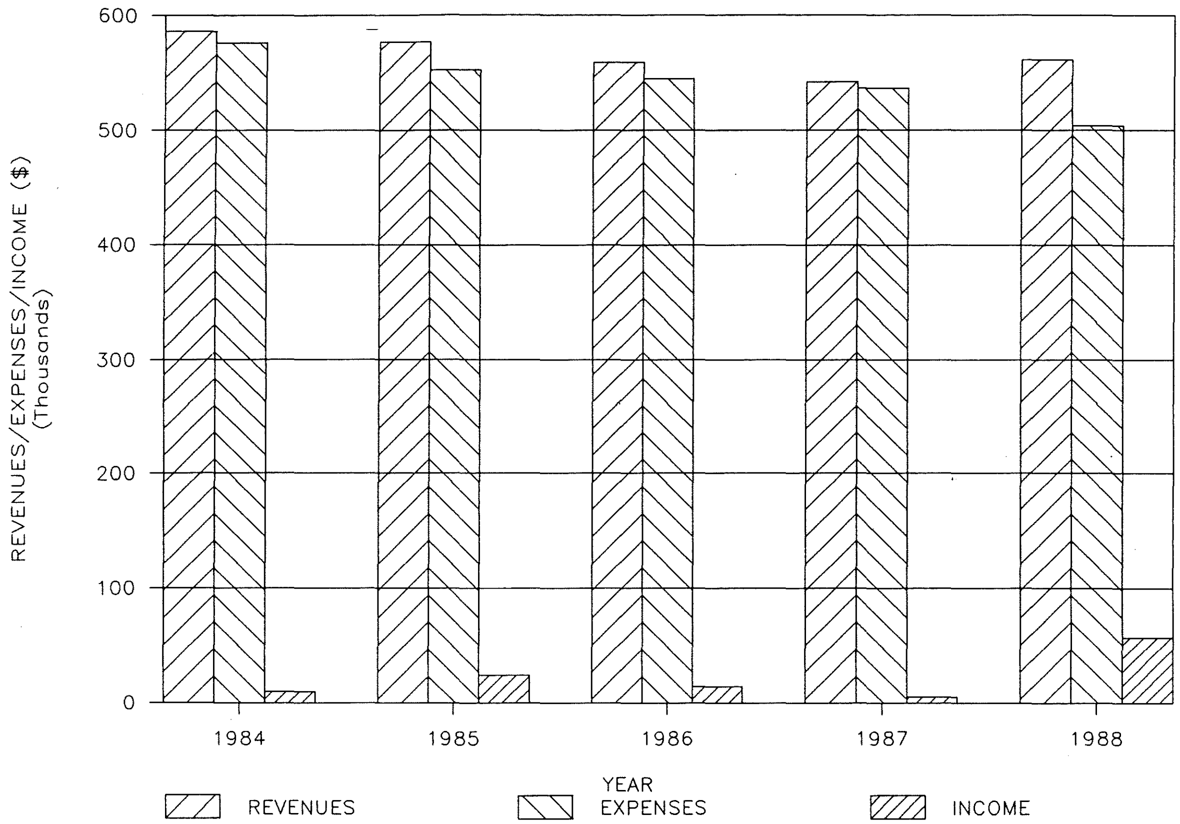
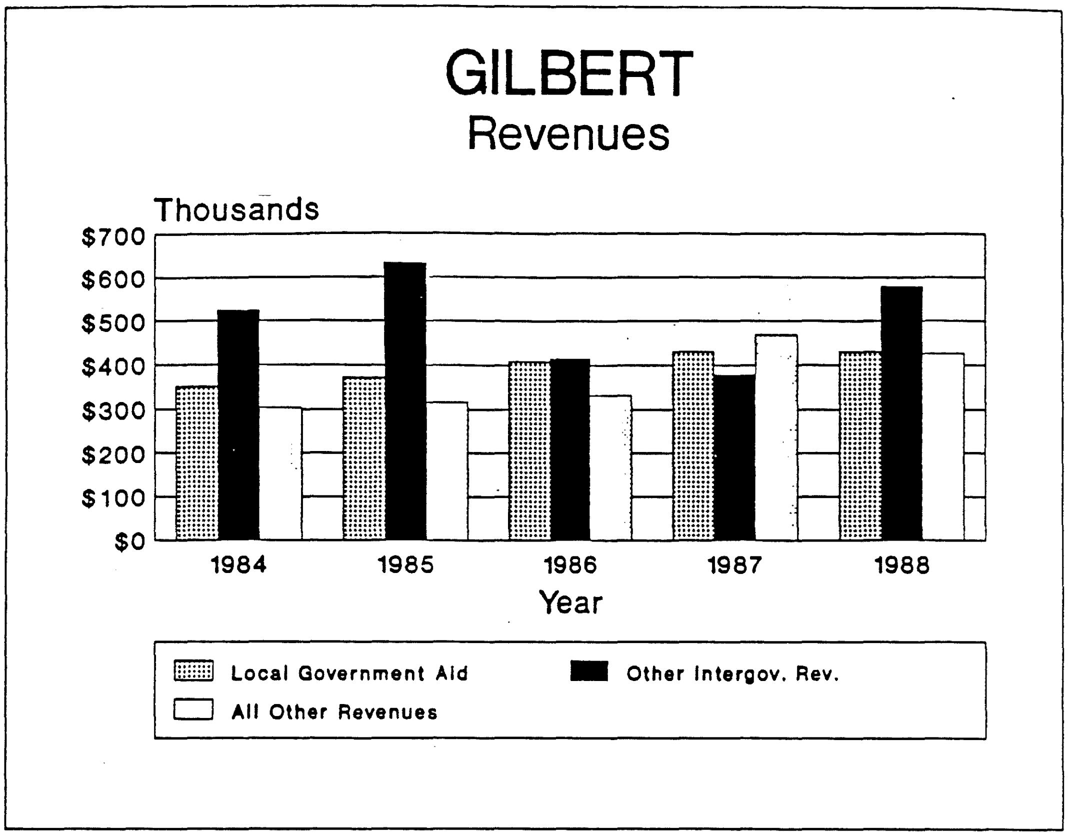


Figure 4.26

ELECTRIC UTILITY INCOME

CITY OF GILBERT, MINNESOTA



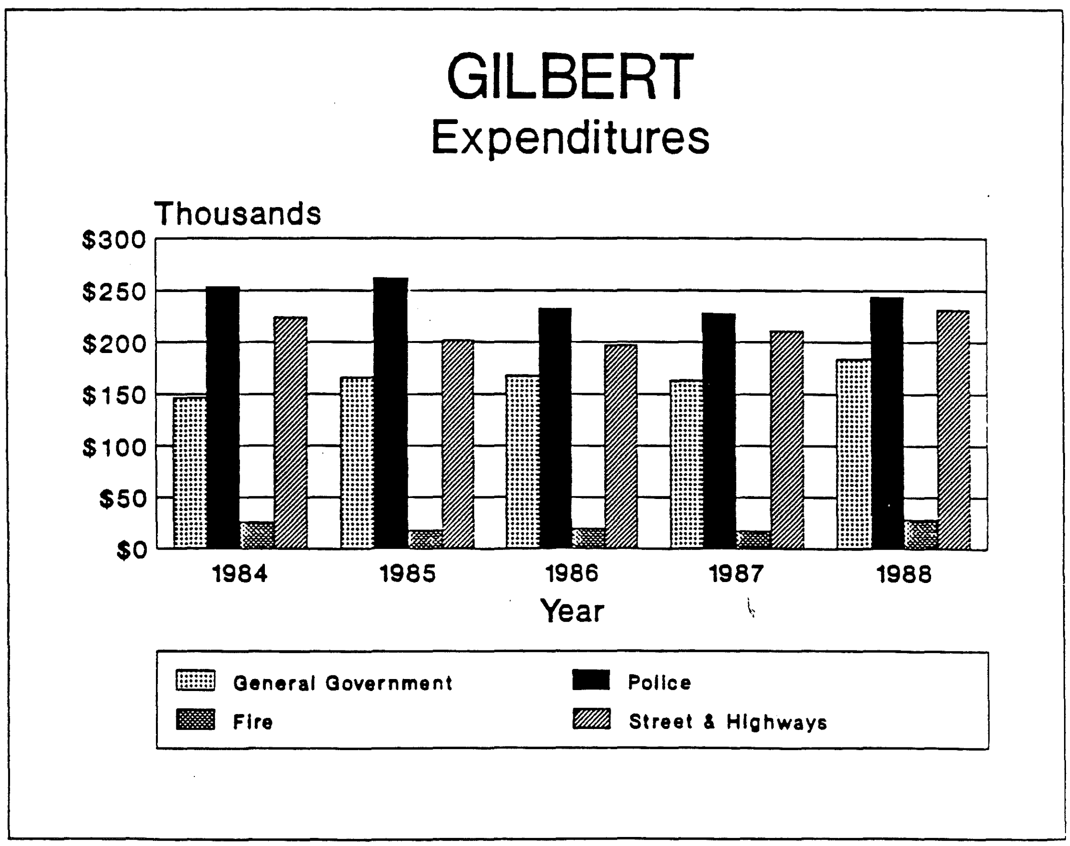


Figure 4.27

REVENUES AND EXPENDITURES

CITY OF GILBERT, MINNESOTA

$143,118. The Taconite Homestead Credit was $76,766, with a total homestead credit of $231,689.

A summary of total revenues and expenditures for the City of Gilbert is shown in Table 4.34. General government expenditures have continued to rise while other expenditures vary from year to year.

Non-Ferrous Mineral Leases

A number of both state and private non-ferrous (non-iron) mineral leases exist within the proposed project area (Figure 4.28). It is not possible to present complete information on mineral leases in this Draft EIS due to the complexities of mineral leases and uncertainties as to how the lessees intend to develop the properties. In some areas, the state controls the surface while in others it has sold the surface rights. With private leases, information on specific surface and mineral rights is not available.

The primary mineral interest at this time is gold, which has been found in similar geologic formations in Canada. The primary concern of the Minnesota Department of Natural Resources is that ferrous mining not inhibit the potential for developing non-ferrous mineral resources.

Old Trunk Highway 135

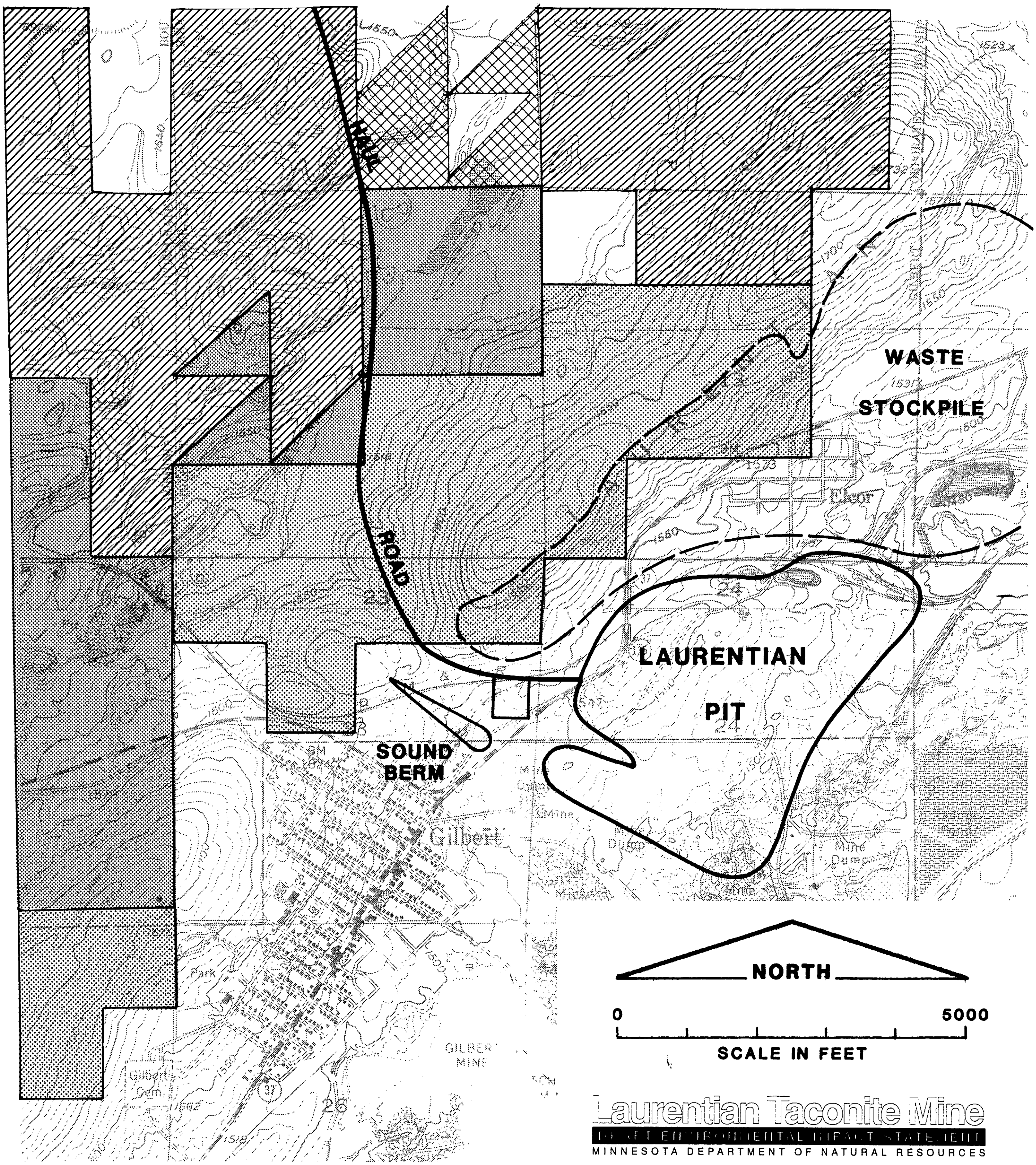
The proposed Laurentian Mine project would remove old Trunk Highway 135, which was abandoned in 1973 (see Figure 4.29 and Table 4.35). Old TH 135 is still used for travel between Gilbert and McKinley, even though it is officially closed.

TABLE 4.34

ECONOMIC DATA - CITY OF GILBERT, MINNESOTA

GOVERNMENTAL FUNDS	GILBERT
CLASS OF CITY	4
POPULATION - 1987 estimate	2,146
ASSESSED VALUATION	5,238,185
TOTAL TAXABLE VALUATION	5,238,185
1986 LOCAL TAX LEVY (Collect. in 1987)	424,030
SPECIAL ASSESSMENTS (Collect. in 1987)	8,540
REVENUES	
PROPERTY TAXES	174,823
TAX INCREMENTS	....
GRAVEL TAX	....
FRANCHISE TAXES (Public Utilities)	2,710
SPECIAL ASSESSMENTS	149,574
LOCAL SALES TAXES & HOTEL-MOTEL TAXES	....
LICENSES AND PERMITS	5,689
FINES AND FORFEITS	3,149
INTERGOVERNMENTAL REVENUES	
Federal Grants - Comm. Develop. Block Grants	....
- Other	396
State Grants - Local Government Aid	430,645
- Homestead Credit	214,410
- Highways	1,741
- Other	160,835
County Grants - Highways	....
- Other	776
Local Units Grants - Highways	....
- Other	....
TOTAL INTERGOVERNMENTAL REVENUES	808,803
DEPARTMENT FEES AND SERVICE CHARGES	
General Government	86
Public Safety	....
Streets and Highways	460
Sanitation (Refuse Collection)	44,197
Libraries	1,164
Recreation and Parks	6,315
Airports	....
Other Service Charges	5,760
TOTAL DEPARTMENT FEES & SERVICE CHARGES	57,982
MISCELLANEOUS REVENUES	
Interest Earnings	36,381
All Other Revenues	38,198
TOTAL REVENUES	1,277,309
OTHER FINANCING SOURCES	
BORROWING - Bonds for Capital Outlay	....
- Other Long-Term Debt	....
- Short-Term Debt	....
TOTAL BORROWING	....
Other Financing Sources	....
TRANSFERS FROM - Enterprise Funds	....
- Governmental Funds	28,835
TOTAL REVENUES AND OTHER SOURCES	1,306,144
Type of Public Service Enterprise	W,S,E

GOVERNMENTAL FUNDS	GILBERT
EXPENDITURES	
GENERAL GOVERNMENT - Current Expenditures	163,321
- Capital Outlay	9,908
TOTAL GENERAL GOVERNMENT	173,229
PUBLIC SAFETY	
Police Department - Current Expenditures	227,673
- Capital Outlay	15,440
Fire Department - Current Expenditures	17,324
- Capital Outlay	10,821
Other Protection - Current Expenditures	3,882
- Capital Outlay	....
TOTAL PUBLIC SAFETY	275,140
STREETS AND HIGHWAYS - Maintenance	186,203
- Lighting	24,764
- Construction	128,611
- Other Capital Outlay	48,049
TOTAL STREETS AND HIGHWAYS	387,627
SANITATION (Excluding Sewer)	
Refuse Collect & Disposal - Current Expend.	39,339
Other Sanitation - Current Expenditures	....
Sanitation - Capital Outlay	12,800
TOTAL SANITATION	52,139
HEALTH - Current Expenditures	....
- Capital Outlay	....
TOTAL HEALTH	....
CULTURE AND RECREATION	
Libraries - Current Expenditures	57,797
- Capital Outlay	486
Park and Recreation - Current Expenditures	53,241
- Capital Outlay	2,518
TOTAL CULTURE AND RECREATION	114,042
CAPITAL OUTLAY FOR ENTERPRISE FUNDS	....
UNALLOCATED INSURANCE AND JUDGMENTS	56,489
AIRPORTS - Current Expenditures	....
- Capital Outlay	....
UNALLOCATED PENSION CONTRIBUTIONS	12,103
HRA & ECONOMIC DEVELOPMENT - Current Expend.	8,288
- Capital Outlay	....
ALL OTHER UNALLOCATED - Current Expenditures	31,099
- Capital Outlay	....
DEBT SERVICE - Interest & Fiscal Charges	32,231
- Principal Payment on Bonds	50,000
- Other Long-Term Debt	20,000
TOTAL CURRENT EXPENDITURES	881,523
TOTAL CAPITAL OUTLAY	228,633
DEBT SERVICE - Principal & Interest	102,231
TOTAL EXPENDITURES	1,212,387
OTHER FINANCING USES	
DEBT REDEMPTION - Refunded	....
- Short-Term Loans	....
Other Financing Uses	....
TRANSFERS TO - Enterprise Funds	....
- Governmental Funds	28,835
TOTAL EXPENDITURES AND OTHER USES	1,241,222



State Lands Leased (Rhude & Fryberger)

State Lands Leased (Newport Exploration)

Resource/ Longyear

Private Leases

Figure 4.28

MINERAL LEASES IN PROPOSED PROJECT AREA

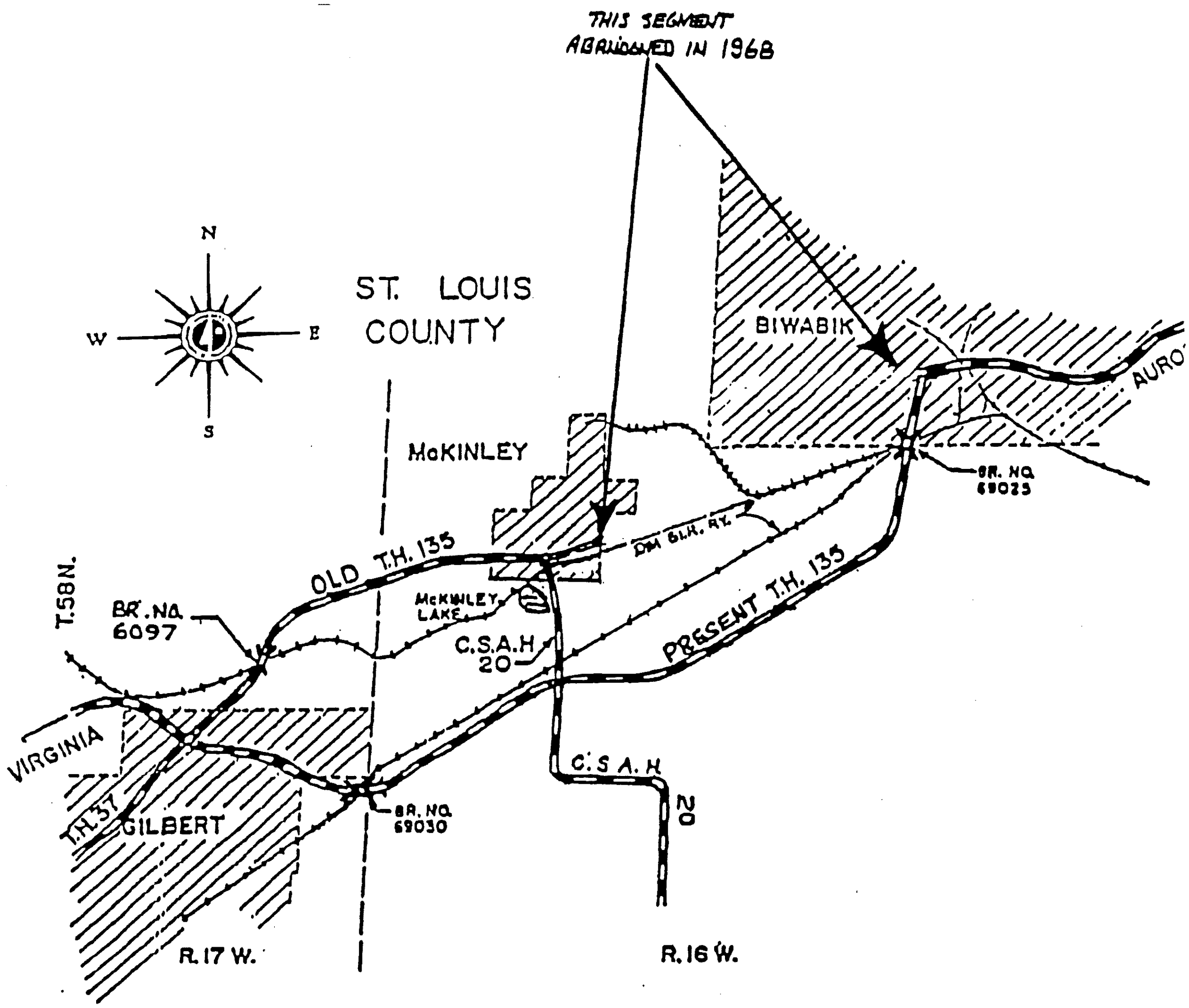


Figure 4.29

HIGHWAY AND RAILROAD ROUTES NEAR PROPOSED PROJECT AREA

TABLE 4.35

HISTORY OF T.H.135 AND BRIDGE 6097

October 7, 1919	. A license agreement made between Rouchleau-Ray Mining Co. (U.S. Steel) and St. Louis County to permit a road across Company land. The agreement listed conditions for relocating the road if required for future mining operations.
1922-1923	. Bridge 6097 was built in 1922 by the DM&IR Railroad. The roadway between Gilbert and McKinley was constructed by the County.
February 5, 1924	. St. Louis County and DM&IR Railroad entered into an agreement regarding reimbursement for construction and continued maintenance of the bridge and roadway. The agreement provided that the cost of the bridge structure maintenance be borne by the DM&IR "forever", and maintenance of the road and road surface on the bridge be borne by the County.
March 11, 1924	. Centerline Order No. 6024 designated the routing of Trunk Highway 35 as taken on the trunk highway system by Constitutional Article.
March 6, 1952	. U.S. Steel provided St. Louis County first notification of its desire to terminate the license agreement of 1919. This began the process which was to require the relocation of Trunk Highway 35.
February 28, 1955	. Width Order 24408 designated the right-of-way width of Trunk Highway 35 to be 66 ft.
1958	. Trunk Highway 35 was redesignated Trunk Highway 135.
October 31, 1968	. During the mid 1960's J & L Steel Corporation declared their intent to mine the area under Trunk Highway 135. On this date an agreement was reached with J & L Steel providing the conditions under which the relocation would occur. The new location was to be approximately one half mile south of McKinley.
August 22, 1969	. The City of McKinley realizing that old Trunk Highway 135 would be abandoned by the relocation of the highway sued the State to stop the relocation. On this date the Supreme Court of Minnesota ruled in favor of the State indicating that reasonable access would be maintained by a planned extension of C.S.A.H. 20.
1972 - 1973	. The reconstruction and relocation of Trunk Highway 135 was accomplished.
October 1973	. Bridge 6097 and roadway were closed.
November 1973	. A Council Meeting was held in McKinley, attended by Senator Tony Perpich, Representative Bill Ojala, Commissioner Ed Hoff, County Engineer Ben Beauclair, and officials of the J & L Mining Company. This meeting was called for the purpose of discussing the opening of old Trunk Highway 135 between Gilbert and McKinley.
January 8, 1974	. As a follow-up of the November 1973 meeting a Legislative Transporation Hearing was held at McKinley. This meeting was conducted by Don Samuelson and Augie Mueller. At this meeting Representative Ojala suggested that a bill be submitted to the Legislature for adding that portion of Temporary Trunk Highway 135 between Gilbert and McKinley to the trunk highway system. It was the contention of the City of McKinley that the access by CSAH 20 was interrupted by two railway crossings of the DM&IR which landlocked McKinley in periods of emergency.
July 31, 1974	. (Trunk Highway Order 55272) As a result of continued discussions it was decided to reopen the road and bridge (after modifications because of its condition) as a temporary trunk highway.
September 23, 1974	. An agreement was reached under which Mn/DOT took over the maintenance of the bridge and roadway as a temporary trunk highway until its closure.
March 1983	. Concrete edge barriers were added, the bridge narrowed to 1 lane with a stop condition at each end, and load restricted to 3 ton.
May 8, 1987	. Bridge 6097 was closed to traffic.

St. Louis County

Economic analysis shows that there are general regional benefits to be derived from particular businesses. Profits generated in one business show up as sales in many other area businesses, as well as in the tax revenues. The concept of economic multipliers is meant to show this "cascade" effect. An economic multiplier shows the overall regional impact of a $1 increase in regional output. The St. Louis County multipliers shown on Table 4.36 can be used to determine the relative impacts of the Minorca facility on St. Louis County, especially if the plant were closed.

Table 4.36 shows the direct, indirect, and induced effects of local purchases by the iron ore industry and several major related industries (mining services, railroads, and electric utilities). Type I multipliers show the short-term impacts of a $1 increase in regional output, while the Type III multiplier takes into account population and employment growth over the long term in response to an increase in regional output. Thus, the Type III multiplier can be considered to reflect longer-term impacts.

TABLE 4.36

SELECTED ST. LOUIS COUNTY MULTIPLIERS

SECTOR NAME	DIRECT	INDIRECT	INDUCED	TOTAL	TYPE I	TYPE III
OUTPUT MULTIPLIERS						
28 Iron ore					1.1903	1.4624
35 Mining services				1.2096	1.4849	
446 Railroads					1.3110	1.6266
456 Elec utilities				1.1302	1.2461	
EMPLOYMENT MULTIPLIERS						
28 Iron ore					1.1919	1.6301
PERSONAL INCOME EFFECTS & MULTIPLIERS						
28 Iron ore	0.3421	0.0551	0.0806	0.4779	1.1712	1.3969
35 Mining serv	0.3920	0.0567	0.0815	0.5303	1.1447	1.3529
446 Railroads	0.4417	0.1294	0.0935	0.6647	1.2929	1.5047
456 Elec util	0.1290	0.0494	0.0344	0.2166	1.3717	1.6030

For the short term, a $1 increase in iron ore output will yield a regional benefit of $1.19, while over the long term this is estimated to have a $1.46 benefit. On the other hand for electrical utilities, the short-term impact is $1.13 versus a long-term impact of only $1.25. The employment multiplier shows greater long-term benefits. In the short term, the increase in one direct job yields a total of 1.19 jobs in the region, while over the long term, the single job leads to a total increase of 1.63 jobs.

Use of these industry multipliers permits the evaluation of impacts in St. Louis County under the no build alternative, which could lead to the closing of the Minorca taconite facility and its related employment and expenditures in the region (St. Louis County).

Source: St. Louis County IMPLAN model and data base.

Historical Background

Regional History

The proposed Laurentian Mine would be developed in the Mesabi Iron Range, which extends approximately 120 miles across northeastern Minnesota. (See Figure 4.30.)

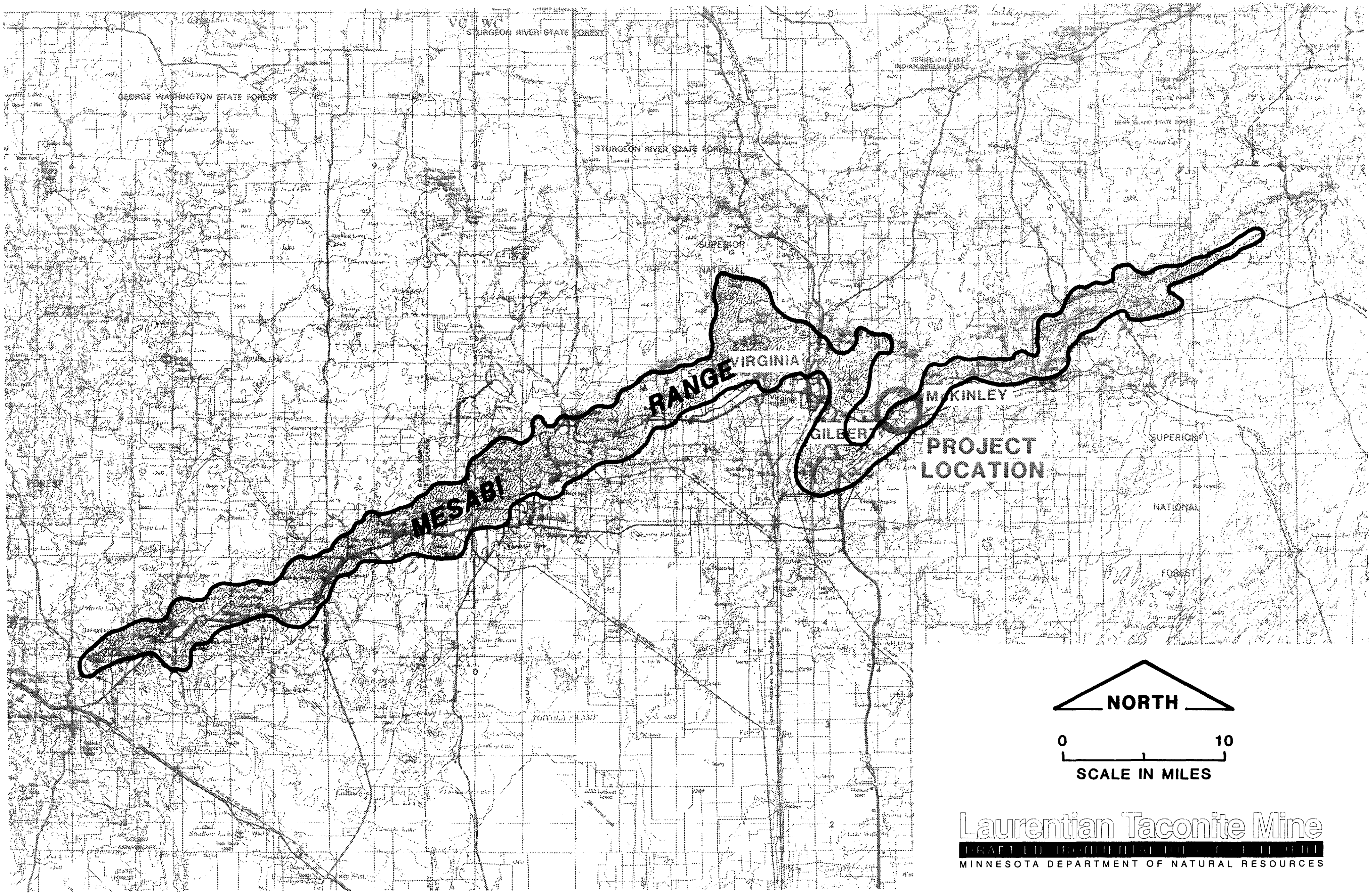
The Mesabi Range has been the site of intense mining since 1892, as well as lumbering. The area is covered by active and inactive open pit mines, some underground mine shafts, waste stockpiles, tailing basins, and mining towns. The range has been the country's major source of iron ore for the past 100 years. A total of 3.5 billion tons of natural iron ore were mined from the Mesabi Range.

With exhausted domestic natural switch ores and increasing foreign competition, taconite is an important domestic ore alternative. Taconite is a hard rock containing 20 to 30 percent iron ore. Large processing facilities were constructed from 1955 to 1977 to turn the low-grade ores into high-grade taconite pellets. Today seven taconite plants operate on the Mesabi Range, with a combined annual capacity well over 40 million tons.

Local History

The area surrounding the proposed Laurentian Mine has had intense mining activity since 1901. Figure 4.1 shows previous and current mining activity near the proposed project site. Natural iron ore mines in the immediate vicinity included the Gilbert, Schley, Mariska, and Corsica pits. The Corsica Pit was abandoned in 1962, the Mariska Pit in 1963, the Schley Pit in 1969, and the Gilbert Pit in 1971. Stockpile shipments from the Gilbert Pit continued until 1981.

Inland Steel Mining Company currently operates the Minorca Taconite Mine and Plant in Virginia approximately 6 miles from the proposed Laurentian Mine (Figure 4.1). Completed in 1977, this facility consists of an open pit mine, a taconite pellet plant, water reservoirs, a tailings disposal basin, and associated equipment and



Laurentian Taconite Mine

MINNESOTA DEPARTMENT OF NATURAL RESOURCES

Figure 4.30

LOCATION OF MESABI RANGE

administrative buildings. The plant has an annual capacity of 2.5 million tons of fluxed taconite pellets. At current mining rates, the Minorca open pit will be exhausted of minable crude ore by the end of 1992.

The proposed Laurentian Mine site has been considered for development previously. In 1958, Pickands Mather, Inc. planned to mine the Laurentian Reserve ore body and build a nearby processing facility. In the mid-1960s, Jones & Laughlin Steel proposed to mine the Laurentian Reserve as well as two reserves to the east. They proposed to build a taconite plant on top of the Laurentian Divide and use the Pike River watershed area for a tailing disposal basin. Trunk Highway 135 was relocated in preparation for that project. For financial reasons, neither plan materialized.

SECTION 5: Impacts of Proposed Project and No-Build Alternative

This section explains the potential impacts of constructing and operating the proposed Laurentian Mine. Impacts of not developing the mine are also discussed. This section is organized by what would be impacted: surface water, groundwater, water quality, noise/vibration, air quality, vegetation/wetlands, fish/wildlife, and socio-economics. Ways to mitigate significant impacts are discussed in Section 6.

Surface Water

Project Impacts

This section describes the impacts of the proposed Laurentian Mine on surface water in the vicinity of the project. Impacts on surface water would increase gradually throughout the mine's life. The greatest impacts would occur when the mine is at its greatest depth and size and the stockpiles reach their ultimate size. Under these ultimate mine conditions, three factors would reach their maximum: (1) groundwater drawdowns, which would tend to lower surface waters; (2) the mine dewatering rate, which would affect Leaf Lake and the dewatering route; and (3) changes in the character and/or size of the White Lake and Corsica Pit watersheds. Therefore, this section discusses the surface water impacts of the project during ultimate mine conditions (conditions immediately before the mine closes). Impacts on surface water after closure of the mine are also discussed.

The four significant bodies of public waters that would be impacted by the mine are the Corsica Pit, the Mariska Pit, White Lake, and Leaf Lake (Figure 5.1). The surface water features along the proposed dewatering route will also be impacted. The impacts of the proposed project on the Mariska Pit are not discussed in detail because the Mariska Pit would be incorporated into the ultimate Laurentian Mine. Possible effects on Lake Orebegone are discussed in the following groundwater section.

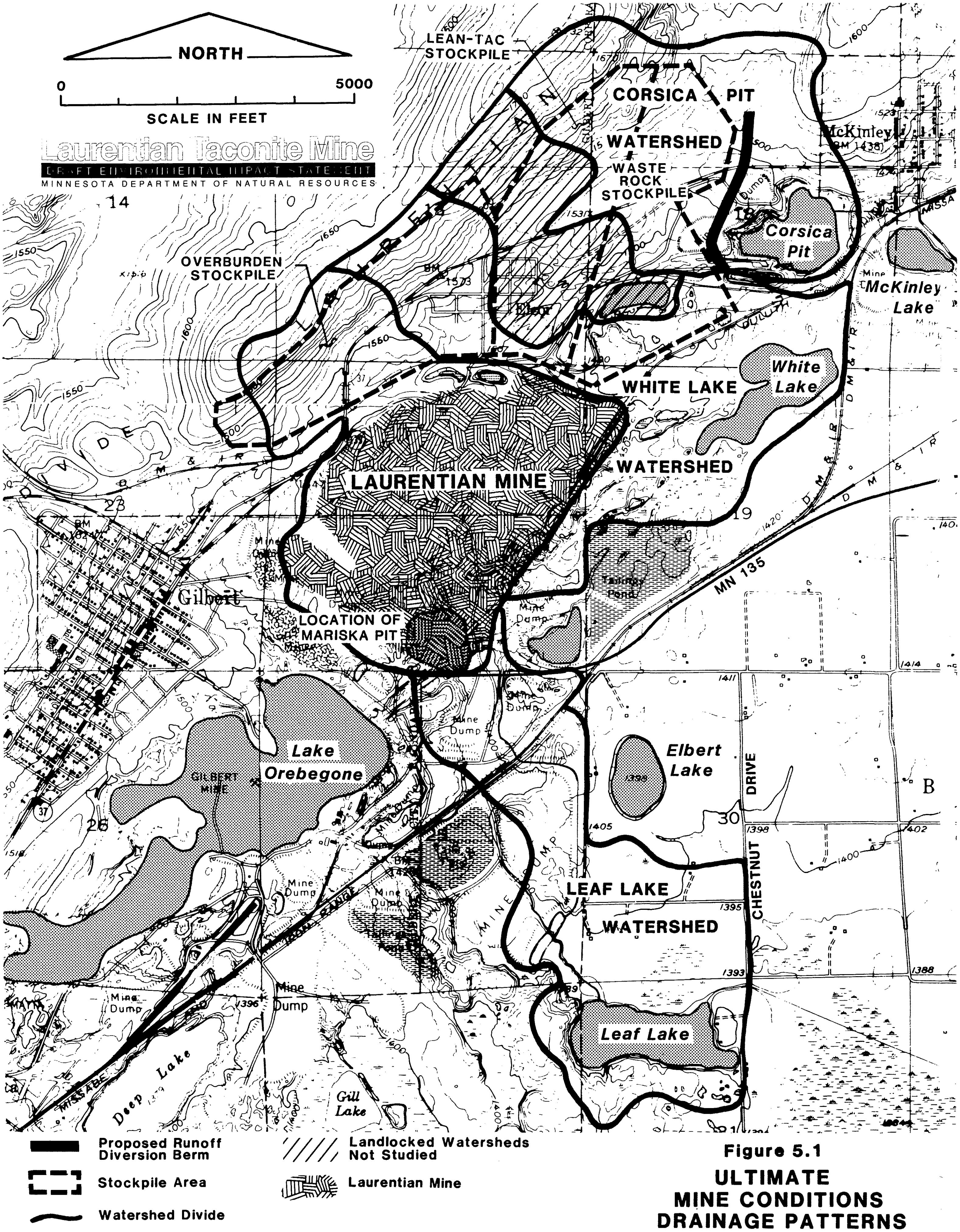


Figure 5.1

ULTIMATE MINE CONDITIONS DRAINAGE PATTERNS

The impacts of the project on public waters were estimated by comparing the existing conditions results of a computerized water budget model with the results assuming land use and mine dewatering rates near the end of the mine's life ("ultimate mine"). A computerized flood routing model was used to predict peak flow rates along the dewatering route during rainstorms with a 10 percent (10-year storm) and a 1 percent (100-year storm) chance of occurring in any single year. Because the dewatering route eventually reaches Leaf Lake, the model was also used to predict the lake's flood levels for each rainstorm.

<u>Corsica Pit</u> -- Water in the Corsica Pit has a direct connection with the region's groundwater and its elevation reflects groundwater levels. The level of water in the pit would be expected to drop up to 3 feet due to the groundwater level drop caused by the Laurentian Mine dewatering. This drop is considered insignificant because the pit is very deep. The pit would still seep water to the groundwater during ultimate mining conditions. The water surface level is primarily controlled by the groundwater level.

The surface runoff to the Corsica Pit is expected to increase due to the construction of stockpiles in its watershed. However, the increased amount of water entering the pit would have little impact on the water surface level because the water surface level is primarily controlled by the groundwater level.

The water levels in the pit would recover after mining stops and eventually return to levels that occur under existing conditions.

<u>White Lake</u> -- The watershed draining to White Lake would decrease if the mine project were developed. In addition, the groundwater level around the lake would drop because of the mine dewatering. Therefore, the average level of White Lake could be expected to drop up to 6 feet. The amount of the drop would depend on how well the lake is connected with the adjacent groundwater. Mitigation steps are recommended if significant drops in the level of White Lake occur because of the mine project.

The average level of White Lake after mining operations stop and groundwater levels recover would be lower than under existing conditions. This is because of the decreased watershed area. The average lake level after mining ends is expected to be less than 0.5 feet lower than existing levels.

__Leaf Lake__ -- The average level of Leaf Lake under ultimate mining conditions would be approximately 8 inches higher than under existing conditions. The rise in lake level would be due to the water pumped from the Laurentian Mine. This estimate of impacts assumes that the existing outlet to Leaf Lake is unaltered.

The level of Leaf Lake would closely match existing conditions after mine dewatering ends, again assuming no changes were made to the lake outlet.

__Dewatering Route__ -- The ditch that is proposed to be used as the dewatering route could adequately convey the dewatering discharge and could also convey the flow from the 1 percent chance rainstorm if improvements were made. However, there are several locations along the route where culverts would have to be provided or enlarged to convey the flow. The presence of trees in the ditch is expected to obstruct the flow in the channel and their removal is recommended. Erosion of the ditch is not expected to be a problem.

The surface water impacts summarized above are discussed in detail in the following pages.

1. Surface Drainage Patterns

The land area that would be altered by the Laurentian Mine drains to four significant bodies of public water: the Corsica Pit, the Mariska Pit, White Lake, and Leaf Lake. However, the Mariska Pit would ultimately become part of the Laurentian Mine, so further analysis is not included in this section. Mining construction and operation would impact the other three water bodies by affecting the size of their watersheds and/or land uses in their watersheds, by mine dewatering discharges, and by lowering the surrounding groundwater levels.

Table 5.1 summarizes the acreages and land use for each lake watershed shown on Figure 5.1. An additional land use type is used in this section to model the

TABLE 5.1

ULTIMATE MINING WATERSHED CONDITIONS

Watershed	Total Area (Acres)	Land Use Area (Acres): Forest/ Grass	Till Stockpile	Wetland	Mining	Open Water
Corsica Pit	437.9	209.3	188.2	0	0	40.4
White Lake	463.2	332.3*	67.1	17.3	0	46.5
Laurentian Mine	650.4	213.0*	46.8	0	390.6	0
Leaf Lake	528.1	325.7	100.3	48.8	0	53.3
Laurentian Mine and Leaf Lake Combined	1178.5	538.7	147.1	48.8	390.6	53.3

*Overburden stockpiles were assumed to be vegetated and included in forest/grass land use.

TABLE 5.2

MONTHLY AVERAGE WATER BALANCE FOR MINE AREAS ESTIMATED BY MEYER MODEL (1933-1986)

Month	Precipitation (inches)	Land Evaporation (inches)	Transpiration (inches)	Surface Runoff (inches)	Percolation (inches)
Jan	0.93	0.19	0	0	0
Feb	0.64	0.31	0	0	0
Mar	1.21	0.57	0	0.55	0
Apr	2.13	0.31	0	4.42	0
May	2.84	0.30	0	2.54	0
Jun	4.13	0.20	0	3.93	0
Jul	3.77	0.20	0	3.57	0
Aug	3.73	0.20	0	3.53	0
Sep	3.18	0.30	0	2.88	0
Oct	2.26	0.29	0	1.96	0
Nov	1.52	0.41	0	0.32	0
Dec	0.92	0.25	0	0	0
ANNUAL*	27.24	3.52	0	23.70	0

*The summation of land evaporation, transpiration, surface runoff, and percolation does not equal precipitation due to changes in surface storage.

bare rock in the Laurentian Mine. The water budget for the mine pit area is shown in Table 5.2.

Much of the area considered landlocked in the existing conditions analysis (areas draining to old collapsed mines and dry depressions) would be overlaid by stockpiles. The areas that would be overlaid by waste rock and lean-ore stockpiles are assumed to follow their current drainage patterns. This is because precipitation that does not evaporate after falling on those stockpiles would be expected to infiltrate to the existing ground surface and follow the existing surface and subsurface drainage patterns.

The proposed overburden stockpiles were assumed to be revegetated during reclamation and be designed to maintain the existing drainage divides in most cases.

2. Water Budget Results

Tables 5.3 through 5.5 and 5.7 show the average monthly and annual water budgets for the Corsica Pit, White Lake, and Leaf Lake if the mine were fully developed. The level of the groundwater adjacent to White Lake would be expected to drop due to mine dewatering. Two different cases were studied for White Lake so that the potential range of impacts could be shown.

Corsica Pit

The size of the watershed draining to the Corsica Pit is expected to remain the same, though much of the watershed would be used for stockpiles. An earthen diversion berm has been proposed so that surface runoff from the stockpiles would not flow directly into the pit. The surface runoff would pond behind the berm and infiltrate through the berm and/or ground before entering the pit. The amount of runoff water entering the pit after the stockpiles were constructed would increase. This is because less water would be used by plants (reduced transpiration) on the stockpiles than is used by the existing forest.

The increased amount of drainage entering the pit would not be enough to significantly affect the pit's water level. However, the drop in the surrounding groundwater level during mine dewatering would reduce the Corsica Pit's

TABLE 5.3

MONTHLY AVERAGE WATER BALANCE
FOR CORSICA MINE PIT FOR ULTIMATE MINE CONDITIONS
ESTIMATED BY MEYER MODEL (1933-1986)

Month	Surface Runoff (cfs)**	Precipitation Falling Onto Surface Water (cfs)**	Surface Water Seepage through Diversion Berm (cfs)**	Surface Water Evaporation (cfs)**	City of McKinley Pumping (cfs)**	Change in Groundwater (cfs)**
Jan	0	0.05	0	0.01	0.05	-0.01
Feb	0	0.04	0	0.02	0.06	-0.04
Mar	0.04	0.07	0.08	0.03	0.05	0.11
Apr	0.36	0.12	0.67	0.07	0.06	1.02
May	0.05	0.16	0.13	0.11	0.06	0.17
Jun	0.17	0.23	0.42	0.14	0.07	0.61
Jul	0.15	0.21	0.38	0.20	0.08	0.46
Aug	0.15	0.21	0.38	0.23	0.08	0.43
Sep	0.06	0.18	0.16	0.20	0.07	0.13
Oct	0.04	0.13	0.09	0.12	0.06	0.08
Nov	0	0.09	0.01	0.04	0.06	0
Dec	0	0.05	0	0.01	0.05	-0.01
ANNUAL	0.09	0.13	0.19	0.10	0.06	0.25

*Residual of Surface Runoff + Precipitation - Evaporation - Pumping.
Assumes no net change in water level.
**cfs - cubic foot per second

water level by approximately 3 feet. The pit's water has a direct connection with the region's groundwater and its elevation reflects groundwater levels. This drop in groundwater level is discussed in detail in the groundwater impacts portion of this Section 5.

White Lake

The watershed area of White Lake would decrease because part of the watershed would become part of the Laurentian Mine. Two water budgets were estimated for ultimate mine conditions for White Lake. This was necessary to estimate the potential range of lake fluctuations that could occur. The first water budget, shown on Table 5.4, reflects the assumption that the seepage rate from the lake to the groundwater would remain the same as under existing conditions (29 inches/year). This would be the case if the soils underlying the lake are fine-grained and restrictive to the flow of water. Seepage rates would then be controlled by these soils and the depth of water in the lake. The second water budget, shown on Table 5.5, assumes that the soils under the lake are coarse enough so that the lake is well connected to the groundwater. This means that the seepage rate would increase due to the drop in groundwater levels adjacent to the lake (estimated to be 3 to 10 feet as discussed in the groundwater impacts section). The lake level would drop enough that surface outflows would not occur. The two conditions modeled give the estimated highest and lowest lake levels that would be expected during ultimate mine conditions.

Figure 5.2 shows water level-duration curves for the modeled existing conditions and the two cases analyzed for the ultimate mine conditions. Table 5.7 shows average monthly lake levels for the historical record, existing conditions modeled, and the two ultimate mine modeled conditions.

The ultimate mine conditions curve for the highest lake levels case on Figure 5.2 shows that 75 percent of the time, lake levels would be similar to those under existing conditions. The lake would tend toward lower levels than existing conditions during drier periods, such as droughts and winter.

The lowest lake levels case curve on Figure 5.2 shows that the lake level exceeded 50 percent of the time is 6 feet below that for existing conditions. The lake level also has a much wider fluctuation because the stabilizing

TABLE 5.4

MONTHLY AVERAGE WATER BALANCE FOR WHITE LAKE FOR ULTIMATE MINE CONDITIONS ESTIMATED BY MEYER MODEL (1933-1986)

(Highest Levels)

Month	Surface Runoff (cfs)*	Precipitation Falling Onto Surface Water (cfs)*	Surface Water Evaporation (cfs)*	Seepage (cfs)*	Surface Outflow (cfs)*	Lake Level (feet)
Jan	0.02	0.05	0.01	0.14	0	1422.2
Feb	0.01	0.04	0.02	0.14	0	1422.0
Mar	0.12	0.07	0.03	0.14	0.01	1422.0
Apr	1.02	0.12	0.08	0.14	0.37	1422.8
May	0.18	0.16	0.12	0.14	0.14	1422.8
Jun	0.53	0.24	0.15	0.14	0.32	1423.0
Jul	0.44	0.22	0.21	0.14	0.33	1423.0
Aug	0.42	0.22	0.24	0.14	0.28	1422.9
Sep	0.19	0.19	0.21	0.14	0.12	1422.8
Oct	0.12	0.13	0.12	0.14	0.07	1422.7
Nov	0.03	0.09	0.04	0.14	0.01	1422.5
Dec	0.02	0.05	0.01	0.14	0	1422.4
ANNUAL	0.26	0.13	0.10	0.14	0.14	1422.6

*cfs - cubic feet per second

TABLE 5.5

MONTHLY AVERAGE WATER BALANCE FOR WHITE LAKE FOR ULTIMATE MINE CONDITIONS ESTIMATED BY MEYER MODEL (1933-1986)

(Lowest Levels)

Month	Surface Runoff (cfs)*	Precipitation Falling Onto Surface Water (cfs)*	Surface Water Evaporation (cfs)*	Seepage (cfs)*	Surface Outflow (cfs)*	Lake Level (feet)
Jan	0.02	0.04	0.01	0.27	0	1416.0
Feb	0.01	0.02	0.01	0.26	0	1415.5
Mar	0.13	0.05	0.02	0.25	0	1415.2
Apr	1.05	0.08	0.05	0.27	0	1416.9
May	0.18	0.12	0.08	0.28	0	1416.8
Jun	0.54	0.17	0.11	0.29	0	1417.5
Jul	0.47	0.16	0.16	0.30	0	1417.8
Aug	0.43	0.17	0.18	0.30	0	1418.0
Sep	0.19	0.14	0.16	0.30	0	1417.8
Oct	0.13	0.10	0.09	0.30	0	1417.4
Nov	0.03	0.06	0.03	0.29	0	1417.0
Dec	0.02	0.04	0.01	0.28	0	1416.5
ANNUAL	0.26	0.10	0.08	0.28	0	1416.9

*cfs - cubic feet per second

TABLE 5.6

AVERAGE WHITE LAKE WATER SURFACE LEVELS (Feet)

Month	Historical*	Modeled Existing Conditions**	Modeled Ultimate Mining Conditions** High Levels	Low Levels
Jan	1422.35	1422.38	1422.18	1415.99
Feb	1422.35	1422.21	1422.00	1415.46
Mar	1422.46	1422.20	1421.98	1415.18
Apr	1422.84	1423.04	1422.83	1416.91
May	1422.92	1422.93	1422.75	1416.79
Jun	1422.73	1423.14	1423.00	1417.47
Jul	1422.54	1423.07	1422.96	1417.78
Aug	1422.31	1423.03	1422.91	1418.00
Sep	1422.23	1422.88	1422.77	1417.75
Oct	1422.32	1422.77	1422.65	1417.42
Nov	1422.38	1422.66	1422.53	1416.97
Dec	1422.39	1422.53	1422.40	1416.48
ANNUAL	1422.49	1422.74	1422.58	1416.85

*1955-1978 averages
**Modeled using 1933-1986 climatic data

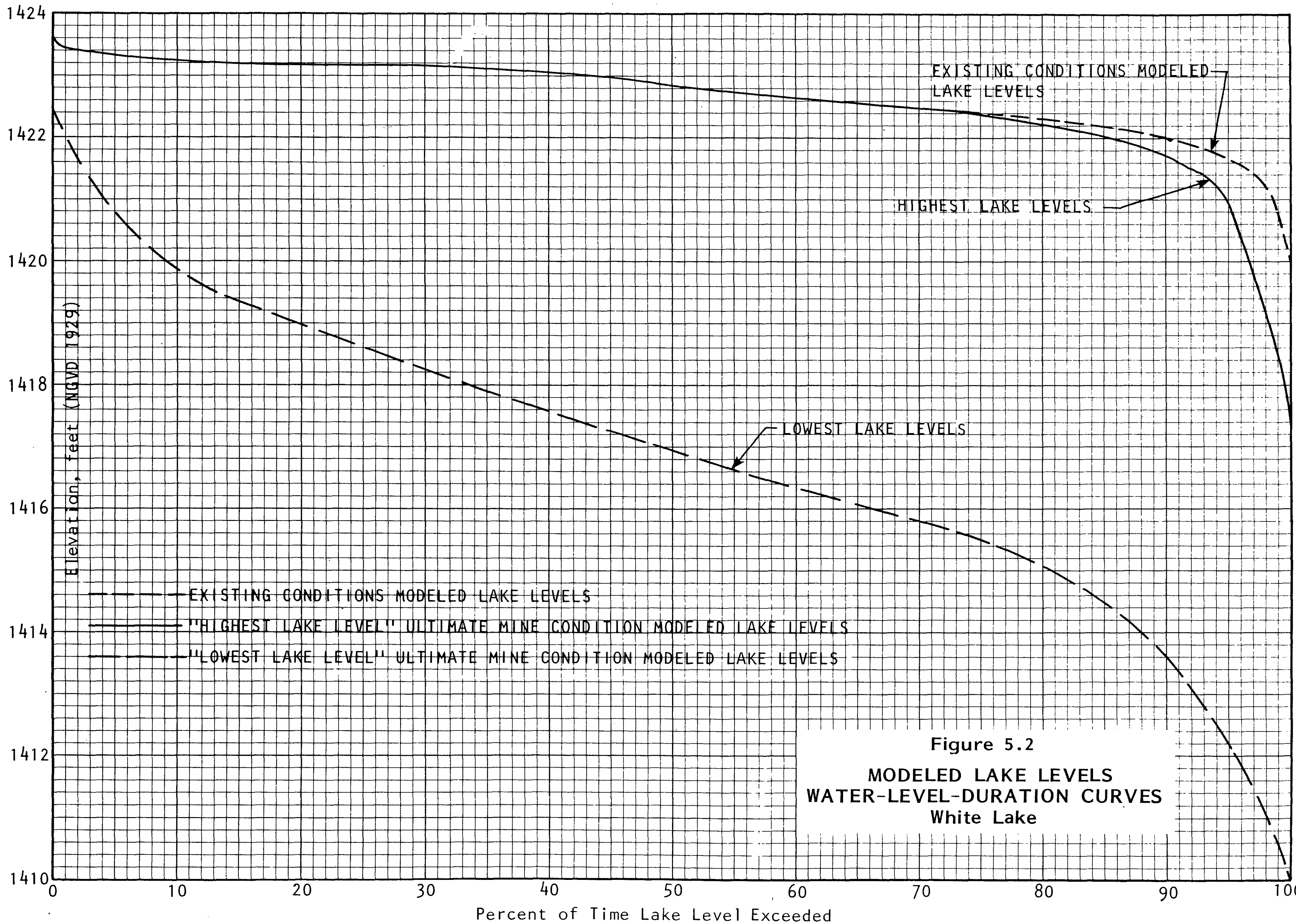


Figure 5.2

MODELED LAKE LEVELS
WATER-LEVEL-DURATION CURVES
White Lake

influence of a surface outlet is lost. Table 5.6 shows that the seasonal fluctuations in the lowest lake level case would be much greater than in both the existing or highest lake level models. If the lake dropped significantly due to the mining project, steps to sustain the lake level at existing levels should be taken (Section 6).

Leaf Lake

The watershed of Leaf Lake would remain unchanged under mining conditions except that a culvert would be constructed between the old sedimentation pond and Leaf Lake. Because of the culvert, the surface runoff from areas upstream of the old sedimentation pond would appear in Leaf Lake as surface runoff and not percolation, as assumed in the existing conditions analysis.

The volume of water from mine dewatering entering Leaf Lake would be approximately five times greater than the water flowing into the lake from its watershed. The volume of water from Leaf Lake's watershed should be similar to existing conditions because the mine would cause negligible changes in its watershed. Therefore, any impact on Leaf Lake would be from mine dewatering and not from land use changes in the lake's watershed.

The average monthly and annual volume of dewatering expected from the fully developed Laurentian Mine is shown in Table 5.8. The surface water inflows reflect the watershed areas and land uses shown in Table 5.1 for the Laurentian Mine. It was assumed that half the groundwater inflow into the mine during winter (December through March) froze in the mine and melted during April. A second assumption made is that all the water that enters the pit during a month is pumped out at a constant rate during the same month.

Table 5.7 shows the water budget for Leaf Lake during ultimate mine conditions. Figure 5.3 shows modeled existing and ultimate mine conditions water level-duration curves. Table 5.9 shows average monthly water levels for historical, modeled existing, and modeled ultimate mine conditions. The ultimate mine duration curve in Figure 5.3 and the ultimate mine column in Table 5.9 show a higher water surface level than under existing conditions. The higher water surface is due to the increased flow into the lake from the mine dewatering. The average annual water level would rise an estimated 0.64 feet (approximately 8 inches), assuming the existing outlet is in place and no

TABLE 5.7

MONTHLY AVERAGE WATER BALANCE FOR LEAF LAKE ULTIMATE MINE CONDITIONS ESTIMATED BY MEYER MODEL (1933-1986)

Month	Surface Runoff* (cfs)**	Precipitation Falling Onto Surface Water (cfs)**	Groundwater Inflow (cfs)**	Surface Water Evaporation (cfs)**	Surface Outflow (cfs)**	Lake Level (feet)
Jan	0.73	0.08	0	0.02	0.79	1390.2
Feb	0.72	0.05	0	0.03	0.75	1390.2
Mar	1.21	0.10	0.17	0.05	1.23	1390.4
Apr	8.32	0.19	1.21	0.12	8.05	1391.9
May	3.08	0.25	0.37	0.18	4.50	1390.9
Jun	4.47	0.36	0.17	0.22	4.55	1391.1
Jul	4.08	0.33	0.06	0.31	4.28	1391.0
Aug	4.03	0.33	0.11	0.36	4.12	1391.0
Sep	3.23	0.28	0.39	0.31	3.69	1390.9
Oct	2.65	0.20	0.58	0.19	3.33	1390.8
Nov	1.64	0.13	0.13	0.07	2.15	1390.5
Dec	0.74	0.08	0	0.02	1.09	1390.2
ANNUAL	2.91	0.20	0.27	0.16	3.21	1390.8

*Includes mine dewatering
**cfs - cubic feet per second

TABLE 5.8

MONTHLY AVERAGE MINE DEWATERING

Month	Surface Water Inflow* (cfs)***	Groundwater Seepage Inflow** (cfs)***	Total (cfs)***
Jan	0	0.7	0.7
Feb	0	0.7	0.7
Mar	0.4	0.7	1.1
Apr	3.0	4.2	7.2
May	1.5	1.4	2.9
Jun	2.4	1.4	3.8
Jul	2.2	1.4	3.6
Aug	2.2	1.4	3.6
Sep	1.7	1.4	3.1
Oct	1.1	1.4	2.5
Nov	0.2	1.4	1.6
Dec	0	0.7	0.7
ANNUAL	1.2	1.4	2.6

*Estimates using Meyer Model
**Estimates using SLAEM Model. It was assumed that one-half of the seepage freezes in the mine in December, January, February, and March and melts during April.
***cfs - cubic feet per second

TABLE 5.9

**AVERAGE LEAF LAKE
WATER SURFACE LEVELS
(Feet)**

Month	Historical*	Modeled Existing Conditions**	Modeled Ultimate Mine Conditions**
Jan	1388.33	1390.00	1390.22
Feb	1388.33	1389.98	1390.20
Mar	1388.40	1390.06	1390.37
Apr	1388.80	1390.61	1391.86
May	1388.90	1390.19	1390.92
Jun	1388.71	1390.26	1391.14
Jul	1388.52	1390.14	1391.02
Aug	1388.40	1390.09	1391.01
Sep	1388.36	1390.07	1390.91
Oct	1388.38	1390.14	1390.82
Nov	1388.39	1390.03	1390.52
Dec	1388.37	1389.99	1390.23
ANNUAL	1388.49	1390.13	1390.77

*1949-1979 averages
**Modeled using 1933-1986 climatic data

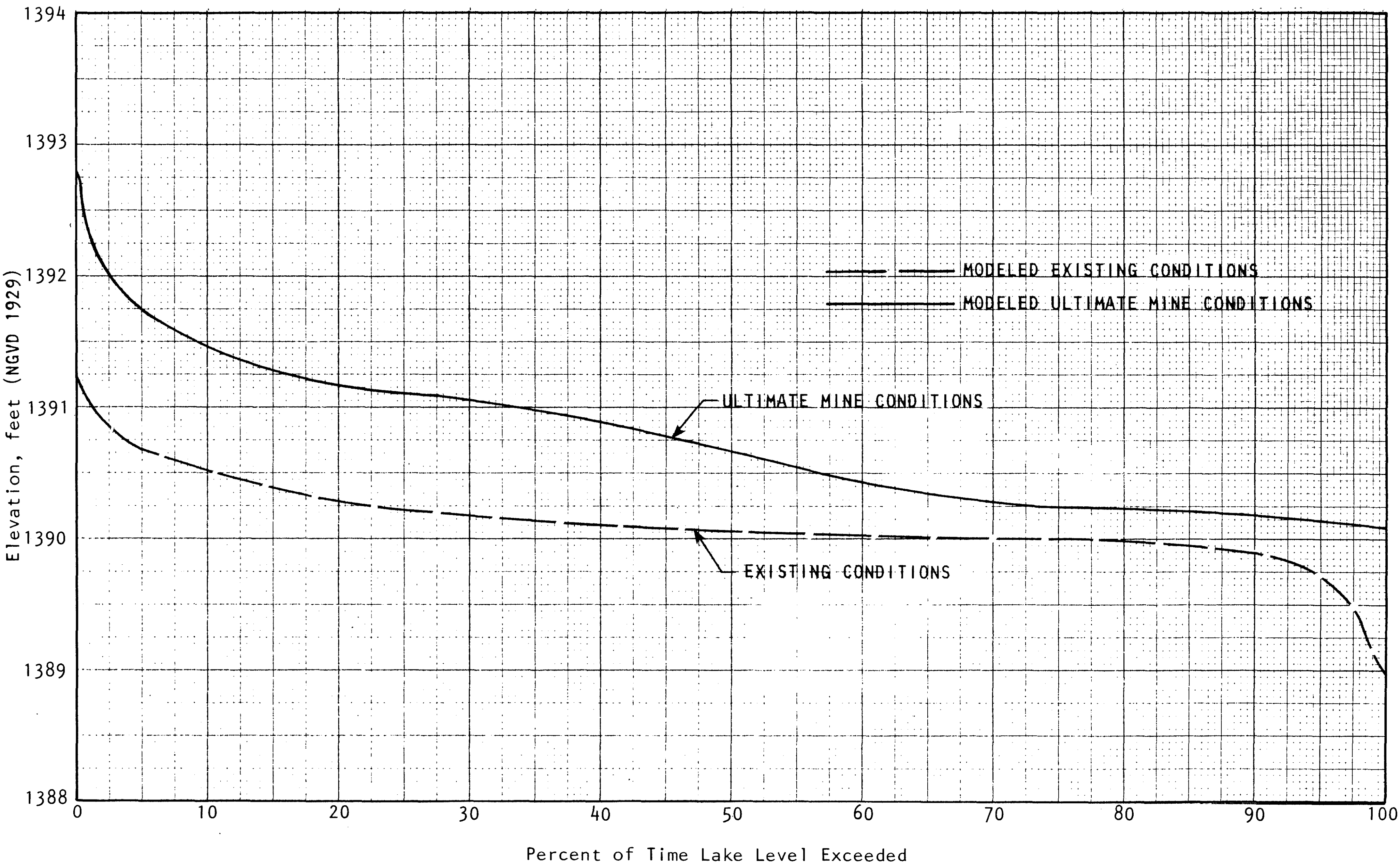


Figure 5.3

MODELED LAKE LEVELS
WATER LEVEL-DURATION CURVES
Leaf Lake

plugging occurred in the outlet. Winter levels would rise only about 3 inches. The largest monthly average water level rise would be 15 inches in April. The duration curves were developed assuming that no beaver activity or other blockage occurs between Leaf Lake and the outlet culvert.

The water balance analysis assumed that pumping from the pit was continuous throughout the year. If pumping were discontinued for an extended period of time, the Leaf Lake level would drop close to existing levels.

Dewatering Route

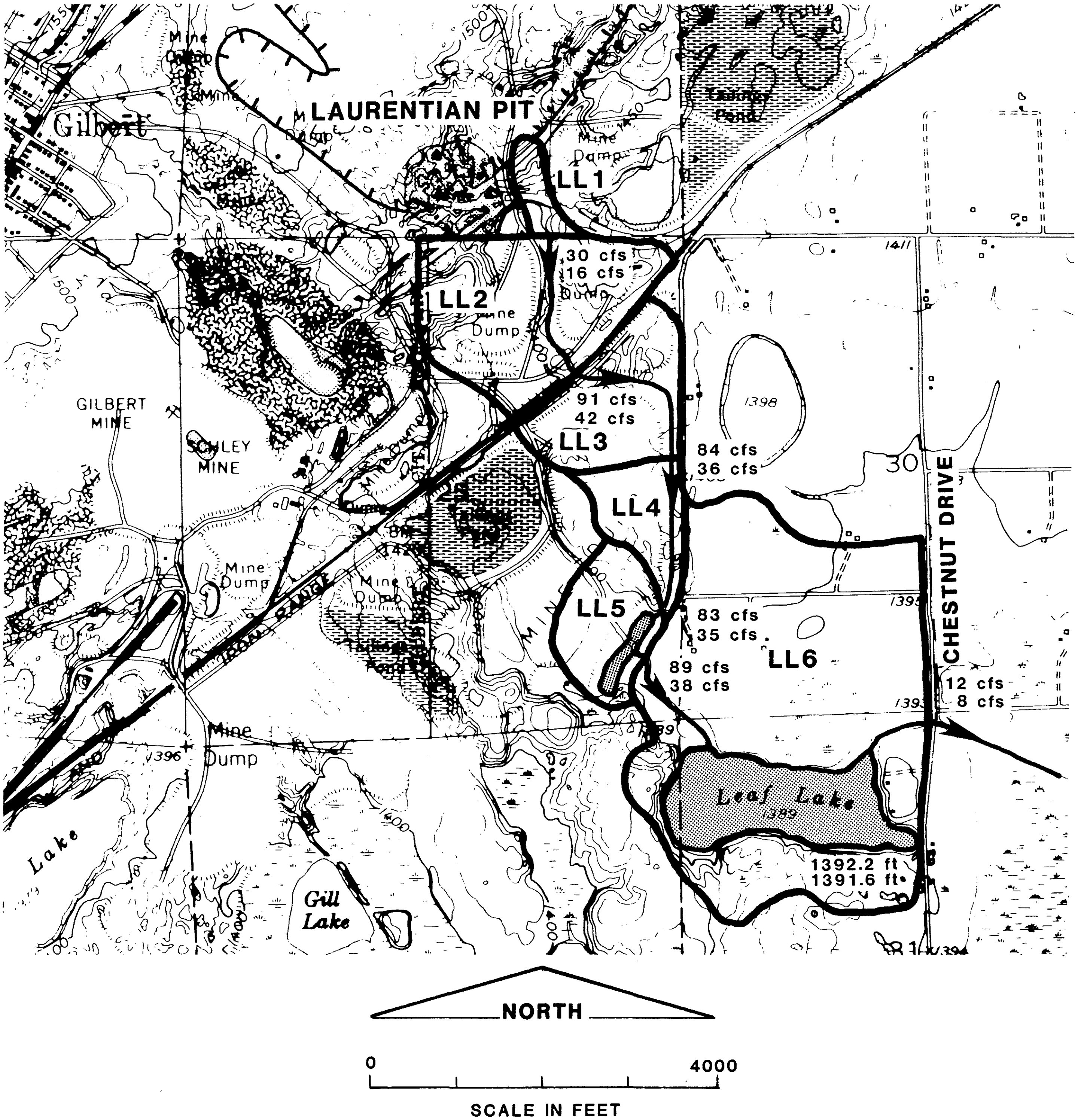
The water budget for the Laurentian Mine and Leaf Lake show that the volume of water that would flow through the proposed dewatering ditch would be greatly increased over existing conditions due to mine dewatering. The average mine dewatering flows through the ditch would still be relatively small when compared to the ditch capacity, but the ditch also has to convey flows from rainstorms. Therefore, the dewatering path was analyzed using three flow conditions:

1. Normal flow during dewatering;

2. Peak discharge during the 10-year, 24-hour storm (one chance in ten that a storm with that much precipitation falling in 24 hours will occur in any given year) during normal mine dewatering; and

3. Peak discharge during the 100-year, 24-hour storm (one chance in 100 that a storm with that much precipitation falling in 24 hours will occur in any given year) during normal mine dewatering.

A discharge rate of approximately 3 cubic feet per second (cfs) (Table 5.8) was assumed for normal mine dewatering flows. The Soil Conservation Service's TR-20 computer model was used to develop hydrographs (discharge versus time relationships) for the 10-year and 100-year, 24-hour events. The subwatersheds used in the analysis are shown in Figure 5.4. The normal discharge of 3 cfs was added to the peak discharges computed from TR-20 for the two storms.



Laurentian Taconite Mine
DRAFT ENVIRONMENTAL IMPACT STATEMENT
MINNESOTA DEPARTMENT OF NATURAL RESOURCES

Top Number	**100 Year Discharge or Water Level**
Bottom Number	**10 Year Discharge or Water Level**
———	**Dewatering Flow**
━━━	**Subwatershed Divide**
LL2	**Subwatershed Name**

Figure 5.4

MINE DEWATERING ROUTE FLOWS

The hydrologic information used as input to TR-20 for each of these subwatersheds is shown in Table 5.10. The SCS Type II storm distribution and Antecedent Moisture Conditions 2 (AMC 2) were used in the analysis. The 10- and 100-year, 24-hour events consist of 3.6 and 5.1 inches of rainfall in a 24-hour period, respectively, in the area of the proposed mine. A starting elevation of 1390.8 (which is the approximate average water surface elevation for the lake shown in Table 5.9 for the ultimate mine analysis) was assumed for the storage routing through Leaf Lake.

Figure 5.4 shows the peak discharge produced during the two storm events. The figure also shows the peak water level of Leaf Lake during each of these events. The existing outlet culvert from Leaf Lake under Chestnut Drive was assumed to be unaltered. Assuming that the existing culvert is unplugged and that downstream conditions do not restrict flow from the culvert, the road over the culvert (Chestnut Drive) would not be overtopped during the flood events examined. However, with current conditions some overtopping could occur. The existing pipe is partially plugged and water levels in the ditch immediately downstream could further restrict flows through the pipe; sediment and debris, which could impede flow and raise water levels, have been found in the ditch downstream. Therefore, clearing these obstructions is proposed in Section 6.

Table 5.11 shows the water depths and average velocities for the three flow conditions for the existing ditch at the three cross sections plotted in Figure 4.11 and locations shown in Figure 4.10 (in Section 4). The results show that the existing ditch would be able to convey all of the modeled flows, including the peak discharge from the 100-year rainfall event, assuming no flow obstructions occur in the ditch. The hydraulic analysis assumed that culverts are placed at ditch crossings that are large enough to minimize energy loss (therefore, minimizing backwater effects) at the crossings.

Currently, there are several locations that do not have culverts to convey the flow. These locations are the two roads adjacent to the DM&IR railroad tracks and the dike between the sedimentation pond and Leaf Lake. The hydrologic/hydraulic analysis of the ditch assumed that the two road crossings were provided with culverts or were removed, and that the sedimentation pond dike is provided with an outlet. These assumptions are valid since the current crossings and the dike are flow obstructions, which would have to be mitigated. If culverts without the hydraulic capacity necessary to convey the

TABLE 5.10

DEWATERING DITCH HYDROLOGIC DATA

Subwatershed*	Area (Acres)	SCS Curve Number	Time of Concentration (hours)
LL1	9.9	70	0.15
LL2	80.4	64	0.73
LL3	46.8	54	0.67
LL4	23.9	54	0.96
LL5	34.6	50	0.49
LL6 (excluding lake)	265.8	75	0.59
LL6a (Leaf Lake)	49.6	100	0.0

*See Figure 5.4

TABLE 5.11

DEWATERING DITCH CROSS SECTION DATA*

Event	Discharge (cfs)***	Depth of Flow (feet)	Velocity (feet/second)
Cross Section 1			
Normal	3.0**	0.3	0.5
10-Year	16	0.9	0.9
100-Year	30	1.3	1.2
Cross Section 2			
Normal	3.0**	0.3	0.4
10-Year	42	1.4	1.2
100-Year	91	2.1	1.6
Cross Section 3			
Normal	3.0**	0.3	0.5
10-Year	35	1.5	1.3
100-Year	83	2.3	1.7

*Assumes Manning's Roughness Coefficient ("n") = 0.08
**Includes approximately 0.4 cfs average flow plus 2.6 cfs mine dewatering discharge
***cfs - cubic feet per second

modeled flows were used, some backwater effects would occur and overtopping of the ditch might be possible during higher flows at some locations.

The capacity of the existing culverts along the ditch, assuming the pipes flow full, is given in Table 4.11. A comparison of the capacities in Table 4.11 and the discharges given in Table 5.11 and Figure 5.4 shows that the culverts under TH 135 and the railroad tracks should be adequate to convey the 100-year discharge. The two 15-inch culverts immediately upstream of the sedimentation pond have inadequate capacity to convey the 10- or 100-year discharges without substantially raising upstream water levels and possibly overflowing the ditch banks at the current overflow location discussed in Section 4.

Along most of its length, the ditch currently has trees and brush growing on the bottom and side slopes. The hydraulic analysis discussed above assumed these trees were in place (Manning's Roughness Coefficient "n" = 0.08), but that no channel plugging occurred. These trees would likely become flow obstructions in the ditch because they would catch floating debris, vegetation, and ice. Therefore, the water levels would most likely be higher than those given in Table 5.11 if the ditch were not cleaned out.

Ditch Erodibility

Table 5.12 lists the depths and velocities in the ditch at the three cross sections assuming that the ditch would be cleaned out and the trees removed along its entire length (Manning's Roughness Coefficient "n" = 0.04). These assumptions produce the highest channel flow velocities. All the average channel velocities are less than 3 feet per second (fps). According to the U.S. Corps of Engineers EM 1110-2-1601, the allowable average velocities for silt-clay and gravel are 3.5 and 6.0 fps, respectively. These soil types are what would be expected in the ditch. Therefore, there should not be a problem with erosion along the ditch.

TABLE 5.12

CROSS SECTION DATA ASSUMING DITCH HAS BEEN CLEANED OUT AND TREES REMOVED*

Event	Discharge (cfs)***	Depth of Flow (feet)	Velocity (feet/second)
Cross Section 1			
Normal	3.0**	0.2	0.7
10-Year	16	0.6	1.4
100-Year	30	0.9	1.8
Cross Section 2			
Normal	3.0**	0.2	0.6
10-Year	42	0.9	1.8
100-Year	91	1.4	2.4
Cross Section 3			
Normal	3.0**	0.2	0.7
10-Year	35	1.0	2.0
100-Year	83	1.6	2.7

*Assumes Manning's Roughness Coefficient ("n") = 0.04
**Includes approximately one-half cfs average flow plus 2.6 cfs mine dewatering discharge
***cfs - cubic feet per second

No-Build Impacts

Surface water conditions would remain unchanged from those described in Section 4 if the Laurentian project were not developed.

Groundwater

Project Impacts

The proposed Laurentian Mine would require the removal of groundwater to the ultimate pit depth (an elevation of approximately 850 feet, MSL or a maximum depth of about 570 feet). There will be localized reductions in groundwater levels in both the Biwabik Iron Formation and the glacial drift, the two productive groundwater sources in the area.

No wells in the area would be adversely affected by mine or road construction and operation. The only concern is whether lower groundwater levels, due to construction and dewatering of the mine pit, would lower the levels of surrounding lakes. It was found that the reduced groundwater levels would probably lower Lake Orebegone 1 foot when the pit is at its ultimate depth and extent. Likewise, it was found that lower groundwater levels would probably lower the Corsica Pit (McKinley's water supply) 3 feet when the Laurentian Mine is at its ultimate depth and extent. Groundwater levels at White Lake would probably be lowered by 6 feet, but the lake's water level drop may be considerably less, depending on the permeability of the lake's bottom sediments and underlying glacial till. Leaf Lake would probably not be detectably affected by lower groundwater levels. At the completion of mining, the proposed Laurentian Mine pit would fill with water and local groundwater elevations would return to pre-mining conditions.

To obtain a detailed estimate of potential adverse impacts, a groundwater flow model was developed that simulates groundwater conditions with and without mining. Such a model is the only reliable method that can account for spatial variations in aquifer parameters, effects of infiltration from lakes and streams, and variations in groundwater flow due to geology. The methodology for the groundwater modeling is described next, followed by the detailed results.

1. Methodology

The Single Layer Analytic Element Model (SLAEM), developed by Professor Otto Strack of the University of Minnesota, was used to construct a groundwater flow model of the area near the proposed Laurentian Mine. After calibration to current groundwater flow conditions, the model was used to predict the effects on groundwater flow and groundwater elevations resulting from mine construction and operation.

The model's input parameters were the existing hydrogeologic data on the Biwabik Iron Formation and glacial drift, results of the Meyer Model water balance for lakes near the proposed mine, and some of the climatologic and geologic parameters discussed in Section 4. Where possible, actual hydrogeologic data from the area were used. When specific types of hydrogeologic data were unavailable, assumptions were made based on engineering judgment and experience to estimate a possible range of parameter values. The sensitivity of the model's results to variations in parameters within expected ranges was examined.

Modeling Assumptions

1. The resistance to groundwater flow vertical to the earth's surface is assumed to be negligible. Experience has shown that this assumption is usually valid.

2. The base of the glacial drift is assumed to be at Elevation 1,350 feet above mean sea level, which is the approximate elevation of the bedrock-drift contact at the Mariska Pit (Winter, et al., 1973).

3. The base of the Biwabik Iron Formation is assumed to be at Elevation 750.

4. Ely Lake, St. Mary's Lake, Deep Lake, and Esquagama Lake are considered sufficiently deep to be in direct contact with the aquifer. Analytic elements called "line sinks" were used to model these features by specifying the elevation of the lakes. The Embarrass River and the St. Louis River were also modeled with head-specified line sinks. Elevations were taken from U.S. Geological Survey maps.

5. Lake Orebegone, the Corsica Pit, the Mariska Pit, Leaf Lake, Lost Lake, White Lake, and unnamed ponds near the proposed mine were modeled using analytic elements called "areal elements," which simulate hydrologic interaction with the groundwater without fixing the groundwater elevations of the aquifer. Areal elements were used because they can more realistically simulate changes in groundwater

flow due to the effects of dewatering, such as dewatering of the Laurentian Mine. Estimates of groundwater recharge from the lakes were obtained from the Meyer Model water balance analyses.

6. A "leaky wall" analytic element was used to simulate groundwater flow through the thin glacial drift overlying the Pokegama Quartzite and the Giants Range Granite up to the Laurentian Divide. A seepage rate of about 4 feet/day over the thickness of the drift was calculated, assuming a recharge value of 5 inches/year and a distance from the Biwabik Iron Formation-Pokegama Quartzite contact to the Laurentian Divide of about 3,000 feet.

7. Modeling results are assumed to represent steady-state conditions.

8. The groundwater system is assumed to be of infinite areal extent.

9. The groundwater flow system can be treated as a porous medium or equivalent porous medium.

Model Calibration

Calibrating groundwater models is generally achieved by varying hydrologic parameter values within expected ranges until the simulated groundwater levels (piezometric surface) closely match observed groundwater levels. Calibration procedures for the SLAEM model are somewhat more sophisticated because not only are simulated and observed groundwater levels matched, there must also be a water balance between surface infiltration (from lakes and direct precipitation) and groundwater outflows (to wells, mine pits, rivers, etc.).

There are no available data on groundwater level measurements in the vicinity of the proposed Laurentian Mine. However, the groundwater surface is typically 10 to 25 feet below the ground surface throughout the region (Winter, et al., 1973) and large lakes and rivers represent surface expressions of the water table. By using the ground surface elevation as a guideline, along with the lake and river elevations, a good approximation of the current groundwater surface can be estimated for purposes of model calibration.

The SLAEM groundwater model was calibrated to the estimated groundwater surface by using initial guesses for the values of aquifer parameters, along with calculated infiltration values obtained from the results of the Meyer Model water balance for White Lake, Corsica Pit, Leaf Lake, and Lake Orebegone. A close match to the estimated groundwater surface was achieved with the first approximation of aquifer parameters. The hydraulic conductivity values for the glacial drift and the Biwabik Iron Formation, along with the value of infiltration due to direct precipitation, were varied slightly to achieve the best match between simulated groundwater levels and the estimated groundwater surface. Checks were performed to verify that inflow and outflow rates from lakes and rivers represented realistic or expected values. In a few instances during the calibration process, additional lakes and rivers some distance from the proposed mine location were put into the model to extend the model area because their inclusion yielded a better simulated groundwater surface. Figure 5.5 shows the layout of some of the analytic elements used in the calibrated model.

Calibrated SLAEM Model Aquifer Parameters

The following aquifer parameters were arrived at through calibration of the SLAEM model:

1. The average hydraulic conductivity of the glacial drift was found to be 150 feet/day for the calibrated model. This value of hydraulic conductivity is approximately the same as that calculated from data found in Winter, et al. (1973, Plate 2B) for a test hole approximately 1 mile east of Gilbert.

2. The average hydraulic conductivity of the Biwabik Iron Formation was initially assumed to range from 0.1 to 1.0 feet/day. Varying the hydraulic conductivity of the formation was found to have little effect on calibration. This range of hydraulic conductivity values is within the range of values described by Siegel and Ericson (1980) for altered portions of the Biwabik Iron Formation. Altered portions of the formation are expected to have higher hydraulic conductivity values than unaltered portions. By using hydraulic conductivity values for altered portions of the formation, the predicted effects of the mine may

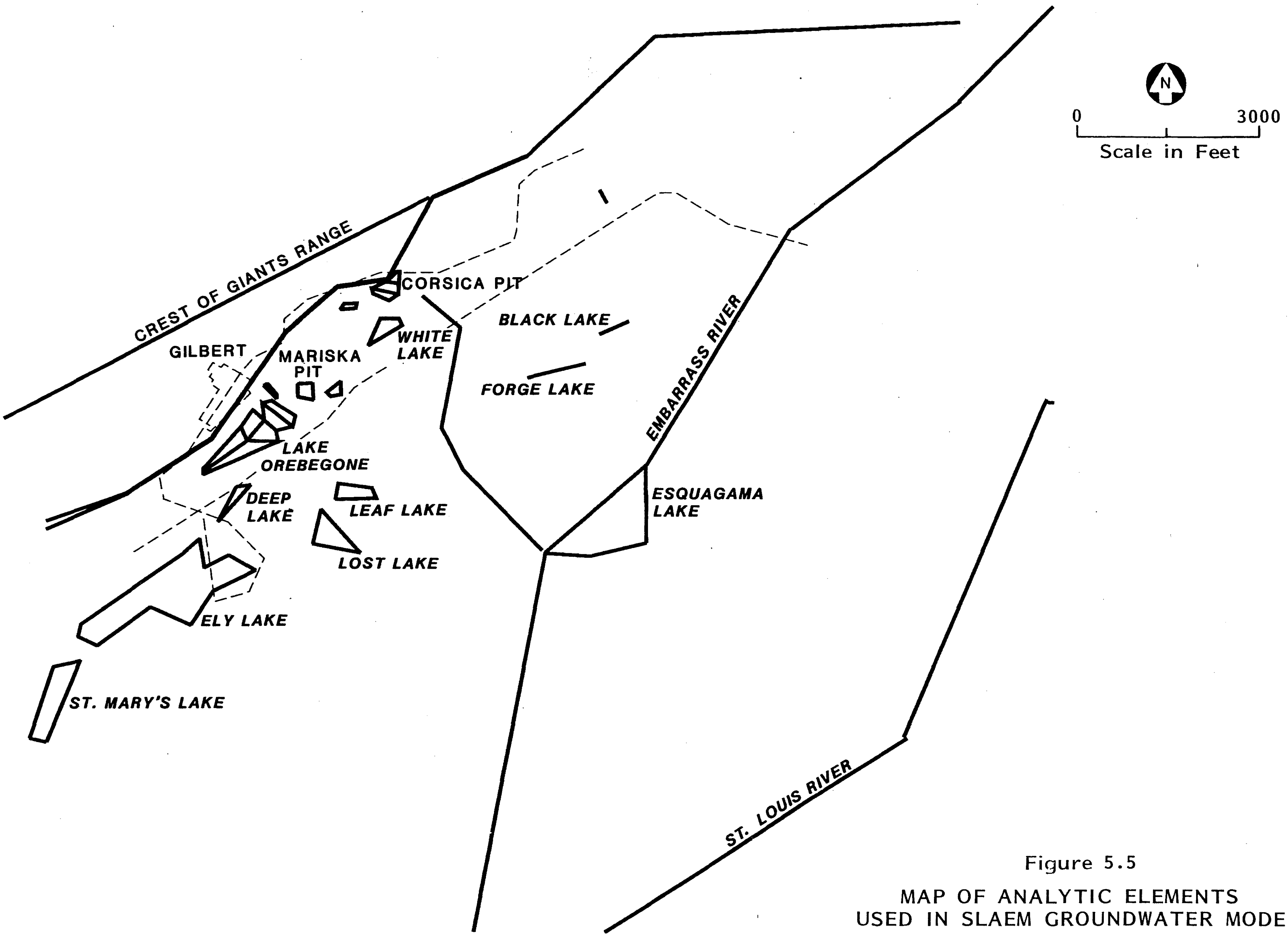


Figure 5.5

MAP OF ANALYTIC ELEMENTS
USED IN SLAEM GROUNDWATER MODEL

be slightly overestimated (i.e., the predicted lowering of the water table in the mine vicinity may be slightly overestimated).

3. Infiltration from direct precipitation was found to be 4.4 inches/year for the calibrated model. Winter, et al. (1973) indicate that infiltration is about 5 inches/year.

4. The results of the Meyer Model water balance yielded values for infiltration into the groundwater from Lake Orebegone of 18 inches/year, from White Lake of 29 inches/year, and from the Corsica Pit of 20 inches per year. These values were not changed during calibration.

5. There were no pumping wells in the vicinity of the proposed Laurentian Mine that needed to be accounted for. McKinley's water supply withdrawal from the Corsica Pit was accounted for in the water balance calculations.

2. Results

The groundwater impacts of the proposed Laurentian Mine were analyzed by introducing analytic elements that set the groundwater elevation equal to the elevation of the pit bottom into the calibrated SLAEM model to simulate the mine pit. The maximum depth of the pit was assumed to be 850 feet, MSL.

Figure 5.6 shows the predicted effects that the ultimate mine pit will have on groundwater levels in the vicinity of the proposed Laurentian Mine, assuming that steady-state conditions have been reached. The effect of the pit on groundwater levels will not be as great if steady-state conditions have not been reached. Flow paths are shown in Figure 5.6 to illustrate where groundwater entering the pit is coming from. The model predicts that water entering the pit will come from the Laurentian Divide, the Corsica Pit, Lake Orebegone, and White Lake. The model predicts that the required dewatering rate of the ultimate pit will be in the range of 625 to 720 gpm due to groundwater flowing into the pit.

Figure 5.7 shows the predicted decrease in groundwater levels from current conditions due to dewatering the ultimate pit. Several simulations were performed to account for the possible range in hydraulic conductivity of the Biwabik Iron Formation

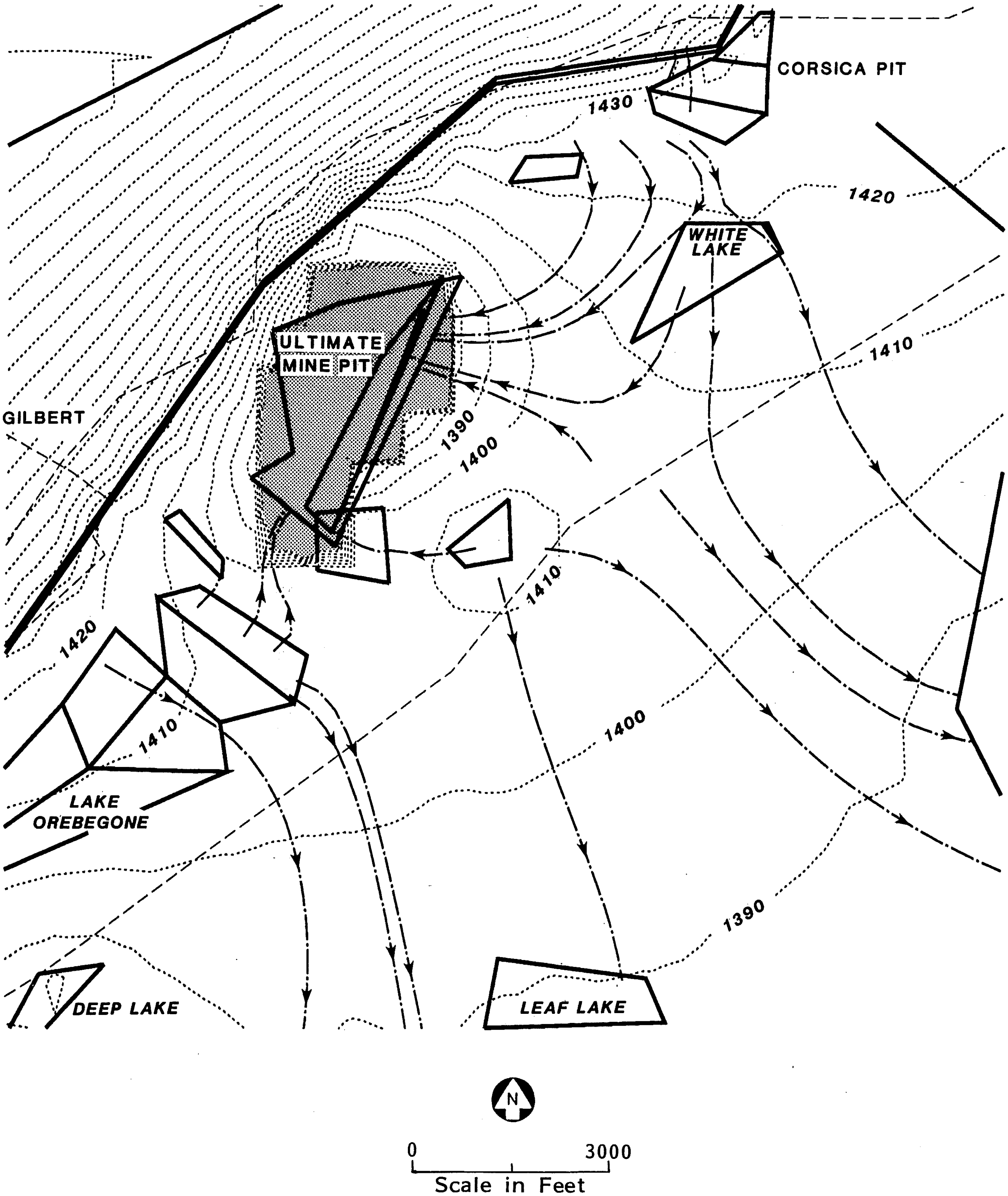


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Figure 5.6

MAP OF SIMULATED GROUNDWATER ELEVATIONS
(FEET, NGVD 1929)
FOR ULTIMATE MINE PIT CONDITIONS

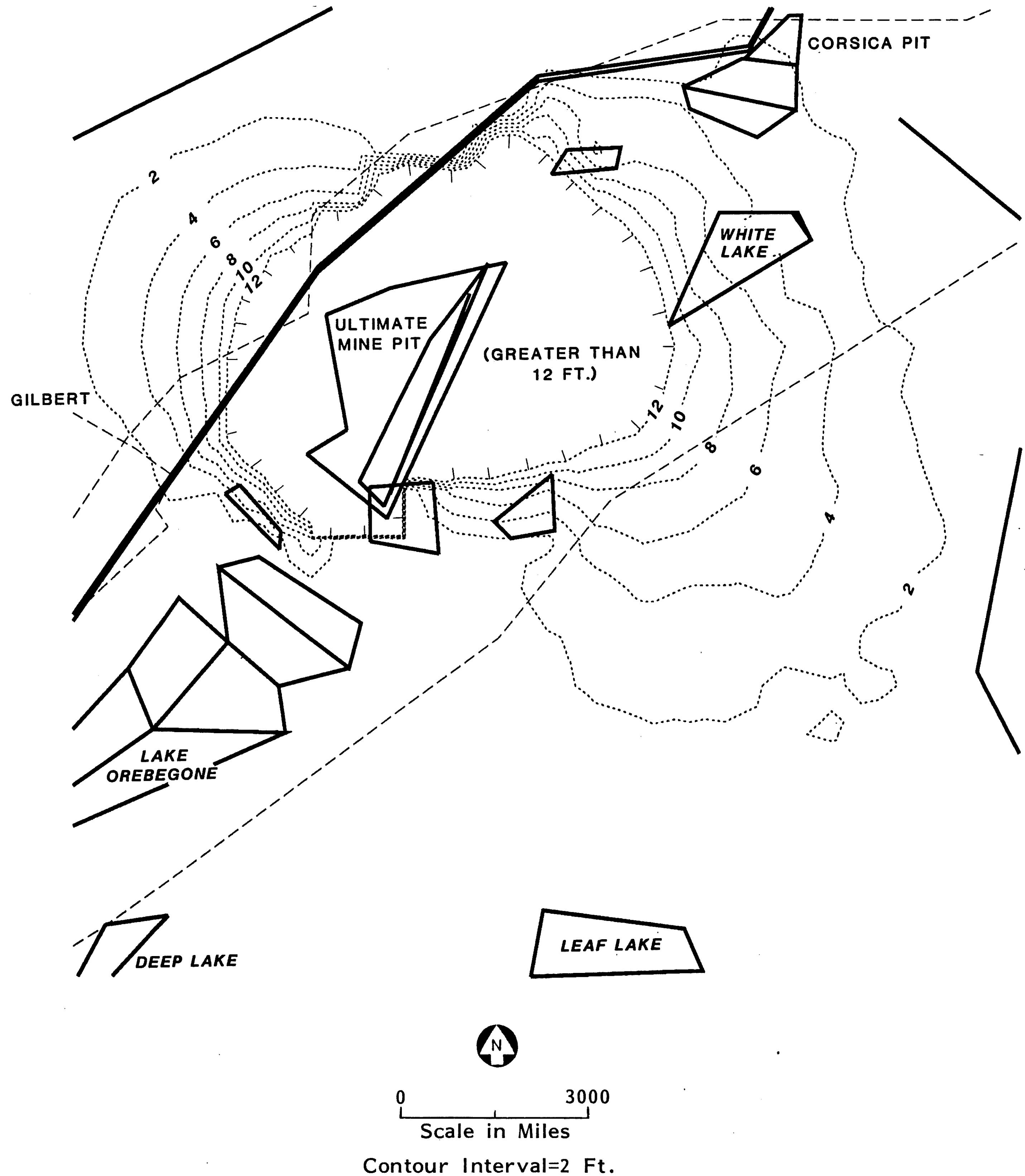

Figure 5.7

MAP OF GROUNDWATER ELEVATION CHANGE (FEET) DUE TO DEWATERING OF ULTIMATE MINE PIT

(0.1 to 1.0 feet/day) and the possibility of no surface water outflow from White Lake. Predicted groundwater levels adjacent to the lakes are summarized below. No significant changes in groundwater levels are expected adjacent to other major lakes in the area.

Lake	Expected Change in Groundwater Level	Potential Range in Groundwater Level
Lake Orebegone	1 foot	0.5 to 1 foot
Corsica Pit	3 feet	2 to 5 feet
White Lake	6 feet	3 to 10 feet
Leaf Lake	No change	No change

The above predicted changes in groundwater levels adjacent to the lakes may translate directly to changes in lake levels for Lake Orebegone and the Corsica Pit because their great depth provides for direct hydraulic connection with the groundwater.

White Lake is not very deep in comparison to other lakes in the area and is probably not in direct hydraulic connection with the groundwater, so water levels in White Lake will probably not drop as much as groundwater levels adjacent to the lake. If White Lake contains fine-grained bottom sediments or the glacial till is not very permeable underneath the lake, the drop in lake level may be small or negligible. There is not enough information on the bottom sediments of White Lake to actually determine how much of a drop in lake levels may occur, but the average lake levels cannot drop below the groundwater level.

The relatively small predicted drop in the groundwater level adjacent to Lake Orebegone may seem surprising, given that Lake Orebegone is very close to the proposed ultimate pit. The model indicates that the groundwater flow from Lake Orebegone to the ultimate pit will be 60 to 70 gpm, which is roughly 10 percent of the predicted dewatering rate of the ultimate pit but only about 30 percent of the estimated surface water yield to Lake Orebegone. The relatively small predicted drop in groundwater level for Lake Orebegone can probably be attributed to the lake's large surface and watershed areas, which provides for considerable surface water inflow to offset the effects of mine dewatering.

A search of the Minnesota Geological Survey well records was conducted to determine if any domestic or municipal wells existed within the area of groundwater level decrease predicted by the SLAEM model. The search did not disclose any wells within the area of predicted groundwater impacts.

Groundwater impacts resulting from the haul road were estimated based on an understanding of the geologic and hydrogeologic setting along the proposed route. The haul road would cross an area of thin glacial drift overlying very low-permeability bedrock of Pokegama Quartzite and Giants Range Granite. Neither the glacial drift nor the bedrock over which the road would be constructed are significant or potential sources of groundwater because the glacial drift is usually much less than 25 feet thick and the bedrock formations are too impermeable to yield useable quantities of groundwater. The potential impact to groundwater resources resulting from the haul road are therefore expected to be negligible.

It is assumed that when mining is completed, dewatering of the mine would cease. Water levels in the mine would gradually rise to a level near the pre-mining groundwater level. As mine water levels rose, groundwater inflows from the surrounding area would decline and groundwater levels would rise. When the mine water level stabilized, groundwater levels at nearby lakes affected by mining would be expected to return to their pre-mining levels.

No-Build Impacts

The no-build alternative would not affect existing groundwater flow conditions and groundwater levels.

The methodology for modeling groundwater impacts if the mine were not built is described in the previous section on project impacts.

Groundwater flow conditions for the no-build alternative can be represented by the SLAEM model's groundwater levels calibrated to current conditions. Figure 5.8 shows the calibrated groundwater surface, representing conditions before the construction of the proposed Laurentian Mine.

Primary groundwater recharge occurs in the upland areas of the Giants Range, south of the Laurentian Divide. Groundwater flows steeply southeast through the glacial drift overlying the Giants Range Granite and the Pokegama Quartzite. The hydraulic gradient flattens considerably over the Biwabik Iron Formation, due primarily to the increasing thickness and increasing hydraulic conductivity of the glacial drift and

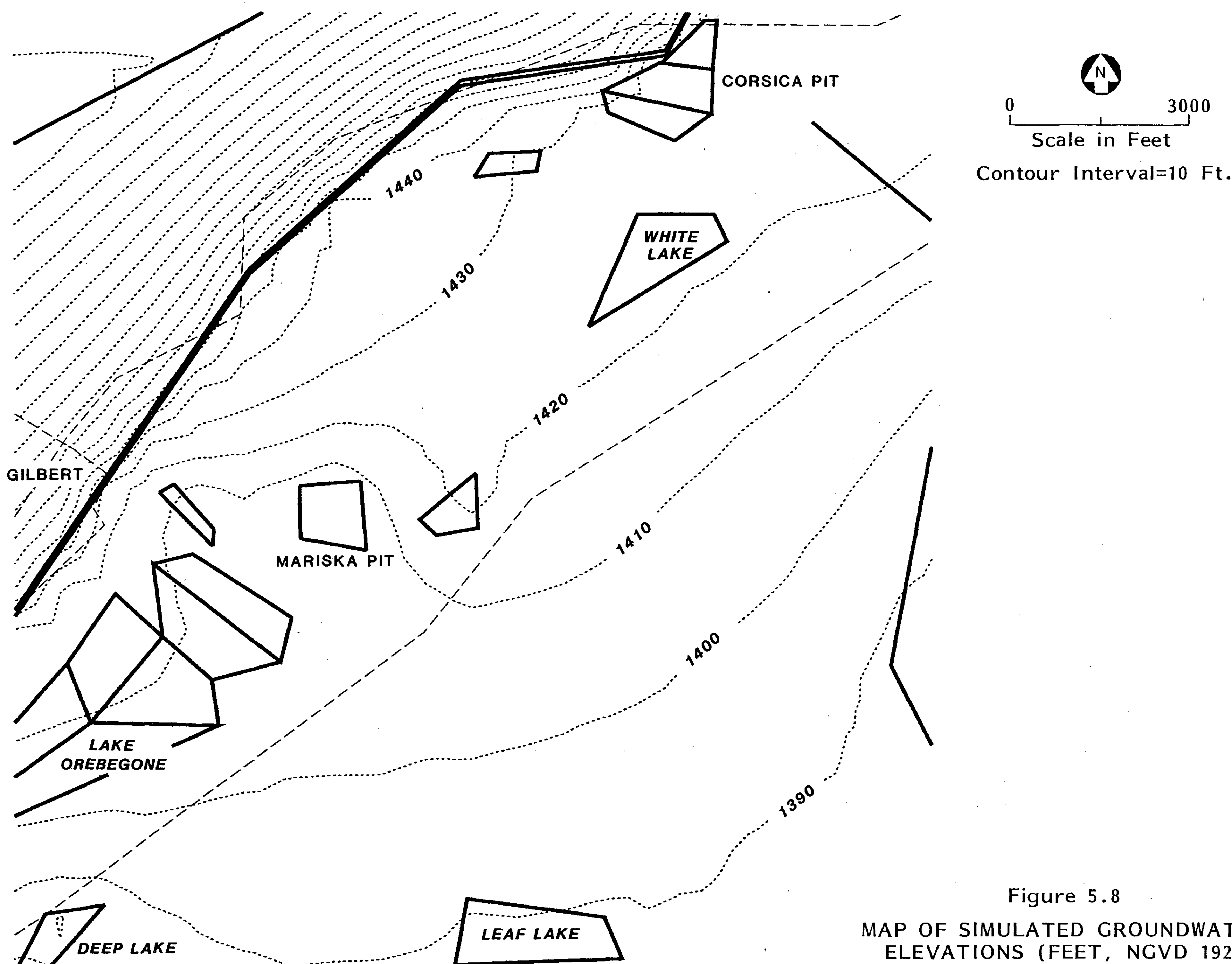

Figure 5.8

MAP OF SIMULATED GROUNDWATER ELEVATIONS (FEET, NGVD 1929) CALIBRATED TO EXISTING CONDITIONS the relatively higher hydraulic conductivity of the Biwabik Iron Formation, compared to the Pokegama Quartzite and the Giants Range Granite.

The groundwater flow direction is to the southeast from the Laurentian Divide toward the Embarrass River. The groundwater is further recharged by various lakes near the Laurentian Divide that receive surface flows. Discharge appears to occur primarily in the vicinity of the Embarrass River. The conditions depicted in Figure 5.8 represents steady-state groundwater flow.

Some of the groundwater in the Biwabik Iron Formation likely flows southeast under the Virginia Argillite. It is not possible to obtain a reliable estimate on how much groundwater flows under the Virginia Argillite. Because the Biwabik Iron Formation is probably only slightly altered below the Virginia Argillite, the quantity of groundwater flowing under the argillite in the Biwabik formation is probably small compared to groundwater flow in the exposed section of the Biwabik formation and glacial drift.

Water Quality

Project Impacts

There are three principal water quality concerns associated with the construction and operation of the proposed Laurentian Taconite Mine:

1. Summer water quality conditions (total phosphorus and chlorophyll *a* concentrations, water transparency, and hypolimnetic oxygen depletion).

2. Winter oxygen depletion (winter fish kill conditions).

3. Sedimentation due to erosion caused by stormwater runoff.

The first two concerns pertain exclusively to lake water quality, while the third concern relates primarily to the effects of the haul road on the Pike River's water quality. All three water quality concerns are long-term problems that would require mitigation. The short-term impacts associated with mine and haul road construction are expected to center on sedimentation caused by the erosion of disturbed ground and unvegetated road embankments. Separate, temporary mitigation measures would also be required to prevent these short-term, construction impacts.

This section of the Draft EIS describes the water quality impacts of the proposed mining operations as they reach their ultimate development. The water quality of area lakes is expected to be intermediate, between current and ultimate conditions, as mining operations proceed. The estimated impacts may be partially mitigated through the use of watershed Best Management Practices (BMPs).

Analyses conducted as part of this Draft EIS indicate that the proposed project would degrade Leaf Lake's water quality somewhat. The water quality of White Lake would likely remain at its present level, and the quality of the Corsica Pit's water would improve in terms of its phosphorus concentrations, algal abundances, and water transparencies. The base flow water quality of the Pike River would be protected at current levels, provided Best Management Practices are used to control runoff from the proposed haul road. Despite the use of BMPs, stream water quality may be temporarily degraded by runoff during large storm events and during periods of snowmelt runoff.

1. Methods

Very little water quality data are available for the three lakes potentially affected by the proposed project, so conclusions regarding the effects of mining activities on lake water quality must be based on nutrient budget estimates and mass balance modeling analyses. This section of the Draft EIS reports the results of such analyses.

Phosphorus Budgets

Estimated phosphorus budgets were constructed for Leaf Lake, White Lake, and the Corsica Pit lake, all potentially affected by the proposed mining activities. These estimates are based on nutrient export rate coefficients applied to areas of corresponding land use within the lakes' watersheds. The phosphorus export rate coefficients developed by Uttormark and Wall (1976) for northern Wisconsin were used in this assessment. Table 5.13 lists these coefficients adapted for use in this Draft EIS.

A literature search failed to produce a phosphorus export rate coefficient for unvegetated stockpiles. Consequently, the export rate coefficient for agricultural land use was used to estimate phosphorus export from unvegetated stockpiles of overburden, waste rock, and lean ore. It was rationalized that the land disturbed by mining activities, and the unvegetated stockpiles, were most closely analogous to the agricultural land use category. The phosphorus export rate for agricultural land use is 50 percent higher than the corresponding rates for forest and open land use categories. This analysis is conservative in the sense that the estimated phosphorus yields from the disturbed mine site are unlikely to exceed the rate from a similarly sized agricultural watershed where fertilizer is added. Phosphorus, both naturally occurring and fertilizer-derived, is normally tightly adsorbed (attached) to soil particles. Therefore, phosphorus export from either unvegetated stockpiles or from agricultural lands would be largely associated with the movement of particulates.

This assessment also assumes that the atmospheric contributions (precipitation and dry fallout) of phosphorus to lakes averages 0.56 kg/ha (0.5 lbs/acre) of lake surface. Literature values for atmospheric phosphorus additions to lakes range from 0.1 to 1.0 kg/ha annually (Tetra Tech, 1982).

TABLE 5.13

PHOSPHORUS EXPORT COEFFICIENTS FOR NORTHERN MINNESOTA WATERSHEDS (Adapted from Uttormark and Wall, 1976)

Land Use	Phosphorus Export (kg/ha/yr)
Urban	1.0
Agricultural (≃ Unvegetated Stockpiles)	0.3
Forest	0.2
Open	0.2
Wetlands	0.0
Cottages	0.2 kg/yr

In-Lake Water Quality

The summer water quality of northern Minnesota lakes is inversely related to the abundance of phytoplanktonic algae. Algal abundance, in turn, is related to the concentration of phosphorus in lake waters. Water transparency declines as algal abundance increases in response to higher phosphorus concentrations. These relationships are well established in limnological literature and are often used in conjunction with phosphorus mass balance analyses that are performed for lakes where phosphorus is the element controlling algal abundance. Based on the water quality data available, algal growth in Leaf Lake, White Lake, and the Corsica Pit lake all appear to be phosphorus limited. The observed total nitrogen to total phosphorus ratios of their waters all exceed the threshold value of 12, indicative of phosphorus limitation. This is typical of northern Minnesota lakes.

One of the most commonly used phosphorus mass balance models is the Dillon and Rigler (1974) model:

$$[P] = \frac{L\,(1-R_p)}{\bar{z}\,\rho}$$

where: [P] = steady state phosphorus concentration (mg/L)

L = areal phosphorus load ($gP/m^2/yr.$)

R_p = phosphorus retention coefficient (Chapra, 1975)
= $16/(q_s + 16)$
[The value 16 is an empirically determined apparent settling rate (m/yr)]

q_s = areal water load; lake outflow divided by surface area (m/yr.)

$\bar{z}$ = mean depth (m)

ρ = flushing rate ($year^{-1}$); number of basin volumes of water that pass through the lake each year

This model was used with estimated phosphorus budgets and simulated watershed hydrology to calculate in-lake total phosphorus concentrations for the lakes considered in this Draft EIS. Calculated phosphorus concentrations correspond to average in-lake conditions during spring circulation (overturn) since the model assumes a completely mixed system.

Since the phosphorus mass balance model predicts phosphorus concentrations at spring overturn, it will seriously underestimate mid-summer conditions in lakes such as Leaf and White, where internal phosphorus loading from anoxic sediments is significant. Therefore, to estimate the mid-summer total phosphorus concentration of each of these lakes, an incremental phosphorus concentration, equal to the phosphorus released from its anoxic sediments, over an assumed 100-day stratification period, divided by the lake volume, was calculated and added to previously calculated spring phosphorus levels. An assumed areal phosphorus release rate of 10 $mg/m^2/day$ was applied to anoxic sediments below the 15-foot depth contour in this analysis.

After estimating in-lake phosphorus concentrations, regression equations developed by the MPCA (Heiskary and Wilson, 1988) were used to predict average summer chlorophyll *a* based on average summer total phosphorus concentrations, and average summer transparencies (Secchi disc) based on average summer chlorophyll *a* concentrations, as follows:

$$\text{Log}_{10} \text{ Chl } a = 1.45 \text{ Log}_{10} \text{ TP} - 1.18, \ (R^2 = 0.80; n = 87)$$

$$\text{Log}_{10} \text{ Secchi} = -0.59 \text{ Log}_{10} \text{ Chl } a + 0.89 \ (R^2 = 0.83; n = 87)$$

The foregoing regression equations are based on data from phosphorus-limited lakes only. Water transparency, related to the abundance of algae, is the condition upon which lake users' perceptions of water quality generally depend.

Hypolimnetic Oxygen Depletion

Changes in either the water quality or mean depths of Leaf Lake, White Lake, and the Corsica Pit lake would affect their hypolimnetic oxygen depletion rates. This is especially important in Leaf and White lakes since they already have exhibited high rates of hypolimnetic oxygen depletion and tendencies toward winter fish kill conditions.

Numerous researchers have investigated the factors controlling hypolimnetic oxygen depletion in lakes (Lazenby, 1975; Stewart, 1976; Cornett and Rigler, 1979; Smith, 1989; Walker, 1979; Charlton, 1980, Mathias and Barica, 1980). Initially, hypolimnetic oxygen depletion was related to lake productivity alone. More recently, it has been shown that it is related to hypolimnion thickness and temperature as well as productivity (Charlton, 1980). Cornett and Rigler (1979) also developed an empirical model to predict hypolimnetic oxygen deficit from areal phosphorus retention, mean summer hypolimnetic temperature, and mean thickness of the hypolimnion. The latter two papers demonstrate the influence of lake morphometry (i.e., size and shape) on hypolimnetic oxygen depletion. The Charlton (1980) methodology was chosen to evaluate summer hypolimnetic oxygen depletion because it considers changes in both lake basin morphometry and productivity while winter oxygen depletion was estimated according to the methods of Mathias and Barica (1980) instead because they are specific to ice-covered lakes.

To predict the degree to which productivity, hypolimnion thickness, and temperature will determine a lake's summer areal hypolimnetic oxygen depletion rate (AHOD), Charlton derived the following expression:

$$AHOD = 3.80\ [fChla \cdot \frac{\bar{Z}_\eta}{50 + \bar{Z}_\eta} \cdot 2^{((\bar{T}_\eta - 4)/10)}] + 0.12,$$

where

$$fChla = \frac{1.15(Chla)^{1.33}}{9 + 1.15\ (Chla)^{1.33}}$$

$\bar{T}_\eta$ = mean hypolimnion temperature

$\bar{Z}_\eta$ = mean hypolimnion thickness

Chl*a* = average Chlorophyll *a* (ug/L)

This analysis assumes that AHOD is directly related to productivity (as a function of chlorophyll, fChl*a*, based on spring total phosphorus concentration), and a function of temperature $2^{((\bar{T}_\eta - 4)/10)}$, ($Q_{10} = 2$). Predicted

AHOD values were extrapolated over an assumed 100-day period of thermal stratification and each lake's average depth to estimate the mass of oxygen consumed during a summer season. In these analyses, the hypolimnion was assumed to be that portion of the lake volume below the 15-foot depth contour. Also, mean hypolimnetic water temperatures were estimated to be 10°C in Leaf and White lakes, and 5°C in the Corsica Pit lake.

Winter oxygen depletion rates were calculated for Leaf Lake, White Lake, and the Corsica Pit lake according to the methods of Mathias and Barica (1980). Volumetric oxygen depletion rates were calculated for Leaf and White lakes according to the relationship they determined for eutrophic lakes:

$$Y = 0.226X + 0.010$$

where:	X =	surface area of sediment/lake volume (m^2/m^3)
	Y =	winter oxygen depletion rate ($g/m^3/day$)

Corresponding depletion rates for the Corsica Pit lake were estimated according to their relationship for oligotrophic lakes:

$$Y = 0.075X + 0.012$$

where: X and Y are defined as above.

The X variables in the foregoing regression equations were assumed to be equivalent to the inverse of the lakes' mean depths. Calculated results were extrapolated over an assumed 150-day period of ice-cover, and the mass of oxygen consumed was calculated on the basis of the estimated depletion rate applied to the entire lake volume.

2. Results

Phosphorus Budgets

Estimated phosphorus budgets were prepared for Leaf Lake, White Lake, and the Corsica Pit lake based on watershed land use information and phosphorus export rate coefficients. The following tables (tables 5.14 through 5.16) present the results of these phosphorus budget computations. For each lake, current and future (ultimate mine) phosphorus budget estimates are given.

Pit dewatering would stop when mining ends, and the stockpiles would be revegetated during and after mining. Consequently, the phosphorus budgets of area lakes would be likely to revert back to conditions similar to those that exist currently. Lake water quality would also be likely to revert to near-current conditions following mine closure.

In-Lake Water Quality

Using the simulated watershed hydrologic regimes for current and future (ultimate mine) watershed land uses, and corresponding phosphorus loading rates, in-lake total phosphorus concentrations were calculated for Leaf Lake, White Lake, and the Corsica Pit lake. These calculations and results are summarized in tables 5.17 and 5.18, respectively. Chlorophyll *a* concentrations and Secchi disc transparencies were also calculated. Note that two predictions were made for future White Lake water quality. These two predictions, termed "highest lake levels" and "lowest lake levels," correspond to conditions where the lake drops by 0.5 foot and 6 feet, respectively. This is the probable range of lake level fluctuations attributable to changes in the level of the regional groundwater surface caused by dewatering of the adjacent Laurentian Mine pit. In-lake water quality would change in response to changes in lake depth and volume as well as to changes in areal phosphorus loads, thus the need to provide dual estimates of White Lake water quality.

TABLE 5.14

ESTIMATED* PHOSPHORUS BUDGETS FOR LEAF LAKE CURRENT AND FUTURE (ULTIMATE MINE) WATERSHED LAND USE

Estimated Current Phosphorus Budget

Source	Phosphorus Export (kg/yr)	% of Total
Watershed Runoff		
Forest/Open (219.2 ac.)	17.7	61.2
Wetland (48.8 ac.)	0	
Open Water (53.3 ac.)	0	
"Internally Drained" (206.8 ac.)***	0	
Atmospheric Fallout**	11.2	38.8
TOTAL	28.9	

Estimated Future Phosphorus Budget

Source	Phosphorus Export (kg/yr)	% of Total
Watershed Runoff		
Forest/Open (323.8 ac.)	26.2	17.5
Stockpile (100.3 ac.)	12.2	8.2
Wetland (48.8 ac.)	0	
Open Water (53.3 ac.)	0	
Atmospheric Fallout**	11.2	7.5
Laurentian Mine Pumpage	100	66.8
TOTAL	149.6	

*Groundwater excluded
**Direct rainfall and dustfall
***Runoff from Forest/Open and Stockpile areas that is directed into infiltration basins -- no surface runoff to lake. The infiltrating water from these basis is assumed to reach the lake via the groundwater pathway.

TABLE 5.15

ESTIMATED* PHOSPHORUS BUDGETS FOR WHITE LAKE CURRENT AND FUTURE (ULTIMATE MINE) WATERSHED LAND USE

Estimated Current Phosphorus Budget

Source	Phosphorus Export (kg/yr)	% of Total
Watershed Runoff		
Forest/Open (471.8 ac.)	38.2	76.6
Stockpile (11.5 ac.)	1.4	2.8
Wetland (17.3 ac.)	0	
Open Water (50.3 ac.)	0	
Atmospheric Fallout**	10.3	20.6
TOTAL	49.9	

Estimated Future Phosphorus Budget

Source	Phosphorus Export (kg/yr)	% of Total
Watershed Runoff		
Forest/Open (332.3 ac.)	26.9	59.4
Stockpile (67.1 ac.)	8.1	17.9
Wetland (17.3 ac.)	0	
Open Water (46.5 ac.)	0	
Atmospheric Fallout**	10.3	14.2
TOTAL	45.3	

*Groundwater excluded
**Direct rainfall and dustfall

TABLE 5.16

ESTIMATED* PHOSPHORUS BUDGETS FOR THE CORSICA PIT LAKE CURRENT AND FUTURE (ULTIMATE MINE) WATERSHED LAND USE

Estimated Current Phosphorus Budget

Source	Phosphorus Export (kg/yr)	% of Total
Watershed Runoff		
Forest/Open (357.1 ac.)	28.9	67.5
Stockpile (39 ac.)	4.7	11.0
Wetland (1.4 ac.)	0	
Open Water (40.4 ac.)	0	
Atmospheric Fallout**	9.2	21.5
TOTAL	42.8	

Estimated Future Phosphorus Budget

Source	Phosphorus Export (kg/yr)	% of Total
Watershed Runoff		
Forest/Open (136.0 ac.)	11.0	50.5
Stockpile (12.9 ac.)	1.6	7.3
Open Water (40.4 ac.)	0	
"Internally Drained" (248.6 ac.)***	0	
Atmospheric Fallout**	9.2	42.2
TOTAL	21.8	

*Groundwater excluded
**Direct rainfall and dustfall
***Runoff from Forest/Open and Stockpile areas that is directed into existing depressions and bermed drainage swales -- no surface runoff to lake. The infiltrating water from these basins is assumed to reach the lake via the groundwater pathway.

TABLE 5.17

SUMMARY OF LAKE WATER QUALITY CALCULATIONS -- CURRENT AND FUTURE (ULTIMATE MINE) WATERSHED LAND USE

	Lake Dimensions (units)		Water Quality Model Parameter (units)					
Lake	V (ac-ft)	A (acres)	L (g/m²/yr)	q_s (m/yr)	R_p	$\bar{z}$ (m)	Θ (yr)	[P] (mg/L)
Current Conditions:								
Leaf	465.5	49.6	0.144	2.67	0.986	2.86	1.07	0.008
White	470.5	45.4	0.27	0.83	0.976	3.16	3.82	0.016
Corsica Pit	4500	40.4	0.26	0.34	0.979	34	100.2	0.016
Future Conditions:								
Leaf	465.5	49.6	0.745	14.28	0.565	2.86	0.20	0.028
White								
"highest lake levels"		43.8	0.26	0.75	0.931	3.09	4.38	0.016
"lowest lake levels"		260.0	30.1	0.35	0	1.0	2.38	--0.022
Corsica Pit	4375	40.4	0.133	0.34	0.979	33.3	97.5	0.008

V = lake volume (acre-feet)
A = lake surface area (acres)
L = areal phosphorus loading rate (g/m²/yr)
q_s = lake overflow rate (m/yr)
R_p = phosphorus retention coefficient (dimensionless)
$\bar{z}$ = average lake depth (m)
Θ = mean hydraulic residence time (years)
[P] = phosphorus concentration predicted by mass balance modeling techniques (Dillon and Rigler, 1974; and Chapra, 1975)
"highest lake level" assumes a 0.5 foot drop in the normal water level of White Lake
"lowest lake level" assumes a 6.0 foot drop in the normal water level of White Lake

TABLE 5.18

AVERAGE, MID-SUMMER WATER QUALITY CONDITIONS IN LEAF, WHITE, AND CORSICA PIT LAKES -- CURRENT AND FUTURE (ULTIMATE MINE) WATERSHED LAND USE CONDITIONS

Lake	Total Phosphorus (mg/L): $[P]_{Spring}$ [P] @ Spring Circulation	Total Phosphorus (mg/L): Internal Load from Anoxic Sediments	Average, Mid-Summer Water Quality: $[P]_{avg}$* (mg/L)	Average, Mid-Summer Water Quality: [Chl*a*] (mg/L)	Average, Mid-Summer Water Quality: Secchi Disc Transparency (m)
Current Conditions:					
Leaf	0.008 (0.010)**	0.094	0.055	0.022	1.25
White	0.016 (0.020)**	0.096	0.064	0.027	1.11
Corsica Pit	0.016 (<0.010)**	--	0.016	0.004	3.6
Future Conditions:					
Leaf	0.028	0.094	0.075	0.035	0.95
White					
"highest lake level"	0.016	0.093	0.063	0.027	1.11
"lowest lake level"	0.022	0.032	0.038	0.013	1.71
Corsica Pit	0.008	--	0.008	0.001	7.76

*$[P]_{avg} = [P]_{spring} + 0.5$[Internal Load]
**Observed -- March 15, 1990

$[P]_{Spring}$ = total phosphorus concentration predicted by mass balance modeling techniques (Dillon and Rigler, 1974; and Chapra, 1975)

[Chl*a*] = chlorophyll *a* concentration (mg/L; from MPCA, 1988)

Transparency = Secchi disc visibility (m; from MPCA, 1988)

Hypolimnetic Oxygen Depletion

Results of hypolimnetic oxygen depletion rate calculations for both winter and summer seasons are presented in Table 5.19. These rates have been extrapolated to estimate the seasonal masses of oxygen consumed (assuming no diffusion limitation) in the lakes' hypolimnions, both currently and under conditions of ultimate watershed development.

3. Discussion

Phosphorus Budgets

The phosphorus budget of Leaf Lake (Table 5.14) is expected to increase dramatically, from 28.9 kg/yr (64 lbs/yr) to 149.6 kg/yr (330 lbs/yr), as the Laurentian Mine is developed. This increase in phosphorus loading is due primarily to the large amounts of water that would be pumped from the Laurentian Mine through the Mariska Pit to Leaf Lake. Phosphorus derived from the Leaf Lake watershed runoff is also expected to increase slightly (20.7 kg/yr) due to the outletting of areas that are currently landlocked and internally drained. Water pumped out of the Laurentian Mine to Leaf Lake is apt to have a relatively low average phosphorus concentration (0.043 mg/L assumed, approximately twice the current Mariska Pit phosphorus concentration) since it will first pass through the Mariska Pit, but the high flow rate (2.6 cfs, average) coupled with this low concentration still results in an additional 100 kg of phosphorus load to Leaf Lake annually. The effect of this increased phosphorus load on in-lake water quality is only partially mitigated by the increased flushing rate and decreased residence time that the pumpage causes for Leaf Lake. Eventually, the Laurentian Mine would break into the Mariska Pit and detention facilities would need to be developed for mine dewatering pumpage before it was released to Leaf Lake.

The annual phosphorus budget for White Lake (Table 5.15) is expected to remain relatively constant, despite mine development. A portion (55.6 acres) of the lake's watershed that is currently in the forest/open land use category would be converted into stockpile. This conversion of 55.6 acres, coupled with the loss of 87.7 acres of watershed area, is estimated to cause a net 4.6 kg/yr (10.1 lbs/yr) decrease in the lake's phosphorus budget. This relatively

TABLE 5.19

ESTIMATED HYPOLIMNETIC OXYGEN DEPLETION IN LEAF LAKE, WHITE LAKE, AND THE CORSICA PIT LAKE -- CURRENT AND FUTURE (ULTIMATE MINE) WATERSHED LAND USE CONDITIONS DURING SUMMER AND WINTER SEASONS

Summer Oxygen Depletion: (100 days of thermal stratification assumed)

Lake	AHOD ($g/m^2/day$)	Oxygen Consumed (mg/L)	Oxygen Consumed (kg)	Hypolimnion A_η (ha)	Hypolimnion $\bar{Z}_\eta$ (m)	Hypolimnion $\bar{T}_\eta$ (°C)	Epilimnion Chl*a* (mg/L)
Current Conditions:							
Leaf	0.23	20	1,280	5.46	1.15	10	0.022
White	0.22	23	1,220	5.58	0.95	10	0.027
Corsica Pit	1.13	2.3	17,180	15.18	50.3	5	0.004
Future Conditions:							
Leaf	0.24	21	1,320	5.46	1.15	10	0.035
White							
"highest lake levels"	0.16	40	830	5.1	0.4	10	0.027
"lowest lake levels"	0	0	0	0	0	10	0.013
Corsica Pit	0.35	0.7	5,300	15.18	49.6	5	0.001

Winter Oxygen Depletion: (150 days of ice cover assumed)

Lake	VOD ($g/m^3/day$)	Oxygen Consumed (mg/L)	Oxygen Consumed (kg)	Lake A (ha)	Lake $\bar{Z}$ (m)
Current Conditions:					
Leaf	0.089	13.3	7,630	20.07	2.86
White	0.082	12.3	7,140	18.37	3.16
Corsica Pit	0.014	2.1	11,670	16.35	34
Future Conditions:					
Leaf	0.089	13.3	7,630	20.07	2.86
White					
"highest lake levels"	0.083	12.0	6,820	17.73	3.09
"lowest lake levels"	0.105	16.0	4,570	12.19	2.38
Corsica Pit	0.014	2.1	11,320	16.19	33.3

AHOD = areal hypolimnetic oxygen depletion rate ($g/m^2/day$)
A_η = hypolimnion surface (upper) area (ha)
$\bar{Z}_\eta$ = mean hypolimnion thickness (m)
$\bar{T}_\eta$ = mean hypolimnion water temperature (°C)
VOD = volumetric oxygen depletion rate ($g/m^3/day$)
A = lake surface area (ha)
$\bar{Z}$ = mean lake depth (m)
[Chl*a*] = chlorophyll *a* concentration (mg/L)

small decrease in annual phosphorus loading would have correspondingly small affects on the in-lake water quality of White Lake.

It is expected that the annual phosphorus budget of the Corsica Pit lake (Table 5.16) would decrease by about 49 percent due to a large decrease (248.6 acres, 43 percent) in its effective watershed area. Much of its current watershed is classified as forest/open. A large fraction of that area would be converted to stockpile, the runoff from which would be directed to infiltration basins (bermed swales and natural depressions) prior to reaching the Corsica Pit lake. (The infiltrating runoff from these basins is assumed to reach the Corsica Pit via the groundwater pathway.) Consequently, the lake's annual phosphorus budget would be reduced by 49 percent.

In-Lake Water Quality

The dramatic increase in Leaf Lake's annual phosphorus budget would cause its water quality to degrade significantly (tables 5.17 and 5.18). Average mid-summer phosphorus concentration is expected to increase from 0.055 mg/L, currently, to 0.075 mg/L after ultimate mine development. Higher phosphorus concentrations would result in higher amounts of phytoplanktonic algae. Chlorophyll *a* (the photosynthetic pigment of algae) concentrations, it is estimated, would increase by 59 percent, from 0.022 mg/L to 0.035 mg/L. Increased algal abundance would cause average summer water transparency to be reduced by 0.3 meters (1 foot), from 1.25 meters (4.1 feet) to 0.95 meters (3.1 feet). The magnitude of these changes is less than proportional to the expected increase in the lake's annual phosphorus budget, however, because the simultaneously increased flushing rate of the lake would tend to prevent retention of much of the phosphorus in Leaf Lake.

The average summer water quality of White Lake (Table 5.17) is expected either to remain relatively constant or to improve slightly, depending on changes in its normal water surface elevation. If dewatering of the adjacent Laurentian Mine pit causes little (0.5 foot) or no drop in the lake's surface elevation, current summer water quality would remain unchanged. However, if the lake recedes by 6 feet, as was estimated it might, the lake's surface water quality would probably improve slightly. This predicted improvement would result from reduced internal phosphorus loads expected from a smaller area of anoxic sediments. (If the lake level falls, there would be less sediment area below the 15-foot depth contour, the level below which anoxic sediments are assumed to occur.) This predicted improvement is speculative, however, since reduced overall depth may also make the lake susceptible to periods of temporary stratification during which hypolimnetic anoxia develops, and release of phosphorus from anoxic sediments subsequently occurs. The circulation of the water column that occurs between periods of temporary stratification would mix the released phosphorus into the upper stratum of the lake where it would become available for algal growth. If this process is recurrent and frequent, the result would be poorer water quality than would be expected in a similar dimictic (i.e., twice mixing -- spring and autumn) lake where the phosphorus released from anoxic sediments is confined below the lake's thermocline until autumn circulation occurs.

The average summer water quality of the Corsica Pit lake (Table 5.18) is expected to improve after Laurentian Mine development. The effective area of the Corsica Pit watershed which contributes to phosphorus loading by direct surface runoff to the Corsica Pit would be reduced by approximately 57 percent, and its phosphorus budget would be reduced by 49 percent. Instead, as indicated in Table 5-16, surface runoff from approximately 250 acres would be intercepted by a proposed runoff diversion berm and trapped at low points in the ground surface along the berm. This water would infiltrate through soil layers and enter the Corsica Pit as seepage. Consequently, its average in-lake phosphorus concentration would be similarly reduced from 0.016 mg/L, currently, to 0.008 mg/L after ultimate mine development. This is an especially significant change, since it would cause the lake to be reclassified from mesotrophic to oligotrophic. The lake is also expected to exhibit reduced chlorophyll *a* concentrations, and vastly improved transparencies. Secchi disc transparencies in the Corsica Pit lake should increase by 4.16 meters (13.6 feet), from 3.6 meters (11.8 feet) now to 7.76 meters (25.5 feet) in the future.

Hypolimnetic Oxygen Depletion

Leaf Lake and White Lake currently exhibit extended periods of oxygen depletion in both the summer and winter seasons. The calculated oxygen depletion rates (Table 5.19) extrapolated over the anticipated periods of summer thermal stratification and winter ice cover suggest that the current oxygen demands of both lake's hypolimnions far exceed their oxygen supplies. Therefore, increases in the hypolimnetic oxygen depletion rates caused by mine development would not cause changes in the lakes' summer dissolved oxygen regimes. Similarly, winter oxygen depletion rates would not change, except in response to changes in lake depth caused by dewatering of the adjacent mine pit. These depth changes are extremely minor and, except for the "lowest lake levels" analysis of White Lake, would not significantly increase the lakes' susceptibilities to winter fish kill conditions.

In the "lowest lake levels" analysis of White Lake, where its normal water surface elevation is assumed to fall by 6 feet, the probability of winter fish kill occurrence is expected to increase by about 28 percent, based on changes in calculated oxygen depletion rates. These calculated rates do not account for possible photosynthetic additions of dissolved oxygen, however, and assume no diffusion limitations on oxygen depletion. Actual oxygen depletion rates may slow somewhat when ambient dissolved oxygen concentrations fall below 3 mg/L because diffusion would then control oxygen delivery to the anoxic lake sediments from the overlying waters.

The Corsica Pit lake does not currently have an oxygen depletion problem during either summer or winter. Water quality conditions for this lake are expected to improve as a result of decreased annual phosphorus loads after mine development. Therefore, oxygen depletion rates would be reduced in the future, and no adverse impacts are expected for the water quality of the Corsica Pit lake.

Haul Road Runoff

The proposed haul road from the Laurentian Mine to the taconite processing plant would cross the Pike River and an intermittent stream (Figure 3.2). The Pike River is a headwaters stream in this vicinity. Its flows are generally low and variable in response to watershed runoff. Its water quality is also generally determined by the quality of runoff.

The proposed haul road would be constructed of overburden material covered with 6 feet of crushed rock. As such, it would be very permeable and the rainfall from low intensity storm events would infiltrate rather than run off. Consequently, the water quality impacts of small storms would probably be relatively minor. Large, relatively intense storms and snowmelt runoff on frozen ground have the potential to produce significant quantities of runoff, however. Large additions of stormwater runoff from the haul road could potentially dominate both the quantity and quality of Pike River flows under the later conditions. Uncontrolled runoff from the haul road would likely cause stream discharge rates to be elevated during intense storm events since runoff would reach the streams much faster through road ditches than it would otherwise by overland or subsurface drainage. Sediment and nutrient loads to the streams would also probably increase if runoff detention facilities were not provided. Properly designed runoff detention basins and other Best Management Practices (such as vegetated swales and/or infiltration trenches) could minimize this impact, but would not fully mitigate it.

Measures for minimizing lake and stream water quality impacts are discussed in Section 6.

No-Build Impacts

If the Laurentian Taconite Mine were not built, the water quality conditions of area lakes and the Pike River would remain the same as described in this Draft EIS in Section 4, Existing Conditions. Any future changes in water quality would be limited to those caused by changes in watershed land use.

Air Quality

Project Impacts

The construction and operation of the proposed Laurentian Mine would impact air quality through fugitive dust emissions from the haul road, stockpile wind erosion, materials handling, and blasting. However, Inland Steel would be required by law to implement a variety of standard dust control measures that would render these impacts insignificant. Because the area's predominant wind directions are northwest and southeast, dust from the proposed mine would normally not be carried into either Gilbert or McKinley.

With mine construction ending after a few years, air quality impacts related to construction would be relatively temporary. Impacts related to construction are fugitive dust emissions from overburden stripping and stockpiling and from stockpile wind erosion. However, the primary source of fugitive dust would be from truck traffic along the finished portion of the haul road to and from the overburden stockpile for road construction borrow.

The addition of the haul road has the potential to increase the ambient air concentrations of total suspended solids (TSP) and particulate matter less than 10 microns (PM-10). Unmitigated dust emissions from truck traffic along haul roads have been estimated to account for up to 75 percent of the total fugitive dust emissions from mining operations (Cuscino, et al., 1979).

Dust from materials handling (such as loading ore into trucks) would occur primarily inside the mine pit and stay within the pit. Materials handling would have the greatest impact during the first years of mine operation, when the pit would be shallowest.

On a regional scale, operation of the Laurentian Mine would cause essentially the same fugitive dust emissions as that presently occurring at the Minorca Mine; it would change only in location, not in degree. Excluding the effects of the haul road, which would be controlled by Best Management Practices described in Section 6, the air quality of the region would not be adversely affected by operation of the proposed mine. As discussed in Section 4, the Minorca Mine has satisfied state and federal air quality standards at all times, with one exception in the past five years. The annual

TSP concentrations have increased in the past four years, but continue to remain well within the acceptable ambient air concentration levels.

No-Build Impacts

The air quality in the area of the proposed mine is currently of acceptable quality, as defined by the state and federal air quality standards (see Section 4, Air Quality). If the proposed mine is not built, current mining operations would cease and the region's air quality would improve slightly.

Noise and Vibration

Project Impacts

Construction and operation of the proposed mine were evaluated for potential adverse noise and vibration impacts. The main potential sources of noise and vibration are blasting, haul road traffic, equipment operation at the mine site, and activity at the service building near Gilbert. Inland Steel proposes a number of design and operational measures to minimize noise and vibration impacts, such as a sound attenuation berm and certain blasting procedures (see Section 6). Noise and vibration impacts were determined while accounting for these measures.

In summary, it is anticipated that the noise and vibration impacts from the mine would be within the acceptable limits set by the Minnesota Pollution Control Agency and the Minnesota Department of Natural Resources. The Hibbing Technical Institute, which helped evaluate noise impacts, concluded the following:

> "Background noise data is necessary to determine the potential impact of a new mining operation on residential noise receivers. Based on the results of the survey, each of the aforementioned activities, including traffic noise, shovel noise, and truck shop noise, is significantly lower than the Minnesota Pollution Control Standards for residential receivers. Therefore, the residents of Gilbert will not be negatively impacted from noise by the mining activities in the proposed Gilbert Mine site, based on existing mining conditions and activities."

During mine construction and operation, electric power shovels would remove overburden during a five-day work week with two shifts per day ending at 11:00 p.m. The overburden would be loaded into 120- or 195-ton trucks and stockpiled north of the mine. One production shovel and four production trucks per shift would be used in the stripping operation, with an average of 80 trips per shift between the pit and stockpiles.

Mine operations would run 24 hours per day, with shift changes at 11:00 p.m., 7:00 a.m., and 3:00 p.m. The mine would operate Monday through Friday, beginning at 11:00 Sunday night and finishing at 11:00 Friday night. Depending on operational needs, the mine may operate seven days per week, but such a schedule is not anticipated. For the foreseeable near term, ore mining would run three shifts per day, five days per week. Stripping and drilling would run two shifts per day, five days per week.

1. Mine Construction Impacts

Mine construction would consist primarily of clearing and stripping overburden in preparation for drilling and blasting, creating an overburden stockpile, and building a sound attenuation berm, haul road, transmission line, and service building. Stockpiling impacts for both construction and operation are discussed in the next subsection.

During construction of the sound attenuation berm, some unavoidable noise from earth-moving equipment can be expected. This berm would be built between Gilbert and the service building/haul road area (see Figure 5.9). In the early stages of berm construction, noise levels as high as 75 dBA might be experienced at the closest residence 400 feet away, which would exceed state noise standards. Once the berm is built, however, it would serve to shield Gilbert, including the closest residence, from noise during mine construction and operation.

Another source of noise impacts would be construction of the haul road. However, the road would not be built until the adjacent sound attenuation berm was completed, thereby minimizing noise impacts near Gilbert. While sound levels would vary greatly during construction of the haul road and transmission line, the berm would be expected to keep maximum levels below 65 dBA. The berm would end as the road turns away from Gilbert toward the Minorca Plant. However, the road would pass through uninhabited areas the rest of its length, so impacts to humans from road construction there are not considered significant.

2. Stockpiling Impacts

During stripping and stockpiling of overburden during construction and operation, sound levels in the immediate area would be similar to those at the present Minorca operation. Sound levels would remain well below the MPCA noise standard of 55 dBA while stockpiles are shielded by the berm.

However, stockpiling would become higher than the berm after 20 to 25 years of operation. While most stockpiling would occur up to a mile from the berm, some

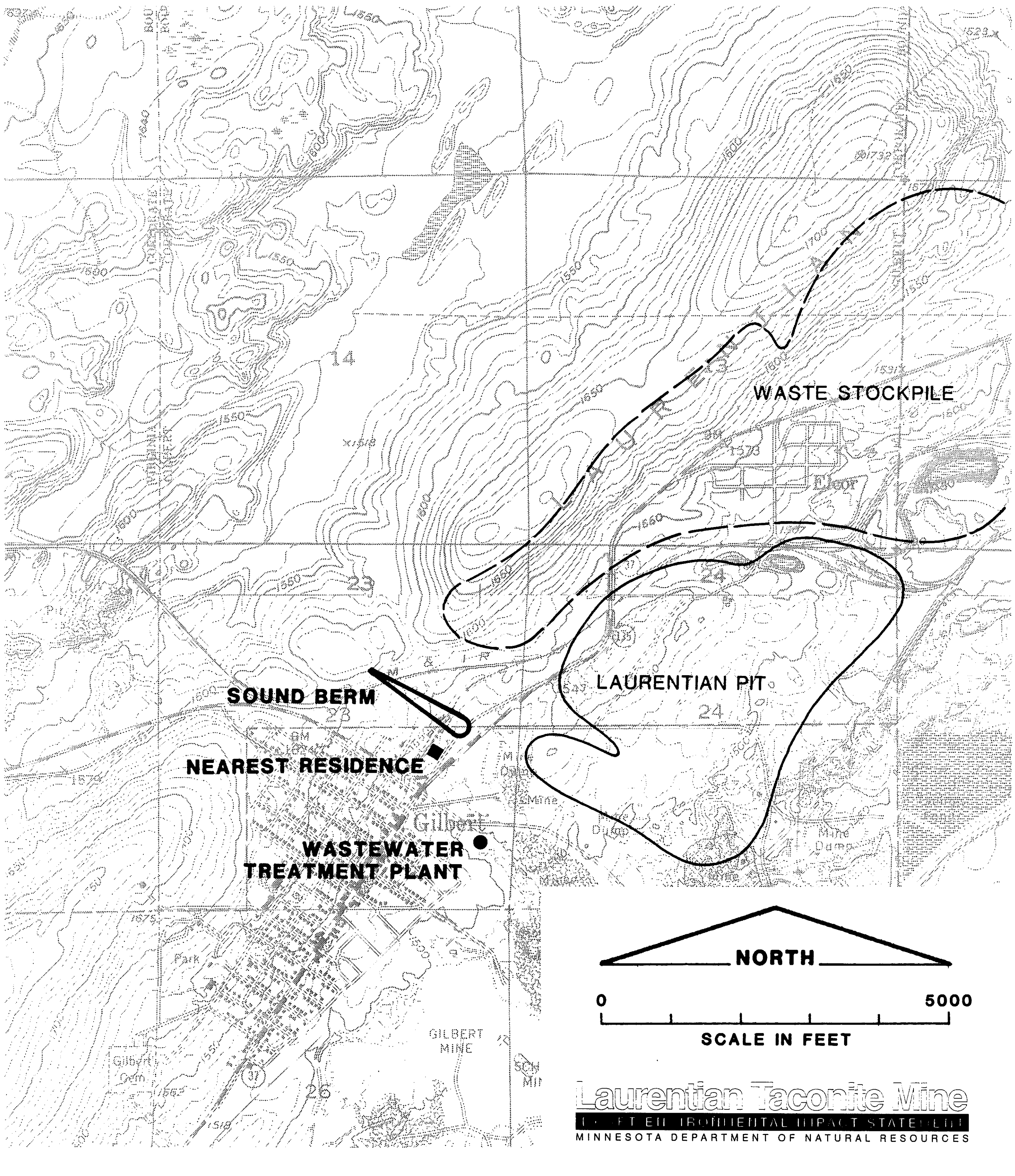

Figure 5.9

LOCATION OF SOUND ATTENUATION BERM, NEAREST RESIDENCE, AND WASTEWATER TREATMENT PLANT

stockpiling would be within 2,000 and 2,500 feet. Once this closer stockpiling became higher than the berm, sound levels could reach 55 dBA at the elevated residential area on the north side of Gilbert, and match or exceed the MPCA's nighttime noise standard. This lower nighttime standard comes into effect at 10:00 p.m. and ends at 7:00 a.m. Inland Steel anticipates that stockpiling would end at 11:00 p.m. and not begin again until 7:00 a.m., so the MPCA nighttime noise standard would be exceeded only between 10:00 and 11:00 p.m. If a night shift for stockpiling were needed, then the noise standard might be exceeded at the closer stockpiles between 10:00 p.m. and 7:00 a.m.

3. Mine Blasting Impacts

Because blasting has the greatest potential to cause adverse noise and vibration impacts, it is described in detail here, including the proposed blasting procedures.

Proposed Blasting Procedures

Inland Steel proposes blasting procedures that are very similar to those used at the Minorca Mine. Table 5.20 lists the blasting procedures used at the Minorca Mine. Blasting data from the Minorca Mine were valuable in determining potential blasting impacts at the Laurentian Mine.

The proposed blasting procedures were selected to minimize ground vibration and air shock. Inland Steel would begin blasting with small patterns of tightly spaced holes, with each blast hole individually delayed to minimize ground shock. In addition, a noiseless trunkline would be used to connect blast holes to reduce air shock noise. A data base on blasting would be developed over time, and blasting procedures could change based on the information gathered.

The initial blasting configuration would include:

TABLE 5.20

CURRENT MINE BLASTING PROCEDURES

INLAND STEEL MINING COMPANY MINORCA PROCEDURES	PAGE 1 of 3	INDEX NUMBER PITOP-1
SUBJECT BLASTING PROCEDURE	ISSUE DATE 10-28-85	SUPERCEDES

A. One Day Prior to Blast

1. Engineering will notify the following about date and approximate time of the blast: All Inland personnel, gate guards.

2. Engineering will distribute maps which show: Manned lookout posts, personnel, and equipment safety distances, and the monitoring stations.

B. Morning of the Blast

1. Engineering will notify the following about date and approximate time of the blast: Eveleth Airport, Hibbing Airport, FAA.

2. Engineering will notify gate guard to put out "Danger Blasting Today" sign at the gate.

3. Gate guard will notify all fee holders and vendors that there is going to be a blast that day and they will not be allowed in the pit until after the blast is completed and the all clear is given.

4. Engineering will call International Falls for weather conditions at 9:00 A.M. to check for wind velocity, wind direction, and for any temperature inversions aloft.

5. Engineering will give Taconite Aviation clearance (as previously arranged) to fly the area and physically record wind and temperature conditions aloft. If wind conditions are favorable and there are no temperature inversions, the blast will proceed; if conditions are not favorable, the blast is put on hold and conditions will again be checked later in the morning.

6. Assuming weather conditions are "favorable"

   a. Engineering notifies blast crew to proceed.

   b. Blast crew proceeds to install connectors, string lead wire, and ready the blast. (This procedure takes up to two hours.)

INLAND STEEL MINING COMPANY MINORCA PROCEDURES	PAGE 2 of 3	INDEX NUMBER PITOP-1
SUBJECT BLASTING PROCEDURE	ISSUE DATE 10-28-85	SUPERCEDES

   c. The pit foreman than evaluates how long it will take to move the equipment in the area to a safe distance and does so prior to the blast.

   d. Engineering then makes sure that there is somebody stationed at the primary crusher, equipped with a radio, who will test and sound the warning siren.

   e. A blast monitoring station is set up at the nearest private structure to the blast (17th Street North). The station is manned by engineering and consists of a seismograph and/or a noise impact analyzer. These instruments measure and record air vibrations and ground vibrations. Acceptable limits are set by the Bureau of Mines and blasts are designed to emit vibrations within those limits. These records will assist Inland in any possible damage claims.

   f. The pit foreman posts lookouts around the blast perimeter at predetermined locations prior to the blast to stop all incoming traffic until the all clear from the pit foreman is given.

   g. The blast monitorer then notifies the blaster that the monitor is in position and that the man at the primary siren is ready.

   h. The pit foreman then makes a final check of the blast area to make sure all personnel and equipment are clear; and when he is satisfied, and all is clear of the predetermined radius he notifies the blaster the pit is clear.

   i. The blaster then initiates a test shot to record pertinent data on the monitoring equipment for future compression and study. At this time also, the flying service may be called in to make a final surveillance flight to check for intruders in the area.

   j. The monitorer then informs the blaster whether it is safe to blast or not based on his monitoring.

INLAND STEEL MINING COMPANY MINORCA PROCEDURES	PAGE 3 of 3	INDEX NUMBER PITOP-1
SUBJECT BLASTING PROCEDURE	ISSUE DATE 10-28-85	SUPERCEDES

   k. If all is okay, the blaster informs the person on the siren to sound the 5 minute warning (3 long blasts of the sire, 10 seconds a piece).

   l. Engineering asks for radio silence on channel 3 until blast is all clear, and calls the control room to announce the 5 minute warning on the Gai-tronics.

   m. Blaster ties lead in wires to the blasting box.

   n. Blaster has person on siren give one minute warning (2 very long blasts on the siren).

   o. Blaster announces on the radio 30 seconds to main blast, 10 seconds to main blast, and initiates the blast.

7. Post blast procedure

   a. After the blaster is sure all fly rock has settled, he inspects the blast area to be sure of complete detonation.

   b. After it has been determined there are no misfires, the blaster calls the blast monitorer who calls the control room to announce the all clear and recalls pit personnel and equipment into the pit to resume operation.

   c. The blast monitorer notifies gate guard that the area is clear and we are through blasting.

   d. Engineering calls FAA that all is clear.

- 30 holes
- 12.25" hole diameter
- 24' x 28' spacing between holes
- 1,500 lbs maximum delay weight (A "delay weight" is the weight of explosive shot in a hole. The amount of delay between detonations is adjusted to most effectively break up rock.)

The normal blasting configuration would probably include:

- 140 holes
- 13.75" hole diameter
- 30' x 34' spacing between holes
- Variable delays (generally 20 to 70 milliseconds)

Initially, blasting would be no closer than 2,000 feet from Gilbert and Highway 135. As the mine expanded, however, blasting could move as close as 1,000 feet from Gilbert and 500 feet from the highway, which could create problems if not carefully monitored and programmed. As Inland Steel gained experience in the early stages of mine development, they would more clearly identify what procedures would be necessary when the mine boundaries were approached. This may include variation of blast design, powder factor, and other criteria to reduce vibration and air shock. Normally, blasting would be done with a mixture of ammonium nitrate and fuel oil (ANFO).

To gather preliminary data, Inland Steel is considering doing test blasts before starting production blasting at the Laurentian Mine as soon as the pre-production overburden stripping was completed near the end of 1990. Pre-production test blasts similar to those at the Minorca Mine would be set prior to each production blast.

The pre-production test blast is intended to ensure that the DNR's 130 dB limit is not exceeded off mine property. If the test blast yielded an overpressure equal to or greater than 123 dB at the nearest monitoring location, the blast would be delayed. The 123 dB level was selected because at the Minorca Mine the production blast level at the nearest monitor has generally been found to be 7 dB higher than that of the test blast.

Even if the test blast did not exceed 123 dB, blasting would be delayed if the area had a strong and easily detectable atmospheric inversion or winds from the east or northeast greater than 15 mph. This would minimize air shock and dust dispersal over inhabited areas in Gilbert.

It is anticipated that the same type of schedule now followed at the Minorca Mine would be followed at the Laurentian Mine, with blasting every other week (usually on Friday afternoons between noon and 2:00). Occasionally, it could be necessary to blast more frequently, but never more than once per week. The frequency would be dictated by the plant's ore requirements, the size of the blast patterns, and what explosive was being used. For example, if a smaller pattern size were found preferable to minimize air and ground shock, blasting could occur weekly.

During the first few years of mine operation, when the Laurentian Mine would provide only half the taconite processed at the Minorca Plant, blasting would likely occur only once per month. By 1995, however, all mining activity would be at the Laurentian Mine and blasting would occur at least biweekly. Inland Steel has not yet determined the exact bench height for the mine slopes, but it would likely be between 30 and 40 feet. The bench height is the height of rock being mined during any given time period. The bench height used determines the depth of the drill hole and the amount of explosive used. Pattern orientation would depend on the mining situation. Generally, the strike of the ore body parallels a line joining Gilbert and McKinley and blast patterns would be oriented with the formation's strike.

Inland Steel would initially monitor air shock and ground vibration both in the pit, at the nearest residences in Gilbert and McKinley, and at the Gilbert wastewater treatment plant. Inland Steel is planning to upgrade its ground vibration and air shock monitoring equipment for use at the Laurentian Mine.

As experience and knowledge were gained with the effects of blasting at the Laurentian Mine, it is expected that monitoring would be scaled back to that required by law, namely monitoring air and ground shock at the closest structure not on Inland Steel property.

Predicted Ground Vibration Levels

Vibration levels can be predicted using data from the Minorca Mine (Table 5.21) and data collected by the U.S. Bureau of Mines. Figure 5.10 shows available Minorca Mine data and the square root scaled distance for both the wastewater treatment plant and the nearest residence in Gilbert. (Ground vibration and air shock are normally "scaled" to reflect the relative energy content of a blast.)

If the **absolute maximum** vibration level monitored at the Minorca Mine using current procedures were to be extrapolated to the wastewater treatment plant, the 1 inch per second DNR limit would be slightly exceeded, although the nearest Gilbert residence would fall below the limit. If the most likely **expected maximum** vibration level were to be extrapolated to the treatment plant, the DNR limit would not be exceeded. Assuming a smaller-scale blast design and limit of 1,500 lbs delay weight proposed for the Laurentian Mine, it is unlikely that the DNR limit of 1 inch per second would be exceeded.

A ground vibration level of 0.8 inch per second might be expected at the wastewater treatment plant if the 1,500 lb delay weight were used at the boundary of the mined area. However, the plant footings and foundation are sufficient to prevent settlement or differential settlement from ground vibrations of this magnitude (see figures 4.14 and 4.15). Since the foundation is a continuously cast concrete structure, vibrations at the base are likely to be felt at other locations in the plant, but would not be greatly amplified. The 1 inch per second DNR limit is well below the 2 inches per second motion known to cause structural damage, and the ground vibration is not likely to reach the 1 inch per second level at the plant. Therefore, it is not expected that significant adverse impacts would occur to the wastewater treatment plant.

At the nearest residence, a maximum vibration level of 0.4 inch per second is projected. Again, this level is well below the threshold of damage and no adverse vibration impacts on this residence are expected.

It should be noted that if vibration monitoring were not carried out, the delay weights used at the mine would be severely limited by the formula contained in the State blasting regulations (Table 5.22):

TABLE 5.21

BLASTING VIBRATION AND AIR SHOCK DATA
MINORCA MINE

Blast	Date	Air Shock (dB) M-1	Air Shock (dB) M-2	Ground Vib(in/sec) M-1	Ground Vib(in/sec) M-2	#'s/Delay	Weather Sky/Temp/Wind	Tie-In
7 B-9	11/29/89	<100		.031		2560	Clr -(20°) WNW 15-25 mph	17-25 ms Ind Holes Noiseless Trunkline 14,000 A-Cord Echelons
64 B-6	12/11/89	103	124	.024	.06	6022	Clr (-5°) NW 10-15 mph	"
8 B-9	12/22/89	102	130	.046	.08	4125	Cldy Lt Snow (-10°) NW 10-15 mph	23,000 ft A-Cord Ind Holes 17 ms
40 B-8	01/10/90	102	131	.026	.07	2516	Cldy Lt Snow (15°) SSE 15-20	24,000 ft A-Cord Ind Hole 71 ms (25 grain)
66 B-6	01/19/90	<100	127	.05	.05	2186	Clr (28°) SSW 10-15	25,000 A-Cord Ind Holes 71 ms
72 B-7	02/02/90	<100	125	.04	.06	1898	Cldy Lt Snow (5°) SE 10-15	24,000 A-Cord Ind Holes 17 ms
68 B-5	02/15/90	103				1939	Cldy (10°) Calm	Trunkline Noiseless Ind Holes 17 ms
9 B-2	02/27/90	<100	120	.04	.06	1939	Clr (25°) SW 15-20	Noiseless Trunkline 25 ms
61 B-4	03/07/90	<100		.064	.04	1279	Clr (30°) S 3-5	Noiseless Trunkline 17 ms
10 B-2	03/22/90	107	126	.064	.06	1856	Cldy Lt Snow (18°) NW 20-30	Noiseless Trunkline 17- 25 ms
[illegible] 5	4/04[illegible]			.05		[illegible]568	[illegible] (40°[illegible] NW 5-15	Nois[illegible] Tru[illegible] 25 ms

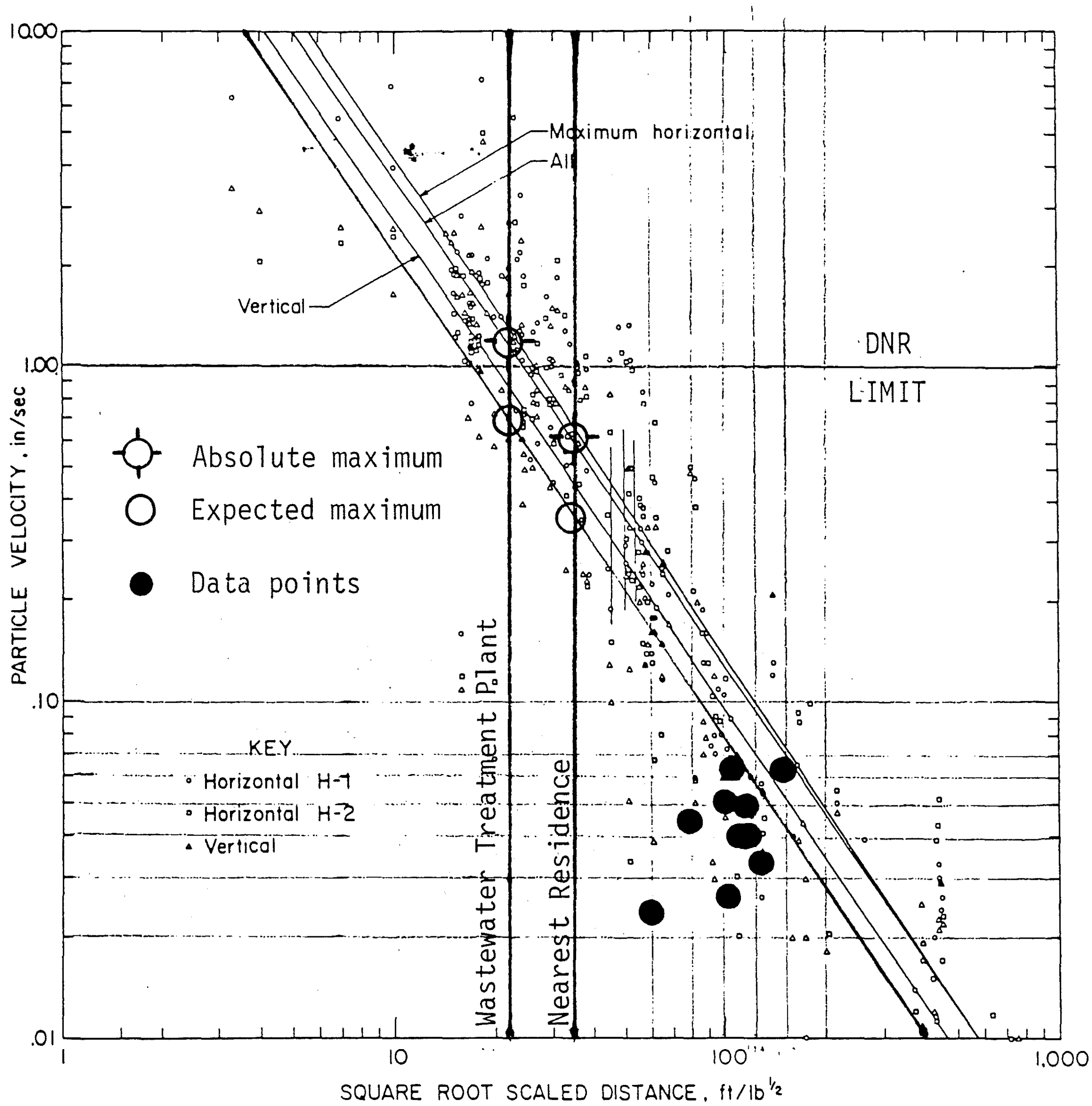

Figure 5.10

PROJECTED GROUND VIBRATIONS FROM PRODUCTION BLASTING AT THE LAURENTIAN MINE

TABLE 5.22

STATE BLASTING REQUIREMENTS

6130.3800 GOAL OF BLASTING.

Effects of air overpressure and ground vibrations from production blasts shall be kept at levels which will not be injurious to human health or welfare and property outside mining areas.

Statutory Authority: *MS s 93.47*

6130.3900 BLASTING REQUIREMENTS.

Subpart 1. **Air overpressure standards.** Air overpressure standards:

A. Air overpressure on lands not owned or controlled by the permittee shall not exceed 130 decibels as measured on a linear peak scale, sensitive to a frequency band ranging from six cycles per second to 200 cycles per second.

B. All open pit blasts shall be monitored by the operator. Monitoring stations shall be located adjacent to the nearest structure located on lands not owned or controlled by the permittee, and where the commissioner deems necessary to investigate complaints. Scram operators are not required to conduct air overpressure monitoring except as required for complaint investigation.

C. All open pit mining operators shall keep a blaster's log of production blasts for a period of at least six years containing the following:

(1) date and time of blast;

(2) type of explosive used;

(3) ignition layout with locations of blast holes and time intervals of delay;

(4) pounds of explosives per each delay of eight milliseconds or more;

(5) total pounds of explosives;

(6) type of material blasted;

(7) monitoring locations and results of monitoring when conducted;

(8) meteorological conditions, including temperature inversions, wind speed, and directions as can be determined from the U. S. Weather Bureau, and ground-based observations;

(9) directional orientation of free faces of bench to be blasted; and

(10) other information which the commissioner finds necessary to determine if the standards of this part and part 6130.3800 are achieved.

D. If a focusing condition is detected which could cause the blast to adversely affect populated areas, blasting shall be postponed until the condition is no longer present.

E. Blasting shall take place only during daylight hours unless a hazardous condition requires blasting at another time.

Subp. 2. **Ground vibration control.** Ground vibration control:

A. The maximum peak particle velocity from blasting shall not exceed one inch per second at the location of any structure located on lands not owned or controlled by the permittee.

B. The permittee shall either:

(1) monitor production blasts for peak particle velocity using a seismograph capable of measuring three mutually perpendicular peak particle velocities, with the peak particle velocity being the largest of these measurements; or

(2) utilize the scale distance formula $W = (d/60)^2$

where: W = the charge weight per delay (eight milliseconds or more), and d = the distance (in feet) from the blast to the nearest structure located on lands not owned or controlled by the permittee to determine the weight of allowable explosive per decay.

When the monitoring is chosen, or complaints are received, seismic measurements shall be conducted adjacent to the nearest structure located on lands not owned or controlled by the permittee and where the commissioner deems necessary to investigate complaints.

C. In the event of a complaint or when ground vibrations have or are likely to exceed the one inch per second standard, the commissioner shall require permittees using underground mining methods to maintain a blaster's log for the purpose of assessing ground vibration control.

Subp. 3. **Retention of monitoring data.** All monitoring data collected shall be saved for a period of six years and made available to the commissioner upon request.

Statutory Authority: *MS s 93.47*

$$W = (d/60)^2$$

Where W = allowable delay weight (lbs)
d = distance from the blast to the closest residence

Following this formula, the permitted maximum delay weights would be:

Wastewater Treatment Plant:
$W = (800/60)^2 = 180$ lbs/delay
Nearest Residence:
$W = (1{,}300/60)^2 = 470$ lbs/delay

However, as historical monitoring has shown, much higher delay weights can be used in the iron formation than permitted by this conservative formula. No adverse vibration impacts are expected with Inland Steel's proposed blasting plan.

<u>Predicted Air Shock Levels</u>

Air shock data from the Minorca Mine do not provide a sufficient base upon which to make predictions. However, generalized predictions can be made using the U.S. Bureau of Mines' extensive data base on air shocks. Figure 5.11 shows a range of sound level data for contained and uncontained quarry blasts. Available data from the Minorca Mine and the cubed root scaled distance for both the wastewater treatment plant and the nearest residence are shown in this figure.

If the **absolute maximum** air shock level monitored at the Minorca Mine using current procedures were to be extrapolated to the treatment plant, the 130 dB DNR limit would be exceeded by approximately 4 dB. The nearest residence would experience 121 dB under the same conditions. If the most likely **expected maximum** air shock level were extrapolated to the wastewater treatment plant, the DNR limit would not be exceeded. The pre-production test blast would help indicate air shock potential, and the production blast would be delayed if the test blast reached 123 dB at the nearest monitor.

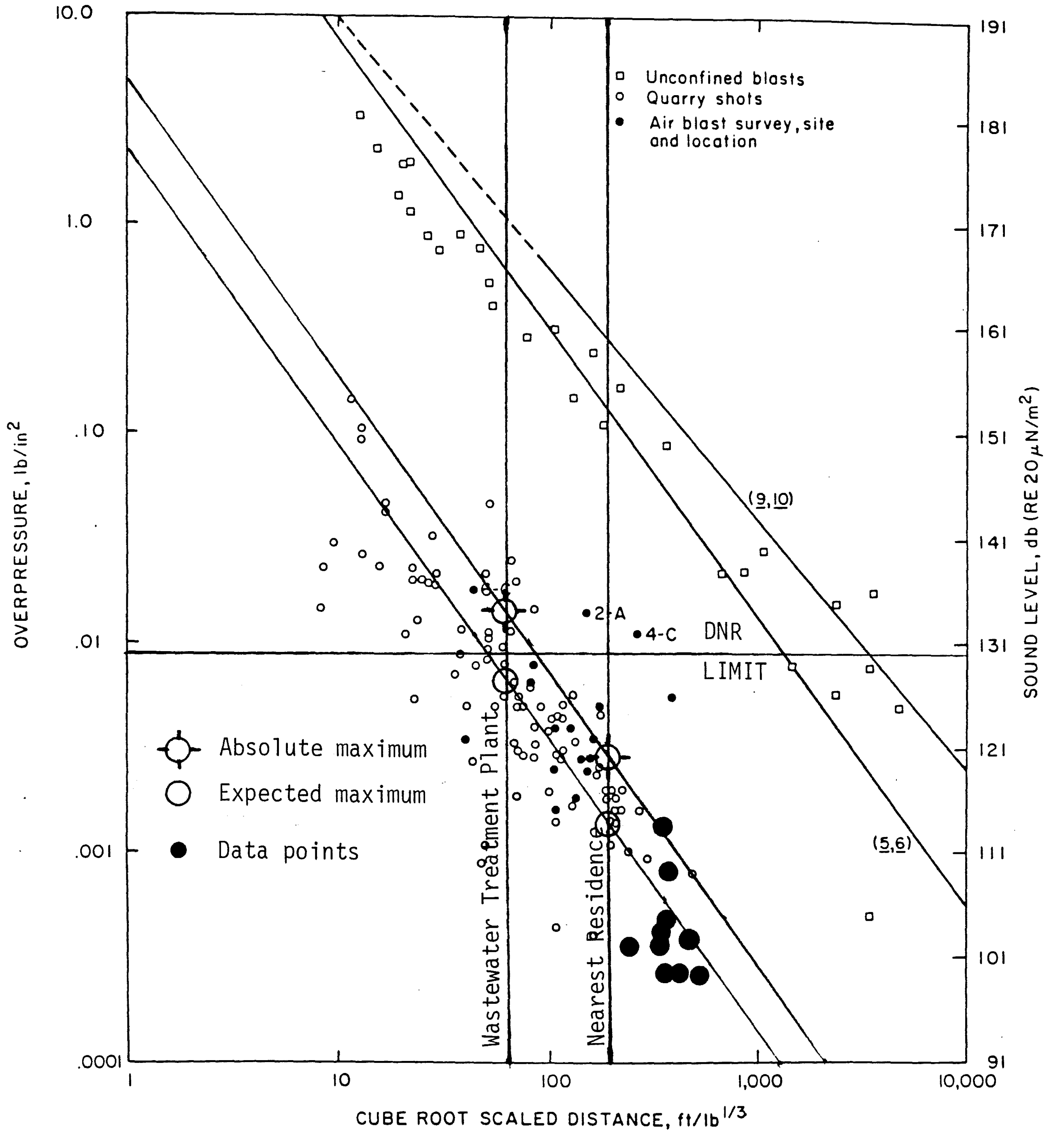

Figure 5.11

PROJECTED AIR SHOCK LEVELS FROM PRODUCTION BLASTING AT THE LAURENTIAN MINE

Therefore, no significant adverse impacts from blasting-related air shock are expected.

4. Mining Equipment Impacts

The following equipment would be used at the Laurentian Mine:

Number	Type	Model	Horsepower
3	P&H Electric Shovel	2100	1875
1	P&H Electric Shovel	1900	1500
2	Caterpillar Front-End Loader	992C	733
3	Caterpillar Bulldozer	D9N	370
12	Unit Rig Haul Truck (120-Ton)	MK3O	1200
7	Caterpillar Haul Truck (195-Ton)	789	1800
3	Gardner Denver Electric Drill	120	N/A

On average, three electric shovels, one front-end loader, one bulldozer, 12 haul trucks, and one drill would be used on any given shift. This usage would not occur until 1995, when the Laurentian Mine would reach maximum output. Less equipment would likely be used in the first few years of mine operation. Daily usage would vary depending on material requirements.

In May 1989, the Hibbing Technical Institute made extensive measurements of shovel, haul truck, and service building noise generated at the Minorca Mine. These noise levels were measured to predict noise levels at the Laurentian Mine, which would be expected to be comparable. The results of the survey are shown on Table 5.23, and the report is included in Appendix D.

Most equipment operation would occur within the mine pit where the pit walls would help muffle and contain the noise, especially as the pit became deeper. However, during the early phases of mining when equipment would be at or near the surface or mine boundary, levels above 55 dBA could be expected.

Hibbing Technical Institute found that one of the loudest noise sources would be shovels loading rocks into trucks. For example, truck loading nearest the closest residence could cause a 57 dBA level at that residence. However, most equipment

TABLE 5.23

MINE AND EQUIPMENT NOISE
MINORCA MINE

Table I: Truck Sound Levels at Various Distances from Intersection (i-s)

Distance from i-s	Sound Level (dBA)	Predicted Sound Level (dBA)	Description
20'	91	--	Upgrade
20'	88	--	Downgrade
500'	65	61	Combined
1000'	51	55	Combined
1500'	47	51	Combined
2000'	38	49	Combined

Table II: Shovel Sound Levels at Various Distances from Shovel

Distance from Shovel	Sound Level (dBA)	Predicted Sound Level (dBA)	Description
100'	82	--	Loading truck
100'	98	--	Bucket noise
500'	70	68	Loading truck
500'	80	84	Bucket noise
1000'	56	62	Loading truck
1000'	68	78	Bucket noise
1500'	56	58	Loading truck
1500'	60	74	Bucket noise
2000'	52	56	Loading truck
2000'	52	72	Bucket noise

TABLE 5.23 (Continued)

MINE AND EQUIPMENT NOISE
MINORCA MINE

Table III: Truck Shop Sound Levels

Distance from Truck	Sound Level (dBA)	Predicted Sound Level (dBA)	Description
2'	107	--	Start up/door open
2'	96	--	Idle/door open
2'	80	--	Start up/door shut
2'	79	--	Idle/door shut
2000'	--	47	Start up/door open
2000'	--	36	Idle/door open
2000'	--	20	Start up/door shut
2000'	--	19	Idle/door shut

Table IV: Sound Levels at 2000' from Noise Source

Noise Source	Sound Level (dBA)	Predicted Sound Level (dBA)	Description
Haul Truck Noise	≤35*	--	Behind Berm
Haul Truck Noise	38	--	Without Berm
Road Traffic**	38	--	Hwy 135/Gilbert
Shovel Idling Noise	50	--	Without Berm
Shovel Loading Noise	52	--	Without Berm
Shovel Bucket Noise	52	--	Without Berm
Truck Shop Noise Start up/Shop door open	--	47	Without Berm

*Sound level at 1000' is 35 dBA so that the level at 2000' is less than or equal to 35 dBA.

**Road traffic or existing background noise at the nearest dwelling, which is 31000' from proposed mine site.

operations would occur more than 2,000 feet from the nearest residence, and the noise level would be well below 55 dBA and approximately equivalent to the mine background noise. The nighttime noise standard (L10) is not expected to be exceeded. Here is an excerpt of the Institute's findings:

> "...peak shovel noise was measured at less than the allowable standards at a distance of 2,000 feet. Calculation of a time weighted average shows that the noise level was below the allowable standards at all distances greater than 1,000 feet from the shovel. The results from shovel noise confirm that Gilbert area residents would receive a noise exposure level that is less than the allowable level as established by the MPCA for residences."

They also concluded that equipment traffic noise in the mine at 2,000 feet from the main haul road would be equivalent to the background traffic noise level at the nearest residence. Traffic noise in the mine measured behind a berm approximately 1,000 feet from a haul road was even lower.

On April 6, 1990, frequency (octave band) data were collected for the shovel and drill. Octave band data are valuable to more accurately predict noise levels with distance using computer models. Table 5.24 shows the dBA noise levels that were measured.

Hibbing Technical Institute found that all of the measured noise levels were less than the L10 and L50 standards for both daytime and nighttime noise area classifications, NAC-1 according to Chapter 7010.040 of the MPCA Noise Pollution Control Rules.

The L10 and L50 are hourly measures of noise used in the MPCA noise standards. The L10 is the noise level exceeded 10 percent of the hour or 6 minutes. The L50 is the level exceeded 50 percent of the hour or 30 minutes, and is the hourly median noise level.

TABLE 5.24

NOISE FROM CURRENT MINING EQUIPMENT
OCTAVE BAND DATA
(all readings in dB)

Freq	Shovel (50′)	Shovel (200′) (Loading Truck)	Truck (50′) (Passing)	Drill (50′)
31	80	86	82	80
63	78	86	86	72
125	82	88	86	76
250	74	80	82	70
500	76	74	80	74
1000	79	74	76	68

These readings were made with an IVIE sound analyzer. The readings were converted to similar situations in the Hibbing report and excellent agreement was found for the truck loading and truck passby operations.

Time of Day Operations

Mining operations at the Minorca facility continue for 24 hours per day. Shift changes are at 11 p.m., 7 a.m., and 3 p.m. For the foreseeable near term, ore mining operations at the Minorca Mine will run three shifts per day, five days per week. Stripping and drilling operations will run two shifts per day, five days per week. The same schedule is proposed for the Laurentian Mine.

5. Truck Traffic Impacts

Inland Steel proposes to build an earth berm to shield the nearest residence and a larger residential area in Gilbert from haul road traffic noise. The 1,800-foot long and 50-foot high berm would taper and end as the road turns away from Gilbert. Because the rest of the road would pass through uninhabited areas on its way to the Minorca Plant, potential noise impacts to humans are not considered significant.

To haul taconite to the Minorca Plant, Inland Steel would use 195-ton Caterpillar Model 789 production trucks and 120-ton Unit Rig MK3O production trucks. By 1995, six to seven of the Caterpillar 789 trucks or nine of the Unit Rig MK30 trucks would be required. Approximately 60 vehicle trips per shift would be required for the larger trucks, or 90 vehicle trips for the smaller trucks. The actual number of vehicle trips should lie between 60 and 90. From 1991 to 1995, about half of that number of vehicle trips per shift would be required. A maximum of 15 trucks per hour would be expected just after the 11:00 p.m. shift change until approximately midnight. Truck traffic would be heaviest then because the trucks would all start from the Laurentian Mine again when the 11:00 shift started.

At the Gilbert residence nearest the haul road, a single truck is expected to produce 55 dBA without the sound attenuation berm and about 40 dBA with the berm. Assuming a maximum of 15 trucks per hour climbing the grade north of the service building, the Federal Highway Administration's highway noise model (STAMINA 2.0) predicts a maximum hourly L10 of 39 dBA and a maximum L50 of 35 dBA. (Without the berm, an L10 of 54 dBA and an L50 of 50 dBA are projected.)

Daytime noise levels are not expected to be a problem. The daytime background level was observed to be an L10 of 48 dBA and an L50 of 41 dBA. With the berm, noise levels from haul trucks at the nearest residence are expected to be 39 dBA (L10) and 35 dBA (L50), so no significant impacts are anticipated.

Noise from the haul road would also be audible at homes on the north edge of Gilbert. Without the berm, an L10 of 53 dBA and an L50 of 49 dBA would be expected during the 11:00-12:00 period at night (when truck traffic would be heaviest due to the shift change). With the berm, an L10 of 43 and an L50 of 35 would be expected. Thus, the nighttime noise standards would not be exceeded. It is important that noise events during night be as close to ambient as possible, which is estimated to be an L10 of 42 dBA, and an L50 of 35 dBA.

In summary, the haul road noise would be 3 dBA lower than Gilbert's ambient noise level. Although the frequency of road noise would cause it to be perceptible above the ambient noise level, the overall dBA would be well below state noise standards. The Hibbing Technical Institute concluded:

> "Peak traffic noise was measured below the allowable day and nighttime intermittent noise standards for all distances greater than 1,000 feet from the haul trucks. This level was measured for traffic with or without a berm. The time weighted average traffic noise level was less than both day and nighttime standards at all distances greater than 500 feet. Based on these traffic noise results, Gilbert area residents would receive a noise exposure that is well below the level which is allowed by the Minnesota Pollution Control Agency for residences."

6. Service Building Impacts

The proposed earth berm would shield the nearest residence and a larger residential area in Gilbert from service building noise as well as traffic noise. The Hibbing Technical Institute evaluated potential noise impacts from the service building and reached this conclusion:

> "...extrapolated truck shop noise, as received by the residents of Gilbert, was below the MPCA standard. Noise levels with both the shop doors open and closed were considerably less than the allowable level as extrapolated to both the nearest dwelling and the City of Gilbert. As with both traffic and shovel noise, truck shop noise does not constitute a noise pollution source."

<u>No-Build Impacts</u>

Under the no-build alternative, no new noise impacts would be expected at the mine site in Gilbert.

The blasting noise from Minorca, which is perceptible in Gilbert but well within state standards, would cease when the Minorca Mine closes in 1995. Vibration from Minorca blasting is not perceptible in Gilbert.

Vegetation and Wetlands

Project Impacts

Development of the proposed mine, mine stockpiles, haul road, and service building would result in the loss of 860 acres of aspen-birch-balsam forest or 0.05 percent of the total of this type found in St. Louis County. A total of 71 acres of wetlands would be impacted; largest impacts would be to the wetland shrub type. Dewatering of the mine might result in additional indirect losses (flooding or water removal) of wetlands adjacent to White Lake, Leaf Lake, and Elbert Lake. Change in these wetlands is dependent on the extent of either groundwater drawdown or water addition.

1. Mine Construction

In the area of the proposed mine pit, there are approximately 400 acres of uplands and old stockpiles, 15 acres of wetlands, and 25 acres of open water. Open pit mining has occurred previously in the area. The Mariska Pit lies on the southern boundary of the proposed Laurentian pit and is now filled with water. Areas disturbed by past mining activities are evident in the vicinity of the Mariska Pit.

Construction of the Laurentian pit would cause a direct physical impact on all upland and wetland vegetation within the proposed pit boundaries. Tables 4.24 and 4.25 show the types and acreages of wetlands and upland habitats that would be lost after completion of mining. This loss of wetlands and upland vegetation would occur over a 40-year period.

After mine dewatering ended, the pit would fill with water and create a very deep, open water lake similar to the other water-filled pits in the region (such as Lake Orebegone). The approximate size of the lake would be 440 acres.

Placing the rock and overburden stockpiles north of the proposed mine pit would result in the disturbance of approximately 565 acres of uplands and 30 acres of wetlands. Tables 4.24 and 4.25 show the types and acreages of upland and wetland habitats that would be affected. Most of this area consists of young aspen-birch-balsam fir forest. The wetlands that would be filled are predominantly alder swamps.

The proposed haul road from the Laurentian Mine to the Minorca Plant would cross approximately 2 miles of land disturbed by the current Minorca operation and 4 miles of relatively undisturbed woodlands and wetlands. The transmission line would be installed within this road corridor. Construction of the haul road, clear zone, and transmission line would physically alter 125 acres of mature aspen-birch forest and aspen-birch-balsam fir forest. Other disturbed areas would include 20 acres of wetland (lowland coniferous swamp and alder swamp), and 10 acres of open brush.

Portions of wetlands would be filled along parts of the road and at the Pike River crossing. Fill material could block the flow of water under the road, thus raising the water table on the upgradient side and lowering it on the downgradient side. The raising and lowering of water tables could induce changes in wetland plant associations (Thibodeau and Nickerson, 1985). Placing culverts under the road at appropriate depths and intervals could minimize the impacts associated with blocked drainage (Verry, 1988). This mitigative technique is discussed in Section 6.

Approximately 7 acres of upland vegetation would be affected by construction of the proposed service building and parking lot. In addition, upland vegetation would be affected along the 1,800-foot length of the proposed sound attenuation berm. No wetlands exist in either area.

A 1977 survey showed that St. Louis County contains a total of approximately 1.6 million acres of balsam fir, aspen, and paper birch forest types (Spencer and Ostrom, 1979). The construction of the Laurentian Mine, including the pit, stockpile area, and haul road, would destroy 860 acres of aspen-birch-balsam forest, which is 0.05 percent of this forest type in the county.

2. Mine Operation

As discussed in the groundwater impacts portion of Section 5, mine dewatering would change the groundwater elevation in the immediate vicinity of the pit. Figure 5.7 shows this expected change in groundwater elevation. This change would most likely affect wetlands in the vicinity. As water levels recede in the wetlands, wetland plant communities would gradually change from hydrophytic to mesophytic, resulting in a change in plant association. Some of the forested and shrub swamps may become dry enough to support upland vegetation.

The wetlands adjacent to White Lake and Elbert Lake could be most affected by mine dewatering. The actual change in wetland water levels would depend on the degree of interconnection between surface and groundwater in the area.

The operation of the mine should have minimal to no effect on the upland vegetation in the proposed project area.

No-Build Alternative

The alternative to not construct the Laurentian Mine would leave the vegetation and wetlands in the area in their present condition. It should be noted that the area north of the proposed mine is currently being logged. Logging activity will most likely continue to disturb the vegetation in the area.

Fish and Wildlife

Project Impacts

Wildlife habitat lost to the mine pit would include 325 acres of balsam fir and aspen-birch forest. The mine pit would also eliminate 35 acres of grass and shrub habitat used by sharp-tailed grouse. Other habitat lost includes a 25-acre lake, 40 acres of old stockpiles and 15 acres of wetland shrubs swamp. Construction impacts would be most damaging during the nesting/reproduction season when wildlife young are immobile and most vulnerable to loss. During other times of the year, the mobility of most species will allow them to escape physical endangerment. However, it is assumed that habitats surrounding the project area are at carrying capacity and that although displaced individuals might temporarily relocate, over time the population would decrease.

The stockpile area would be converted from forested habitat to grassland habitat. Eventually, tree species would invade the grassed areas and reestablish forest cover. Wildlife species remaining would be those adapted to use of grassland and brush areas. Local populations of many wildlife species would be reduced until the area is revegetated during reclamation.

Construction of the haul road would have short-term impacts, such as sedimentation and erosion at the crossing of the Pike River. Long-term change in aquatic organism composition in the Pike River is not expected.

Minimal fisheries habitat would be affected by construction of the mine pit, stockpile area, and haul road. The Mariska Pit and other smaller abandoned mine pits would be destroyed during the mining process. Dewatering of the Laurentian pit could have adverse impacts on the fish populations in White Lake as the result of lowering the lake level.

No negative impacts on either the eastern timber wolf or peregrine falcon are expected. Both species are presently co-existing with current mining operations.

1. Mine Construction

The only potential fisheries habitat within the boundaries of the proposed mine pit is the Mariska Pit. Mine construction would eventually encompass this pit and destroy the fish habitat. This habitat would be replaced when the Laurentian pit is completed and refills with water. The new 400-acre lake would provide habitat for fish such as trout and various coolwater species. Wildlife species that could potentially inhabit the mine pit would depend on the characteristics of the mine pit lake after mining ceases. The exposed cliffs along the pit walls could possibly provide nesting sites for the peregrine falcon until the pit fills with water. However, abandoned mine pits provide limited fish and wildlife habitat because they usually lack shallow water areas, which are typically most productive as habitat. The suitability of the pit for fish would depend on the final shape of the pit.

Habitat for wildlife would be directly impacted by mine construction. Approximately 325 acres of balsam fir and aspen-birch forest and 15 acres of alder swamp would be lost during the mining process. Also, 35 acres of grass and shrubs that have been used by sharp-tailed grouse in the western portion of the proposed pit area would be destroyed and a 25 acre lake would be drained. There would be a permanent loss of approximately 360 acres of upland habitat, 40 acres of old stockpiles, and 40 acres of lake and wetland which would eventually become a 440-acre mine pit lake when mining ceased and the pit filled with water.

Most wildlife species that occupy the area are sufficiently mobile to avoid direct physical endangerment. However, if mine construction and expansion (i.e., clearing and grubbing vegetation) occurred during spring and early summer, when many wildlife species would be nesting and rearing young, then some of the eggs and young could be killed or injured because their limited mobility would prevent escape.

Potential fisheries habitat in the proposed stockpile area is limited to a 5-acre mine pit that has filled with water. This pit would be covered with a rock stockpile. In addition, approximately 600 acres of wildlife habitat in the stockpile area would be eliminated. Local populations of many wildlife species would be reduced until the area is revegetated during reclamation.

Some of the surrounding habitat niches may already be at the saturation level for certain wildlife species. Populations of those species would experience localized declines unless suitable habitat was restored after mining ended.

These stockpiles would be gradually revegetated with grasses, legumes, and aspen, and wildlife species would reinhabit the reclaimed area. This resulting habitat would be different from the mature deciduous-conifer forests now present, and the change in vegetative communities would change the wildlife species composition. Wildlife species that require a mature forest for habitat would probably not inhabit the reclaimed stockpile area until a mature forest was created through natural succession. Species that would no longer have suitable habitat in the area due to the different vegetation communities on the stockpiles are listed in Table 5.25. Ninety-two percent of these species are birds. Since stands of mature forest would remain in areas adjacent to the proposed mine, regional bird species diversity should not be adversely affected.

The proposed haul road would cross the headwaters of the Pike River, a state-protected water. Potential road impacts on fisheries habitat would be associated with this crossing. Placing a culvert under the crossing would alter the physical aquatic habitat in the immediate vicinity. Depending on the type and size of the culvert, stream characteristics such as width, depth, velocity, and streambed type could be modified. However, with the shallow depths, low flows, and organic bottom substrate at the proposed crossing, these impacts on the stream's physical characteristics should be minor. A significant change in the aquatic communities would not be expected after the road crossing is completed. Assuming the culvert is placed properly, fish passage should not be affected. Techniques for ensuring proper sizing and placement of the culvert for fish passage are discussed in Appendix E.

Resuspension of sediments during construction of the haul road crossing would have temporary impacts on the river's aquatic communities. After construction, surface runoff from the road could also increase suspended sediments in the river during periods of heavy rainfall. However, impacts associated with suspended sediments should be minor and of short duration. The aquatic organisms inhabiting the Pike River at the proposed crossing are not expected to be extremely sensitive to minor increases in suspended sediment concentrations. Best management practices for controlling erosion and sedimentation from road runoff are discussed in Section 6.

The proposed haul road would also cross an intermittent stream approximately 1 mile north of the Pike River. The stream at the proposed crossing is essentially a shallow gully with a fairly steep gradient (0.2 ft/ft). Since the stream appears to flow only on a seasonal basis, the stream is not expected to support aquatic life in the area of the proposed crossing. Therefore, the road crossing at the intermittent stream is expected to have minimal impact on aquatic organisms.

TABLE 5.25
WILDLIFE SPECIES THAT MAY BE ABSENT AFTER MINE COMPLETION

Common Name	Scientific Name
Alder Flycatcher	*Empidonax alnorum*
Bay-breasted Warbler	*Dendroica castanea*
Black-billed Three-toed Woodpecker	*Picoides articus*
Bog Lemming	*Synaptomys cooperi*
Boreal Chickadee	*Parus hudsonicus*
Brown Thrasher	*Toxostoma rufum*
Chipping Sparrow	*Spizella passerina*
Common Grackle	*Quiscala quiscalus*
Common Redpoll	*Acanthis flammea*
Common Yellowthroat	*Geothlypis trichas*
Connecticut Warbler	*Oporornis agilis*
Cooper's Hawk	*Accipiter cooperii*
Downy Woodpecker	*Dendrocopus pubesecens*
Eastern Gray Squirrel	*Sciurus carolinensis*
Eastern Kingbird	*Tyrannus tyrannus*
Eastern Newt	*Notophthalmus viridescens*
Evening Grosbeak	*Hesperiphona vespertina*
Golden-crowned Kinglet	*Regulus satrapa*
Gray Jay	*Perisoreus canadensis*
Hermit Thrush	*Catharus guttatus*
House Wren	*Troglodytes aedon*
Indigo Bunting	*Passerina cyanea*
Least Bittern	*Ixobrychus exilis*
Least Flycatcher	*Empidonax minimus*
Lincoln's Sparrow	*Melospiza lincolnii*
Magnolia Warbler	*Dendroica magnolia*
Marten	*Martes americana*
Mourning Dove	*Zenaida macroura*

TABLE 5.25 (cont.)

WILDLIFE SPECIES THAT MAY BE ABSENT AFTER MINE COMPLETION

Common Name	Scientific Name
Nashville Warbler	*Vermivora ruficapilla*
Northern Bog Lemming	*Synaptomys borealis*
Northern Flying Squirrel	*Glaucomys sabrinus*
Northern Three-toed Woodpecker	*Picoides tridactylus*
Olive-sided Flycatcher	*Nuttallornis borealis*
Palm Warbler	*Dendroica palmarum*
Pine Grosbeak	*Pinicola enucleator*
Pine Siskin	*Spinus pinus*
Purple Finch	*Carpodacus purpureus*
Red Crossbill	*Loxia curvirostra*
Red-breasted Nuthatch	*Sitta canadensis*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Redbelly Snake	*Storeria occipitomaculata*
Richardson Shrew	*Sorex arcticus*
Ruby-crowned Kinglet	*Regulus calendula*
Solitary Vireo	*Vireo solitarius*
Song Sparrow	*Melospiza melodia*
Spruce Grouse	*Canachites canadensis*
White-winged Crossbill	*Loxia leucoptera*
Yellow Rail	*Coturnicops noveboracensis*
Yellow Warbler	*Dendroica petechia*
Yellow-bellied Flycatcher	*Empidonax flaviventris*
Yellow-billed Cuckoo	*Coccyzus americanus*

Wildlife habitat would be directly affected by construction of the haul road and clear zone. Approximately 125 acres of forested habitat and 20 acres of wetland habitat would be permanently lost due to road construction.

The construction of a transmission line along the haul road corridor may have an impact on birds. Transmission lines in areas of bird activity, especially wetlands, can cause an increase in bird mortality due to collisions with transmission equipment and electrocution (Avery, 1978). Since birds tend to utilize river valleys, the construction of a transmission line across the Pike River would also have the potential to further increase bird mortality.

2. Mine Operation

The dewatering of the mine and alteration of watersheds would have an impact on the water quality of White Lake, Leaf Lake, and the Corsica Pit. These impacts are discussed earlier in the section on water quality. This change in water quality could affect the fish species inhabiting the lakes. In particular, the decrease in depth of White Lake caused by mine pit dewatering could result in higher winter oxygen depletion rates. The probability of winterkill occurrence would be expected to increase by about 28 percent if the normal water surface elevation of White Lake were decreased by 6 feet (the assumed "lowest water levels" scenario).

The majority of the fish species inhabiting White Lake can survive short periods of low dissolved oxygen concentrations. However, the continual occurrence of severe winterkill conditions could eliminate the most desirable gamefish, such as the largemouth bass. Since rough fish such as suckers and bullheads can tolerate extremely low dissolved oxygen concentrations, these species could survive in greater numbers and become more abundant in subsequent years.

Another impact of dewatering on White Lake would be the loss of spawning areas in the littoral zone of the lake as a result of the maximum 6-foot decrease in normal water surface elevation. Largemouth bass, bluegill, and northern pike use the shallow, vegetated areas for spawning. It is difficult to predict the type of spawning habitat that would be available for these species if a smaller and shallower White Lake resulted from dewatering the mine pit.

Water quality in Leaf Lake is anticipated to degrade as a result of routing minewater discharge through the lake. The predicted increase in phosphorus load to the lake could cause an increase in algal abundance and a subsequent decrease in water transparency. Leaf Lake currently experiences periods of hypolimnetic oxygen depletion in both the summer and winter seasons and the predicted change in water quality caused by mine development is not expected to cause changes in the lake's summer or winter dissolved oxygen regimes. The decrease in water quality is not expected to significantly affect the fish community in Leaf Lake. Black bullheads, which tolerate more eutrophic conditions, could increase in numbers, resulting in a shift of the relative abundance of fish species in the lake. However, since the black bullhead is currently a major component of the fisheries in Leaf Lake, the expected change in fish species abundance should be minor.

As discussed in the previous sections, wetlands within the zone of influence would also be affected by the dewatering of the mine pit. The wildlife habitat value of these wetlands would be decreased for the wildlife species that require a moist to wet environment.

An indirect impact of the haul road would be increased disturbance of wildlife inhabiting the surrounding area. Truck traffic would increase the likelihood of collisions with wildlife. The portion of the road in the relatively undisturbed area would increase the potential for conflicts between humans and wildlife. A species of particular concern is the eastern timber wolf. Studies on roads and wolf populations indicate that a high density of roads (greater than 1 linear mile per square mile) can contribute to a decrease in the survival of wolves (Thiel, 1985; Jensen, et al., 1986).

The existing road density within a 7-mile radius of the proposed haul road is 1.44 linear mile per square mile. Construction of the haul road would not significantly increase the road density in the region (1.48 linear mile per square mile). The existing road density along with the disturbance from other mining activities in the region does not provide favorable conditions for the maintenance of viable wolf populations. Wolf numbers in the Laurentian Mine area are expected to be low, however, so human-wolf interactions should be minimal. Since the regional road density after construction of the haul road would not significantly increase, the impacts on the limited wolf population as a result of the additional 6 miles of road should be minimal.

No-Build Alternative

The alternative to not construct the Laurentian Mine would have no effect on the fish and wildlife in the area. Vegetation and wetlands would remain relatively undisturbed, so wildlife species would continue to inhabit the area. Lakes and rivers would continue to support existing populations of fish and aquatic organisms.

Socio-Economics

Project Impacts

Development of the Laurentian Mine would continue the socio-economic benefits associated with the Minorca Mine. The Laurentian Mine would provide enough ore for the Minorca Plant to operate until 2031. The socio-economic impacts associated with closing the plant are discussed in the "no-build" section. The following section describes the socio-economic impacts that would result from the Laurentian Mine in terms of employment, purchases, taxes, and non-ferrous mineral leasing.

1. Construction Impacts

Inland Steel would hire contractors for all phases of construction, including pre-production stripping, the service building, and the transmission line, and part of the haul road construction. Inland Steel anticipates using Minnesota contractors and, depending on the competitiveness of their bids, local contractors.

Inland Steel expects to spend around $3 million in pre-production stripping and haul road construction, and around $4 million for construction of the service building. Another $500,000 would be spent on power distribution and pre-production drilling and blasting. Information on the specific equipment and employment requirements is not available; details on construction of the service building will be available in 1991.

2. Operation Impacts

Summarized next are how operation of the Laurentian Mine might impact employment, location of employees, regional and local purchases, utility purchases, various taxes, and non-ferrous mineral leasing.

Mine Employment

No net increase or decrease in the work force is anticipated. During 1991-1995, the mine operations work force would be split between the Minorca Mine and the Laurentian Mine depending on the level of activity in each. By 1995, all mine operations employees and some equipment maintenance employees would work at the Laurentian Mine. A total of 75 people would transfer from the Minorca facility to the Laurentian facility. The Minorca Mine and Plant currently employ 328 people.

Location of Employees

Inland Steel does not expect that employees would change residence due to a change of work location.

Purchases in the Region

As with the Minorca Mine, supplies, materials, and mining equipment for the Laurentian Mine would generally be purchased through local vendors that are spread across the Iron Range. Most of these vendors are in Virginia and Hibbing.

Initial mobile equipment purchases would total around $8.5 million, much of which would be purchased from manufacturers outside the region. However, local vendors will likely collect markups on some of these purchases.

Purchases in Gilbert/McKinley

Currently, there are few locations from which materials and supplies can be purchased in Gilbert or McKinley. Therefore, most of these purchases would continue to be made in Virginia and other Mesabi Range communities unless local options became available.

A number of eating and drinking establishments are located in Gilbert within half a mile of the proposed service building. It is expected that some of the shop and mine employees as well as people doing business with the Laurentian Mine would take advantage of these establishments. An exact estimate of economic impact is difficult to make but if even 20 employees each spent $30 per week in Gilbert, this would bring an additional $30,000 into the local economy annually.

Purchase of Utilities

In 1989, the Minorca mine and plant consumed over 1.13 million gallons of diesel fuel and 6.4 million kilowatt-hours of electricity. These figures would not change substantially for the Laurentian Mine and Minorca plant. For the most part, the purchase of electricity for the Laurentian Mine would simply replace the purchase of electricity for the Minorca Mine.

Inland Steel anticipates purchasing electricity for mine operation from Minnesota Power and Light Company. Inland Steel is considering purchasing electricity from the Gilbert electrical utility but no decisions on this option have been made.

Tax Payments from the Laurentian Mine

Taxes from the Laurentian Mine would be similar to those from the Minorca Mine. The one possible exception would be the sales tax on mobile and capital equipment, which could be considerably higher for 1990 and 1991 than before depending on the tax treatment of those purchases. At 6 percent, this would amount to $510,000 in additional tax payments to the State of Minnesota for the $8.5 million expenditure anticipated for mobile and capital equipment.

Taconite Production Tax Revenues

Mining operations pay a Taconite Production Tax that is distributed to communities throughout the Iron Range. As an Iron Range community, the City of Gilbert received $143,000 from the Taconite Municipal Aid fund in 1987. Communities with concentrating facilities receive an additional $0.015/ton and communities with mines receive an additional $0.01/ton. The

Laurentian Mine would increase Gilbert's current revenue from the tax fund by 17 percent ($25,000/year), assuming that Gilbert's taconite tax distribution remained constant and the mine eventually produced 2.5 million tons per year.

Property Tax Revenues

Property taxes would be collected on the service building, which would be located within the Gilbert city limits. In 1987, Gilbert had a total assessed valuation of $5.2 million. Assuming the service building had a $4 million construction cost and assessed value, taxes on the building could significantly add to Gilbert's property tax revenues.

Non-Ferrous Metallic Mineral Leases

Figure 4.28 shows the proposed locations of the Laurentian Mine pit, stockpile area, and related facilities, as well as the locations of current non-ferrous mineral leases. The mine pit and the low-grade taconite and waste rock stockpiles would lie completely outside the non-ferrous lease holdings.

Part of the overburden stockpile would cover 120 acres of State mineral rights leased to Rhude and Fryberger. The State of Minnesota does not own the surface rights in this area. Inland Steel would be responsible for making arrangements with the lessee in this area to ensure that access to potential non-ferrous deposits could be provided if necessary. While this could impact the lessee, loss of this area is not likely to have a significant impact on the region's overall mineral potential.

The proposed haul road would cross state and private non-ferrous mineral leases. Construction of the haul road through these leased areas is not expected to impact the region's non-ferrous mineral development potential.

Traffic

Once mine construction began, the old TH 135 would no longer be available and all traffic would use the new TH 135 and CSAH 20 to travel between

Gilbert and McKinley. Because the DM&IR railroad tracks cross CSAH 20 to McKinley, traffic would be periodically interrupted by trains. This would primarily be a concern for emergency vehicles (which have continued to use old TH 135). For normal traffic and hence economic activity, the loss of old TH 135 is not significant.

No-Build Impacts

If the Laurentian Mine were not developed, Inland Steel would probably have to close the Minorca Taconite Plant between 1992 and 1995 because the Minorca Mine will be exhausted. Inland Steel evaluated mining the Ordean or East Rouchleau taconite reserves to keep the plant open, but determined that either mine would make the plant non-competitive. The EAW Scoping Process rejected those mining alternatives from further consideration; only the socio-economic impacts of plant closure are discussed in this section.

For 1990, the Minorca Plant has an estimated economic output of $80.4 million per year. If the plant closed, this output would stop, as would material purchases, wages, and taxes. The plant is an integral part of the St. Louis County and Minnesota economy, and plant closure would impact a variety of economic sectors. The multipliers discussed in Section 4 can be used to estimate these overall impacts on the county and state, since most of these impacts are expected to be within the county.

The short-term loss in output would be $96 million per year. Over several years as the labor force adjusts, this loss would increase to $118 million per year. Some specific elements of this loss are discussed below.

Within this total amount is employee compensation, currently at $12 million per year. This direct compensation would be lost along with an additional $2.1 million in multiplier effects for a total short-term annual loss of $14.1 million in wages paid. After several years, the total loss (direct and indirect) would be $16.7 million annually in employee compensation alone.

The Minorca mine and plant currently employ 328 workers. Plant closure would cause an immediate reduction of 328 jobs at the mine and plant and 63 related jobs throughout St. Louis County, with a longer term loss of 535 direct and related jobs.

Many of these impacts would occur in the Virginia area, especially the longer-range impacts of reduced employment and lost wages that would normally be spent in the region. An exact estimate of impacts in the immediate area is not possible without knowledge of materials and supply purchases by Inland Steel and detailed data on employee residence.

The county and state would lose the Taconite Production Tax of $3.8 million per year, now paid by the Minorca facility. With plant closure, this $3.8 million would no longer be collected for distribution to Iron Range communities for various uses. The impact on Virginia would probably be the greatest since it is a relatively large city and service center in the region and hence receives a larger portion of the distribution. Some of this loss would be felt by Gilbert as well as other communities on the Iron Range.

Most of the following tax payments made by Inland Steel in 1989 would be lost to the region:

Real Estate and Personal Property	$ 139,700
Unemployment Compensation (paid to the State of Minnesota)	$ 340,100
Sales and Use Tax	$ 515,300
Royalty Tax	$ 191,300
TOTAL TAXES LOST	$1,186,400

It is likely that some real estate and property taxes would still be paid, depending on how the plant and mine property were treated. Without production and employees, the other taxes would be lost.

The overall annual loss to the region and state of $105 million in direct and indirect output would be manifest through a number of changes in employment, associated wages, and taxes collected by various levels of government, in addition to impacts on other businesses and households.

SECTION 6: Mitigation

The previous section described the potential impacts of operation and construction of the Laurentian Mine. This section recommends ways that adverse impacts could be avoided, minimized, or compensated.

Surface Water

Surface water impacts are impacts to the amount of water in area lakes and rivers. Construction and operation of the proposed Laurentian Mine would significantly impact water levels in Leaf Lake, White Lake, and the mine dewatering route. The Corsica Pit, Lake Orebegone, the Pike River, and other surface waters in the vicinity of the proposed project would not be significantly impacted in terms of water quantity. This section discusses methods for monitoring area lakes and for mitigating significant impacts.

White Lake

White Lake could drop up to 6 feet due to a decreased watershed area as well as lower groundwater levels resulting from mine dewatering. If the lake dropped below its historical range of fluctuation, some of the Laurentian Mine dewatering discharge could be sent to White Lake to maintain historical levels. A pipeline could be run from the mine to White Lake or to wetlands southwest of the lake that flow to the lake. The latter option would also help maintain wetland water levels.

The pumping rate should be adjusted so that White Lake's level fluctuates within its normal range. The proposed range of lake levels, based on historical data through 1978, is Elevation 1422 to 1423.5. This range may need to be modified based on a survey of current outlet conditions and data collected in the early years of mine operations. The rate of minewater discharge required to maintain White Lake is expected to be less than 0.2 cubic feet per second (cfs) (less than 90 gallons per minute).

White Lake's water levels should be recorded on a monthly basis to determine if it is being impacted and if mitigation measures were successful. Lake level measurement should begin as soon as possible and continue throughout the life of the mine. If mitigation were necessary, monitoring might have to continue after mining ended until groundwater levels recovered. Lake level data collection should continue after mining ended so the lake's reaction to post-mining conditions could be determined.

A permanent survey benchmark should be established adjacent to the lake to be used in the measurement of the monthly lake levels. A staff gage could also be set, but it would have to be firmly anchored and regularly checked for movement.

After mining ended, the lake would be about half a foot lower than before mining because less area would drain to it.

Leaf Lake

Leaf Lake would rise an average of 8 inches and up to 15 inches in the spring because water from the Laurentian Mine would be routed to the lake. The lake would return to its previous level once mining ended. These higher water levels could be reduced by replacing, and possibly lowering, the Chestnut Drive culvert that outlets the lake. The replacement could consist of either one larger culvert or multiple smaller culverts. Also, the channel immediately downstream of the culvert should be cleared of any sediment or debris.

A new outlet design would have to consider many factors. The existing outlet culvert appears to have been raised twice over the last 25 years for a total of approximately 2 feet. The discharges from mine dewatering would increase gradually over the mine's 40-year life as the mine's area and depth increased, and then would cease when mining ended. Mine dewatering discharges would also likely decrease significantly during winter. The flow through Leaf Lake would also be reduced if some mine discharge were sent to White Lake to raise low lake levels. Therefore, it might prove necessary to either install an adjustable outlet structure at Chestnut Drive or modify the existing outlet over the life of the mine. The outlet design would have to be coordinated among the Minnesota Department of Natural Resources, county road officials, Inland Steel Mining Company, and local residents.

A permanent benchmark should be established adjacent to the lake and the lake level surveyed on a monthly basis. The lake level should be measured on the lake itself and not on the channel between the lake and outlet culvert. A staff gage could also be set, but it would have to be firmly anchored and regularly checked for movement. Lake level measurement should begin as soon as possible to provide additional information on which a new outlet design could be based. Monitoring would likely need to continue for a period after mining ended to document the effects of halting mine dewatering flows.

Dewatering Ditch Route

To avoid flooding along the dewatering ditch, culverts should be installed or enlarged at five locations:

- Where the ditch would cross two dirt roads that run along each side of the DM&IR railroad tracks (the tracks already have a culvert but the roads do not)

- Where the ditch would cross a dirt road immediately upstream of the sedimentation pond

- Where the sedimentation pond should outlet

- At Leaf Lake's outlet (discussed above in more detail)

The culverts should be designed to be large enough to pass the 100-year discharge given in Table 5.11 and also limit the potential for ice blockage. An option for the roads along the railroad tracks and upstream of the sedimentation pond would be to remove the road beds at the crossing points, which would help prevent ice blockage during the winter. Apparently these are old stockpile access roads that are rarely used; removing them should not have an adverse impact.

The trees and shrubs on the ditch's bottom and side slopes should be removed to reduce the potential for blockage in the channel. However, low vegetation (such as grasses) should be maintained on the side slopes to minimize erosion. In addition, high points along the bottom of the ditch should be lowered to create a more uniform slope in the ditch.

Records of mine dewatering rates should be maintained for use in evaluating ditch performance. Such records would also be useful in evaluating impacts observed in lake level monitoring.

Groundwater

Mine dewatering would lower surrounding groundwater levels, which in turn could lower White Lake up to 6 feet. As discussed in the previous section on surface water, some minewater could be diverted to White Lake if the lake were to drop below historical water levels.

Mine dewatering would also lower the Corsica Pit up to 3 feet, but this drop is considered insignificant because the lake is deep with steep sides. Moreover, if White Lake were to receive minewater discharge, the increased seepage from White Lake to the groundwater would help support the Corsica Pit's level. Therefore, no mitigation is proposed for the Corsica Pit, although some adjustment to the McKinley water supply intake structure could become necessary.

Mine dewatering could lower Lake Orebegone up to 1 foot, but this drop is considered insignificant because the lake is deep with steep sides. If the lake level were to drop significantly, some minewater discharge could be diverted to the lake. Lake Orebegone is an important recreational area; if the water level drop restricted public access to the lake, corrective measures should be taken, such as pumping in minewater or extending the existing boat ramp.

To determine if lake levels dropped significantly, benchmarks should be established and monthly water level readings should be collected on White Lake, Lake Orebegone, and the Corsica Pit. These measurements should begin before mining started. Monitored levels in the Corsica Pit and Lake Orebegone should reflect the change in groundwater levels due to their good connection with the regional groundwater aquifer. If lake levels were to drop, monitoring should continue after mining ended until the pattern of water level recovery was identified.

Construction and operation of the proposed Laurentian Mine are not expected to cause impacts in nearby wells.

Water Quality

Construction of the Laurentian project could potentially degrade water quality because disturbed and exposed soil surfaces can more easily erode and add sediment and nutrients to the Pike River and area lakes. In most Minnesota waters, phosphorus is the nutrient of greatest concern because it usually controls the growth of weeds and algae in lakes. Phosphorus is a naturally occurring element, the majority of which is attached to sediment particles. As phosphorus levels increase, algal blooms may occur and aquatic weeds become more abundant. Water clarity may be reduced and, as the weeds and algae die and decay, oxygen is consumed. This can cause a serious decline in the dissolved oxygen levels of a lake. Fish populations may then become dominated by species tolerant of these conditions, which are often rough fish like carp and bullheads.

It is therefore recommended that short-term watershed Best Management Practices (BMPs) be used to protect water quality during construction. The list below shows many of the temporary practices available. Many of these same practices would also be appropriate for long-term use after construction ends and during mine operation.

- Temporary Sediment Basin
- Temporary Sediment Trap
- Silt Fence
- Straw Bale Sediment Trap
- Drain Inlet Protection
- Flotation Silt Curtain
- Temporary Rock Construction Entrance
- Diversion
- Temporary Diversion
- Temporary Right-of-Way Diversion
- Stormwater Conveyance Channel
- Subsurface Drain
- Temporary Slope Drain
- Grade Stabilization Structure
- Outlet Protection
- Temporary Stream Crossing
- Riprap
- Structural Streambank Protection
- Temporary Seeding
- Permanent Seeding
- Sodding
- Mulching

Besides short-term construction impacts, long-term water quality impacts could result from operation of the Laurentian Mine. Mine dewatering could result in the lowering of White Lake, increasing its susceptibility to winter fish kills. As discussed elsewhere in this section, susceptibility to winter fish kills could be reduced by 1) routing minewater to White Lake to increase water levels, or 2) installing an aeration system in the lake to provide more oxygen.

Leaf Lake would receive phosphorus in the mine dewatering discharge, which could increase summer algal blooms. The Minnesota Pollution Control Agency's NPDES permit for the mine dewatering discharge would contain water quality standards for that discharge. Inland Steel would have to apply corrective measures in order to comply with these standards and to avoid significant impacts to Leaf Lake's water quality.

Stormwater runoff from the unvegetated stockpiles could add sediment and nutrients to the Corsica Pit, McKinley's water supply. However, the company has proposed to construct a runoff diversion berm to divert stockpile runoff away from the Corsica Pit to bermed natural drainage swales where infiltration would occur. Stockpile revegetation, as required under state rules, would help minimize stockpile erosion as well. The Corsica Pit's water quality might improve because its watershed area and corresponding phosphorus load would be reduced. Therefore, no steps in addition to the diversion berm and stockpile revegetation are considered necessary to protect the Corsica Pit's water quality.

Runoff from the haul road may affect Pike River's water quality during infrequent storm events or during periods of snowmelt if the runoff is not controlled by BMPs. There are many BMPs available, but of most likely effectiveness are runoff detention/sedimentation ponds in combination with vegetated swales along the road to reduce sediment and nutrients reaching the river. Other potentially beneficial BMPs along the haul road include permanent seeding of slopes, riprap, and stormwater conveyance channels.

Long-term BMPs could be put in place during mine construction to remain as long as needed or permanently, if necessary. Many of the short-term practices listed earlier could be appropriate. Additional practices include:

- Detention Pond
- Extended Detention Pond
- Infiltration Basin
- Infiltration Trench
- Wetland Treatment
- Flotable Skimmer
- Filter Strip
- Vegetated Swale

Selecting practices to mitigate adverse water quality impacts is apt to be site-specific and could include many practices, either alone or in combination. It is not the purpose of this Environmental Impact Statement to specify BMPs for specific locations, but to indicate what appropriate practices are available for implementation.

Short- and long-term watershed BMPs are described in Appendix E. Further information is available in these Minnesota Pollution Control Agency documents:

1. Protecting Water Quality in Urban Areas: Best Management Practices for Minnesota (1989).

2. Agriculture and Water Quality: Best Management Practices for Minnesota (undated).

3. Water Quality in Forest Management: Best Management Practices in Minnesota (undated).

Air Quality

Construction and operation of the proposed Laurentian Mine would release dust through haul road truck traffic, stockpile wind erosion, materials handling, and blasting. Truck traffic on the haul road is expected to be the main contributor of dust. However, Inland Steel would use a number of measures to mitigate air quality impacts, as currently required in their state air quality permit:

1. To reduce dust emissions during construction and operation, the haul road would be watered up to full-time as needed. Calcium chloride would also be applied periodically as a dust suppressant, primarily on the portion of road nearest Gilbert. Calcium chloride is routinely used as a dust suppressant on roads and in mining operations (Holmes, 1990). In addition, the haul road would be covered by crushed mine waste rock and the embankment sideslopes would be covered by riprap (stones and rocks) to minimize dust from wind erosion and truck traffic.

2. Wind erosion of stockpiles would be controlled through stockpile design and location, and by vegetating de-activated stockpile areas (as required by state reclamation rules). In addition, weathering would naturally create an "armor" on the stockpile that would protect the underlying fines from additional erosion. Snow cover and freezing temperatures during winter months would also help protect the stockpiles from wind erosion.

3. Dust from materials handling (such as loading ore into trucks) would occur primarily inside the mine pit and stay within the pit. Materials handling would have the greatest impact during the first years of mine operation, when the pit is shallowest. No mitigation is considered necessary for this potential impact.

4. Dust from blasting cannot be directly controlled. Indirect control would be achieved by using a blast design that causes lateral instead of upward movement of materials. Also, blasting would be delayed if the area had an atmospheric inversion or winds from the east or northeast greater than 15 mph. As with materials handling, the dust from blasting would have the greatest impact during the first years of operation, when the pit was shallowest.

5. Inland Steel's Air Emission Permit from the Minnesota Pollution Control Agency includes a fugitive emissions control plan for the Minorca operation that would apply to the Laurentian Mine as well. This plan (shown on Table 6.1) includes general conditions that provide regulating agencies with broad enforcement powers to ensure the control of fugitive dust.

   To ensure compliance with the permit, the MPCA responds to citizen's complaints and maintains their own monitoring program. Violations can result in penalties ranging from fines to stopping mine operation until the issue is addressed. Thus, conditions of Inland Steel's Air Emission Permit are considered adequate to prevent significant air quality impacts.

With the implementation of these measures, no significant air quality impacts are expected from construction and operation of the Laurentian Mine.

TABLE 6.1

FUGITIVE EMISSION CONTROL PLAN
MINORCA AND PROPOSED LAURENTIAN MINES
INLAND STEEL AIR EMISSION PERMIT

The following is a list of potential fugitive dust sources with the respective control method to minimize the fugitive dust.

Sources	Control Method
1. Storage Piles a. Coarse Ore Pile b. Fine Ore Pile c. Pellet Storage Pile	General controls in reducing fugitive emissions from storage piles is as follows: a. To minimize the distance from point of discharge to the top of the pile. b. Piles are located in such a manner as to minimize wind exposure of the pile. c. The material transported to the piles (via conveyor belts) is sprayed with water and/or other dust suppressant chemicals except during freezing conditions.
2. Plant Site/Haul Roadways	Chloride is periodically applied to the roads. Also water is sprayed on the roads on an as-needed basis (full time when necessary). Also, roadways are constructed using coarse tailings and gravel to minimize dust emissions.

TABLE 6.1 (cont.)

FUGITIVE EMISSION CONTROL PLAN
MINORCA AND PROPOSED LAURENTIAN MINE
INLAND STEEL AIR EMISSION PERMIT

3.	Waste Disposal Areas	All waste disposal areas will be revegetated as soon as the area becomes deactivated. The roadways on these areas are treated in the same manner as other roadways.
4.	Tailings Basin	All the exposed exterior dike slopes have been seeded and the interior slopes have been riprapped. The interior trees at the dike have been left standing to reduce wind effects. At present, tailings beaches are small and fugitive dust is minimized by keeping these areas wet. As tailing beaches increase, chemical dust suppression control will be applied.
5.	Parking Lot	All parking lots in the plant site have been paved and are cleaned by sweeping several times per year.
6.	Blasting	No controls are possible, however, good blasting practices result in materials moving in a lateral direction rather than upward into the atmosphere.

Noise and Vibration

As discussed in Section 5, noise and vibration impacts would be within the acceptable limits set by the Minnesota Pollution Control Agency and the Minnesota Department of Natural Resources, with two exceptions: construction of the sound attenuation berm, and stockpiling within 2,500 feet of the berm at heights above the berm height between 10:00 and 11:00 p.m. To reduce this latter impact, stockpiling at levels above the berm should be limited to daytime or early evening hours. If conducted at night, the activity should be kept as far away from the berm as possible to avoid exceeding the MPCA's nighttime noise standard. Noise associated with construction of the sound attenuation berm would be unavoidable but temporary.

Inland Steel's plan for the mine already includes a number of planning and design measures to minimize noise and vibration impacts:

- To reduce noise reaching the City of Gilbert, an 1,800-foot long sound, 50-foot long attenuation berm would be built near the service building and part of the haul road. Once built, this earthen berm would reduce construction noise as well as operation noise from the service building, mine, and haul road traffic. The berm would shield the residence nearest the mine as well as the elevated residential area on the north side of Gilbert.

  No mitigation measures are proposed for the noise generated on the portion of the haul road that turns away from Gilbert because no impacts to people are expected.

- Noise from haul trucks and mine equipment would occur more than 2,000 feet from the nearest residence. As the Laurentian pit increases in depth, the pit walls would further reduce noise. During the early stages of mining, when much of the activity is at or near the surface, nighttime operations close to Gilbert should be minimized whenever possible.

- Blasting would be done in relatively small patterns of tightly-spaced blast holes with each hole individually delayed to minimize ground shock. In addition, the blast holes would be connected by a noiseless trunkline to reduce air shock noise. The size of the array and the limited delay weight ensure that ground vibrations would not exceed values previously observed at the Minorca Mine, which have been well below the MDNR limit of 1 inch per second.

- Blasting procedures would be adjusted as needed to minimize impacts, especially when blasting approaches the wastewater treatment plant and nearest residence in Gilbert (sometime around the years 2005-2010). Inland Steel would redesign the blast by modifying spacing, delay weights, types of explosive, and other factors to ensure that there would be no structural damage from blasting ground vibration.

- A pre-production test blast would occur before mine blasting to ensure that the DNR 130 decibel limit is not exceeded off mine property. Blasting would be delayed if the pre-production test blast exceeded 123 decibels. Mine blasting would also be delayed if the area had an atmospheric inversion or winds from the east or northeast greater than 15 mph.

- Noise and vibration would be monitored so that adjustments to minimize impacts could be made if needed.

Beyond the measures indicated above, no additional action is considered necessary to mitigate noise and vibration impacts from construction and operation of the Laurentian Mine. However, it would be appropriate for Inland Steel to provide a 24-hour employee-staffed telephone "hotline" for citizens to register any complaints, comments, or questions regarding noise, vibration, and blasting impacts.

Vegetation and Wetlands

Construction and operation of the Laurentian Mine would remove or diminish vegetation and wetlands within the proposed mine pit, stockpile area, service building, and haul road areas.

Approximately 375 acres of vegetation would be impacted in the mine pit, 565 acres in the stockpile area, 135 acres along the haul road (mostly woods), and 7 acres at the service building and parking lot. No vegetation mitigation is proposed except for revegetating the stockpiles (as required by state reclamation rules), which would replace vegetation in nearly half the impacted area.

State mineland reclamation rules 6131.3500 and 6131.3600 require that vegetation be established on overburden stockpiles and on the benches and tops of rock and lean ore stockpiles. Therefore, Inland Steel would revegetate the entire overburden stockpile area (214 acres) and 322 acres of the waste rock and lean taconite stockpiles (excluding steep slopes). During mining, inactive portions of the stockpiles would be revegetated with grasses, legumes, and trees. Besides providing wildlife habitat, revegetation would minimize erosion and screen mining areas from view.

Specifically, Inland Steel would prepare a reclamation plan that would meet the requirements of Minnesota Rules 6130.3600, subpart 4. In general, these requirements are as follows:

A. Once a portion of stockpile becomes inactive, a 90 percent ground cover must be established after three growing seasons except on slopes that primarily face south and west. Those slopes must attain the 90 percent ground cover within five growing seasons.

   Where 90 percent ground cover is not attained, or where unvegetated rills or gullies more than 9 inches deep form and erosion is occurring, the surface must be repaired and replanted during the next normal planting period.

B. Within 10 growing seasons after a portion of a stockpile becomes inactive, it must have a vegetative community with characteristics similar to those in an "approved reference area." The reference area's vegetation may be planted or naturally occurring and must be representative of the site conditions and possible uses that might exist on mining landforms. To control erosion, the vegetation must be self-sustaining, regenerating, or in a recognized vegetation succession that provides wildlife habitat or other uses, such as pasture or timber land.

Wetlands could be affected in various ways. The proposed haul road route would directly affect approximately 20 acres of wetland. Fewer wetlands could be affected if an alternative haul road route were used. Figure 6.1 shows three alternative routes that would minimize wetland impacts, and Table 6.2 lists the amount of wetland area that would be affected by each. As shown in Route 1, the area of affected wetland could be reduced by 50 percent if the haul road crossed the Pike River at a right angle. Route 2 would impact even fewer wetlands, and Route 3 would have the least impact on wetlands, fish, and wildlife. In addition, Route 3 would disturb less mature upland forest because it would cross an abandoned railroad and old stockpile areas.

Another factor is that the proposed haul road route and routes 1 and 2 would cross land that is mostly under the control of Inland Steel, while Route 3 would cross land owned by USX. The overall impacts and engineering feasibility of these alternative haul road routes should be considered before a route is chosen.

It is also recommended that culverts be placed wherever the haul road crossed a wetland to allow the natural flow of water and avoid significant changes in wetland water levels. The bottom of the culvert pipe should be at least 18 inches below the wetland surface. Water collection and discharge ditches upstream and downstream of the road should also be constructed. Culverts should be placed at approximately 300-foot intervals at each wetland crossing (Verry, 1988). A permeable fill material such as crushed rock or gravel should be used for road construction in wetlands for at least the bottom layer (Lightfoot, 1990).

If mine dewatering caused wetlands to dry out, dewatering discharge water could be routed to the wetlands to replenish water levels.

Approximately 45 acres of wetland would be unavoidably lost as the result of stockpiling and mining. More could be lost during haul road construction. It is recommended that wetland losses be compensated by replacing them with wetlands of similar habitat value. The creation or restoration of wetlands should occur as close to the project area as possible.

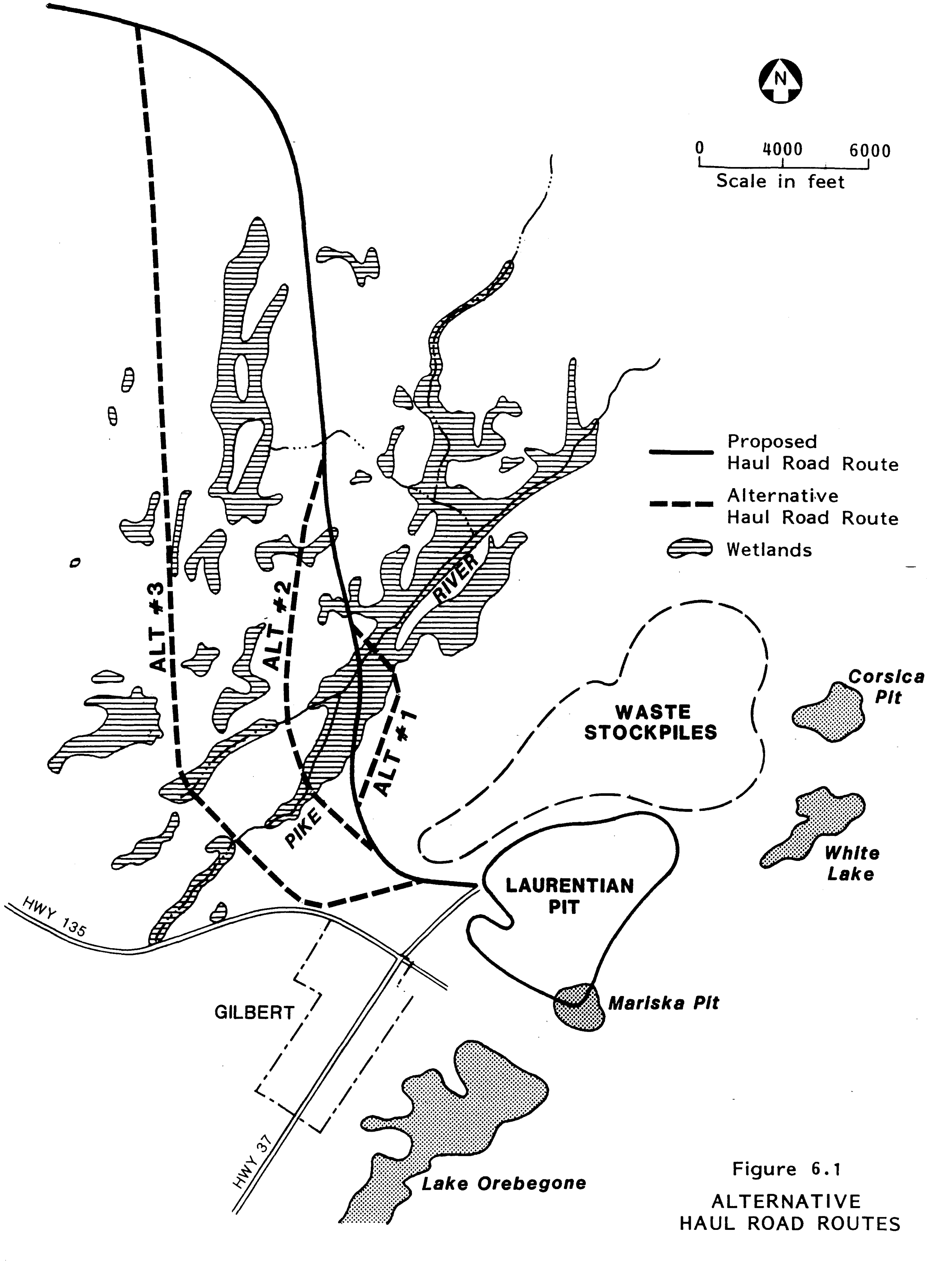

Figure 6.1
ALTERNATIVE
HAUL ROAD ROUTES

TABLE 6.2
WETLAND AREA AFFECTED BY ALTERNATIVE HAUL ROAD ROUTE

Haul Road Route	Wetland Area Affected[1] (acres)	Length of Road[2] (miles)
Proposed Route	20	6.2
Alternative Route 1	10	6.3
Alternative Route 2	5	6.4
Alternative Route 3	5	6.5

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[1] Based on wetlands delineated on National Wetland Inventory Maps (see Figure 4.20)

[2] Distance from old TH 135 to Minorca Plant.

Fish and Wildlife

The Laurentian project would impact fish and wildlife primarily by disturbing or destroying their habitats. It is generally assumed that habitats surrounding the project area are at carrying capacity and that although displaced individuals might temporarily relocate, over time the population would decrease. In addition, some individuals or eggs would be harmed during mining construction and operation. Much of the lost habitat would eventually be replaced by the revegetated stockpile area, which would be a different habitat type, and the water-filled mine pit.

Two federally-designated threatened or endangered species are present nearby, the eastern timber wolf and the peregrine falcon. The proposed mining project would not be expected to impact either species. Bald eagles are not known to occur in the proposed project area.

Inland Steel's end use plan for the Laurentian Mine should include a provision for developing a coldwater or coolwater fishery in the pit after it refills with water. Coldwater fish species such as lake trout have been stocked in other abandoned mine pits with limited success. The construction of ledges in the abandoned pit where the water is less than 15 feet deep would increase the lake's productivity and improve conditions for the growth of aquatic plants and organisms. A more productive lake would most likely support a larger food base, which would be beneficial for the growth and survival of fish.

The potential impacts of mine operation on White Lake fisheries could be minimized by the following measures:

- Route mine dewatering discharge into White Lake to maintain water levels that maximize the amount of available fish habitat and provide adequate spawning areas, and/or:

- Install aeration systems in White Lake to minimize the risk of winter fish kills due to lower lake levels.

Most of the wildlife habitat destroyed by the stockpiles would eventually be replaced when the stockpiles were revegetated, although the habitat type would be different from the existing condition.

Stockpile revegetation could be managed with the habitat requirements of specific wildlife species in mind. For example, stockpiles could be revegetated to serve sharp-tailed grouse, a wildlife species of special interest in northeast Minnesota. Stockpiles in the area have been successfully developed into habitat for sharp-tailed grouse (Lightfoot, 1990). The preferred habitat for sharp-tailed grouse is open grass/brushland that does not contain conifers (Berg). Other wildlife species, such as deer, moose, snowshoe hare, and various non-game species, would also benefit from this type of habitat (Berg). Habitat management guidelines for sharp-tailed grouse are described in a publication by the Minnesota Sharp-Tailed Grouse Society. Management techniques include the following:

- Seed the area with a grass-legume mixture and plant woody shrubs in scattered clumps.
- Control tall brush and non-commercial tree species by burning once every 5 to 7 years.
- Cut small areas of young brush and woodland borders to allow regrowth.
- Plant food plots of one or two acres in size consisting of grains such as buckwheat or oats.

The proposed haul road would cross the headwaters of the Pike River and could impact fisheries and aquatic life. The culvert at the crossing should be designed to promote fish passage and minimize erosion of fill into the river. A single corrugated pipe-arch metal culvert with a maximum width of 10 to 15 feet should be used at the crossing (Hynson, et al., 1982). Culvert placement should allow a minimum of 6 inches of water in the culvert during normal flows and the culvert should not slope more than 0.5 percent (Hynson, et al., 1982).

The river crossing should be constructed using Best Management Practices (BMPs) for controlling erosion and sedimentation. These BMPs are described in the earlier section on water quality mitigation, as well as in Appendix E.

A mitigative measure for wildlife species would be to route the haul road through previously disturbed areas that were not heavily used by wildlife. For example, alternative route 3 (Figure 6.1) would cross an abandoned railroad and old stockpile areas.

Wildlife, including the federally protected eastern timberwolf, could be struck by haul road traffic. This impact could be reduced by preventing public use of the haul road. Locked gates should be put on each end of the road to prevent vehicle traffic when the mining company is not using the haul road. After mining is completed, the haul road should be abandoned by removing the stream and wetland crossings and revegetating the road.

Socio-Economics

If the Laurentian Mine were developed, no adverse socio-economic impacts would be anticipated, and no mitigation is considered necessary. Rather, it is expected that the Laurentian Mine and the continued operation of the Minorca Plant would allow continued socio-economic benefits in terms of employment, purchases, and taxes.

Should the Minorca Mine and plant close, a variety of programs developed by the State of Minnesota would be implemented to assist the City of Virginia and the communities most heavily impacted by the closure and resulting loss of employment and tax revenues.

For example, the Minnesota Department of Jobs and Training is implementing the federal Economic Dislocation and Worker Adjustment Assistance Act (EDWAA). This act was created to assist workers and their communities facing a plant closing or permanent mass layoff, and provides for programs such as retraining, counseling, testing, and limited relocation.

The EDWAA process is initiated by establishing a community task force as a liaison between the Department of Jobs and Training and unemployed workers. The workers meet as soon as possible to discuss potential programs and options, and the workers are surveyed on their interest and willingness to participate in those programs. A proposal is then prepared by the community (in this case, Virginia) which would be submitted to the Department for funding.

The regional office of Jobs and Training in Virginia (serving EDWAA substate area #2) has extensive experience with plant closings in St. Louis County and would be responsible for programs related to the closing of the Minorca Mine and Plant.

APPENDIX A: Glossary

Here are definitions of terms that are not defined in the text of this Draft Environmental Impact Statement. These terms are defined with regard to their use in this Draft EIS.

Absolute Maximum Air Shock Level: The maximum air shock level that could occur based on the worst-case air shock measurement from Minorca Mine operations extrapolated to the Laurentian Mine receptor sites.

Absolute Maximum Vibration Level: The maximum vibration level that could occur based on the worst-case vibration measurement from Minorca Mine operations extrapolated to the Laurentian Mine receptor sites.

Ambient: the sound level that exists without the mine or mine-related activity.

Aquifer: zone below the ground's surface capable of producing water, as from a well.

Berm: an earthen embankment used to deflect sound or divert surface water flows.

Bimodal Distribution: a description for a data set that is distributed in two distinct maxima or modes.

dB: abbreviation for "decibel," which is the basic unit of sound measurement. It is measured relative to a base level that is assumed to be at the threshold of hearing.

dBA: abbreviation for the overall "A-weighted" sound pressure level as measured on a sound level meter. This is the descriptor normally used in community noise impact evaluation to represent a combination of sound frequencies in a manner similar to that of the human ear.

Emergent Vegetation: erect, rooted, herbaceous aquatic vegetation that generally grows in saturated conditions.

Esker Deposit: sinuous ridges of sand and gravel deposited by water flowing through channels in glacial ice.

Expected Maximum Air Shock Level: the most likely maximum air shock level that could be expected at the Laurentian Mine receptor sites based on air shock data from Minorca Mine operations and extrapolated using U.S. Bureau of Mines data.

Expected Maximum Vibration Level: the most likely maximum vibration level that could be expected at the Laurentian Mine receptor sites based on vibration data from Minorca Mine operations and extrapolated using U.S. Bureau of Mines data.

Fugitive Dust Emissions: dust from unconfined areas that cannot reasonably be contained could be directed through a stack, vent, or other functionally equivalent opening.

Glacial Drift: sediment deposited predominantly by glaciers.

Glaciofluvial: pertaining to deposits made by streams flowing from glaciers.

Grain-size Distribution: the statistical percentage of the size of mineral particles making up a rock or sediment.

Groundwater Recharge: the process by which aquifers receive water from precipitation, surface waters, or other aquifers.

Head-specified Line Sink: an analytic element in the Single Layer Analytic Element Model (SLAEM) that fixes the elevation of the groundwater level at a specified value and either takes out quantities of groundwater or puts quantities of groundwater back into the aquifer model to maintain the specified groundwater elevation.

Hydraulic Conductivity: the permeability of rock or sediment -- the ability of rock or sediment to transmit water.

Hydrogeology: the science of groundwater occurrence and flow; the geologic characteristics of a region, rock unit, or sediment unit that affect the movement and occurrence of groundwater.

Igneous: pertaining to rocks deposited by either volcanic activity or by the cooling of molten rock below the rock's surface.

Kettle Hole: depression in glacially deposited sediment caused by the melting of glacial ice blocks. Often kettle holes are the size of small lakes, ponds, or swamps.

Laboratory Bioassay: a method for quantitatively determining the concentration of a substance by its effect on the growth of a suitable animal, plant, or microorganism under controlled conditions.

"Leaky Well" Analytic Element: a feature of the Single Layer Analytic Element Model (SLAEM) that simulates low flow rates through low permeability areas such as rock ridges.

Limnology: the science of the life and conditions for life in lakes, ponds, and streams.

Lithology: pertaining to the physical characteristics of a geologic unit.

Magnetite: a black iron-oxide mineral with the formula FE_3O_4. Magnetite is mildly magnetic.

Mass Balance Analysis: analysis that relies on the principle that mass cannot be created or destroyed in the course of chemical and/or biological reactions.

Meta-sedimentary: pertaining to clay, silt, sand, or gravel that has been changed in physical and chemical characteristics by high pressure and/or high temperature. Generally meta-sedimentary rocks are of Precambrian age (greater than 600 million years old).

Moraine: sediments deposited chiefly by direct glacial action and having topographic characteristics independent of the control of the surrounding topography.

Morphologic: pertaining to the slope of a geologic unit or deposit.

Nutrient Export Rate Coefficient: the rate at which nutrients are lost from a watershed to a lake or stream.

Overburden: In mining terminology, pertaining to sediment or rock on top of an economic ore body.

Percolation: as used in this Draft EIS, the downward movement of water from the shallow soil root zone to the groundwater table.

Permeability: The measure of the ability of rock or sediment to transmit water.

Phytoplanktonic: pertaining to aquatic plant life that is floating or weakly motile (having the power to move spontaneously).

Piezometer: a well used to measure groundwater levels.

Pleistocene: the geologic time period during which glaciers occupied North America (2 million to 10 thousand years ago).

Precambrian: the geologic time period before 600 million years ago.

Regression Equation: given two dependent random variables, regression equations predict the expected value of one relative to a known value of the other.

Specific Conductance: a measure of the resistance of a solution to electrical flow.

Staff Gage: a post with elevations marked on it and driven into a lake bed for the purpose of measuring water levels.

Stoichiometric: relating to the quantitative chemical properties and composition of a material.

Strike of a Geological Formation: the direction taken by a sloping geologic unit as it intersects the horizontal plane.

Tailings: the waste rock remaining after taconite ore is ground up and magnetically separated; most of it is the size of sand.

Transmissivity: the hydraulic conductivity (permeability) of a rock unit multiplied by the thickness of the rock unit that is saturated with groundwater. Transmissivity is a measure of a rock unit's ability to move water over its entire thickness.

Transpiration: the process in which plants draw water from the soil and evaporate it from their leaves.

Water Budget: an accounting system for water in which precipitation falling on an area is balanced against what becomes of that precipitation -- surface runoff, movement to and through the groundwater, evaporation, and transpiration.

Wind Roses: a graphic that shows the frequency that wind blows from a given direction.

2369064/APPA.RPT

APPENDIX B: Economic Analysis of Taconite Ore Conveyance Alternatives

The scoping EAW identified three possible methods for transporting taconite ore from the Laurentian Mine to the processing plant. The three transportation choices were railroad, conveyor, and truck. The method presently proposed is truck.

Based on an analysis of the capital investment requirements, it was determined that transport of ore from the Laurentian Mine to the Minorca processing plant was economically feasible only by truck over a constructed haul road. The scoping decision identified this as the only transportation alternative to be analyzed in the EIS.

The following table compares the capital investment costs for each alternative.

In the case of either the rail or conveyor system, a road would still be required to transport electric shovels, loaders, and other mining equipment between the Minorca facility and the Laurentian Mine. Also, a right-of-way would be required for the electrical powerline. Truck equipment would be needed to transport taconite ore from the active mine face to a rail loading facility or to a conveyor loading hopper.

TABLE B.1

CAPITAL INVESTMENT COSTS FOR TACONITE ORE CONVEYANCE SYSTEMS

(Millions of Dollars)

Expenditure	Conveyance System		
Item	Rail	Conveyor	Truck
Road	$ .5	$ .5	$ 1.0
Service Building	2.0	2.0	4.0
Stripping	2.5	2.5	2.5
Drill & Blast	.2	.2	.2
Powerline	.3	.3	.3
Mobile Equipment	6.0	6.0	8.0
Rail Equipment	14.0	0.0	0.0
Conveyor Equipment	0.0	20.0	0.0
Total	$25.5	$31.5	$16.0

The costs presented in the table are capital investment expenditures only. Additional expenditures are required for operational costs. Operating costs for rail are $3.00 higher per ton of processed pellets than truck costs. The conveyor option has a lower cost per ton of processed pellets than truck haulage.

2364069/APPB.RPT

APPENDIX C: SPECLIST Database

The SPECLIST database is used to determine the possible presence of wildlife species in Minnesota when wildlife checklists or only limited field-collected data are available. Using SPECLIST, predictions can be made about the wildlife species potentially present based on the habitat types in a given project area. The database can also be used to predict the potential change in wildlife species richness resulting from changes in land use, implementation of certain management practices, or implementation of a specific project.

SPECLIST is comprised of three database files: BIRDCOVR for birds, MAMLCOVR for mammals, and AMPHCOVR for amphibians and reptiles. The database includes only species that are permanently or seasonally resident in the state.

Seasonal residents include species that either breed or winter within the state on a regular basis and whose ranges encompass the entire state or portions thereof.

SPECLIST is based on information about the habitat requirements of each species that were collected from a variety of field guides, literature references, and other habitat/wildlife association systems.

The database uses a matrix first developed by Svoboda (1977) and is based on a concept originated by Thomas (1979). This matrix technique is very similar to one used by Niemi (1979), which was developed for the Ottawa National Forest in Michigan. The habitat types described by Niemi are very similar to those used in this system. Both references were used in the development of SPECLIST.

Another technique developed and utilized by the Bureau of Land Management (Short, 1983) categorizes wildlife habitats according to guilds. Guilds are groups of wildlife species having similar patterns of habitat use. The development of wildlife guilds is also based on the structural form of habitat. Wildlife species are categorized according to their choices of habitat for feeding and breeding. Categorization of habitat according to structure is particularly useful for analyzing the impacts of a proposed project on wildlife habitat and permits better project planning and development.

The database system includes 36 structurally-defined habitat/land use cover type designations. These habitat/land use types are listed in Table A and are organized into seven major categories. Each of these major categories falls into various subgroups. The 350+ wildlife species that were identified as being seasonally or permanently resident within Minnesota were then evaluated for habitat use preferences. The wildlife species along with its choices of habitat types was entered into the database system.

Other information within the database includes the regional distribution of the species, regional distribution being organized according to Minnesota Department of Natural Resources Administrative Regions. This regional selection was chosen because the MDNR periodically publishes lists of wildlife species occurring within each region, and includes information about the occurrence, presence, and status of most species.

TABLE C.1
HABITAT/LAND USE

Habitat Type	Habitat Code
GRASSLAND	GR.---
Upland Prairie	GR.UPR
Old Field	GR.FLD
BRUSHLAND	BR.---
Open Brush	BR.BRU
Young Deciduous Upland	BR.YDU
Young Coniferous Upland	BR.YCU
Young Decid-Conifer Upland	BR.YMU
Brush Understory	BR.UND
Wetland Shrub	BR.ALW
Broad-leaved Evergreen Shrub Lowland	BR.EGS
WOODLAND	WD.---
Big Woods	WD.BWD
Mature Deciduous Riparian	WD.BOT
Mature Deciduous Upland	WD.PHH
Savannah	WD.OPW
Old Growth Deciduous Upland	WD.NOH
Old Growth Decid-Conifer Upland	WD.MOG
Old Growth Coniferous Upland	WD.COG
Open Coniferous Upland	WD.COP
Mature Decid-Conifer Upland	WD.MMU
Mature Coniferous Upland	WD.CMU
Closed Canopy Lowland Conifer	WD.CBS
Semi-open Lowland Conifer	WD.MSK
Broad-leaved Deciduous Lowland	WD.HWS
WETLANDS	WE.---
Non-persistent Emergent	WE.PLM
Persistent Emergent	WE.MSH
Sedge Meadow	WE.SMD
Woodland Pond	WE.WPD

TABLE C.1
HABITAT/LAND USE (Cont.)

OPEN WATER	OW.---
Lakes	OW.LAK
Streams/Rivers	OW.STR
SPECIAL HABITATS	SP.---
Banks/Rock Outcrops	SP.BRO
Sand Beaches/Dunes	SP.SBD
Urban	SP.URB
SEASONALLY ALTERED	SA.---
Wooded Pasture	SA.WDP
Open Pasture	SA.OPT
Orchards/Plantations	SA.ORP
Agricultural Field	SA.AGF
Agricultural Meadow	SA.AGM

APPENDIX D: Noise/Vibration Study

Hibbing Technical Institute

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Inland Steel Noise Survey/Minorca Mine/May, June 1989

Summary

A noise survey of the Minorca Mine was conducted in May 1989 due to the forthcoming land acquisition in the Gilbert area. To avert potential concern by area residents over increased noise levels, background noise data was collected on the following activities:

:Haul Truck Traffic Noise without a Berm
:Haul Truck Traffic Noise with a Berm
:Shovel Noise
:Truck Shop Noise

Sound level verses distance measurements were collected in an effort to determine the impact of noise in the City of Gilbert, based on existing operations at the Minorca Mine. Gilbert lies approximately 2000 feet from the outermost boundary of the proposed mine site.

Results of the survey indicate the following:

1. Traffic noise at 2000 feet from the main haul road in the existing Mine was equivalent to the background traffic noise level at the dwelling nearest to the proposed land acquisition.

2. Traffic noise in the existing Mine was measured behind a berm that was located approximately 1000 feet from a haul road. The level that was measured was below both the background traffic noise level at the nearest dwelling to the proposed mine site and the traffic noise at 2000 feet from the main haul road.

3. Shovel noise at 2000 feet from the shovel was approximately equivalent to the mine background noise.

4. Truck shop noise was strictly a short term sporadic noise and would not be a source of noise pollution at 2000 feet from the shop.

5. Each of the above sound levels is less than the L10 and L50 for both day and nighttime noise area classifications, NAC-1 according to Chapter 7010.040 of the MPCA Noise Pollution Control Rules. (See Appendix I for definitions.)

These results confirm that mining activity in the proposed Gilbert mine site which is similar to that which occurs in the Minorca Mine will not negatively impact the residents of the Gilbert area with respect to noise.

Referenced Standards
CFR 30 56.5-50 (MSHA)
CFR 29 1910.95 (OSHA)
Chapter 7010.0400 (MPCA Noise Pollution Control Rules)

Equipment
Bruel and Kjaer Precision Sound Level Meter with Octave Band Analyzer and Calibrator.
Model No.'s 2209, 4230, 4220, 1613.
DuPont Noise Dosimeters with calibrator and audio Read-out Unit.
Model No.'s D-376, C-114, R-225.

Introduction
Inland Steel operates the Minorca Mine on North Hwy 53 in Virginia Minnesota. Due to the finite life of the existing Mine, or the year 1992 as the projected Mine closure, Inland Steel has taken steps to purchase additional land with which to continue mining operations in Minnesota. The proposed land is approximately 2000 feet from the City of Gilbert Minnesota just east of the intersection of Hwy 135 and abandoned Hwy 135. A main haul road will be constructed which will connect the new Gilbert mine site to the existing processing plants in Virginia. This road will be bermed with an earthen berm to reduce both the visual and auditory impact of mine traffic.

The proposed mine site will operate on a basis that is parallel to the existing Mine in Virginia, i.e. similar sound levels will be generated by the same types of operations. Currently 11 haul trucks operate in the existing Minorca Mine and each truck makes approximately 2.5 round trips to the crusher each hour. Due to the additional travel distance from the proposed mine site to the crusher, it is estimated that each truck will make one round trip each hour and in total 64 round trips will be made each shift. Trucks will be hauling ore five days per week, 24 hours per day. However, depending on the demands of the industry, operations may require up to seven days per week hauling activity. Traffic noise from this hauling activity was estimated in the present survey based on existing operations in the Minoca Mine.

With respect to shoveling activity, three shovels operate each shift, five days per week, 24 hours per day. Two trucks are loaded by one shovel and approximately nine buckets of ore fill one haul truck. Mining at the proposed mine site will operate on the same basis, initially, and may increase up to seven days a week as the industry demands. Shovel noise was evaluated in the present noise survey based on current shovel operations.

A truck servicing shop will be located at the intersection of abandoned Hwy 135 and the new main haul road. Sound levels generated from the truck shop were measured and extrapolated to estimate the impact of noise on the City of Gilbert.

Procedure
A noise survey in the existing Minorca Mine was conducted on each of four days to determine the sound levels that may be anticipated in various operations at the new mine site. Traffic, shovel and truck shop noise were each evaluated.

Traffic Noise
Traffic sound verses distance measurements were obtained in the Minorca Mine to determine the potential sound levels experienced by Gilbert residents. Survey marks were established at 500 foot increments up to 2000 feet from the main haul road on the first intersection road running west. This road was chosen for the survey because no other activities were planned in the vicinity of the road on the day of sampling and hence sound level verses distance measurements could be made without extraneous interference. Sound levels were recorded at each of five locations and dosimeters were placed at each of the 1000 and 2000 foot markers. Sound levels were recorded behind a berm with approximate dimensions of 100' x 20' and approximately 1000 feet from road traffic. Background traffic noise was measured at the nearest dwelling which was approximately 1000 feet from the outermost edge of the proposed mine site.

Shovel Noise
Survey marks were likewise established in 500 foot increments up to 2000 feet from Shovel #5. This particular shovel was chosen due to a relatively straight and flat approach to the shovel. Shovel sound levels verses distance were dermined. Dosimeters were also placed at 1000 and 2000 foot marks.

Truck Shop Noise
Noise generated from truck start up and idling were measured both with the shop doors open and closed. Noise levels were extrapolated to 2000 feet to estimate the levels which could be experienced by Gilbert residents.

Results
Tables I-V

Haul truck noise levels both with and without a berm were equivalent to existing road traffic noise levels at a residence which is nearest to the proposed mine site. These noise levels were measured at 35, 38, and 38 dBA, respectively. Shovel noise both while loading and idling were measured at 52, and 50 dBA, respectively. The sound level at 2000 feet from the truck shop was calculated to be 47 dBA during truck start up, with the shop doors open.

No readings were obtained on any of the dosimeters which were placed in various locations within the mine. The lack of a dosimeter reading infers that the noise dose is less than 85 dBA as can be anticipated based on the sound level readings.

Discussion
Acceptable sound levels for the noise receiver are a function of the intended activity in that land area. Acceptable sound levels are established by the Minnesota Pollution Control Agency or MPCA. In the present survey the noise receiver is a residential area and therefore, acceptable noise levels are the most restrictive of all land area classifications. The noise area classification of residencial Gilbert is NAC-1 and the day and nighttime allowable standards {one hour time weighted averages (TWA)} for intermittent noise are 65 and 55 dBA, respectively.

Peak traffic noise was measured below the allowable day and nighttime intermittent noise standards for all distances greater than 1000 feet from the haul trucks. This level was measured for traffic with or without a berm. The time weighted average traffic noise level was less than both day and nighttime standards at all distances greater than 500 feet. Based on these traffic noise results, Gilbert area residents would receive a noise exposure that is well below the level which is allowed by the Minnesota Pollution Control agency for residences.

Likewise, peak shovel noise was measured at less than the allowable standards at a distance of 2000 feet. Calculation of a time weighted average shows that the noise level was below the allowable standards at all distances greater than 1000 feet from the shovel. The results from shovel noise confirm that Gilbert area residents would receive a noise exposure level that is less than the allowable level as established by the MPCA for residences.

Finally, extrapolated truck shop noise as received by the residents of Gilbert, was below the MPCA standard. Noise levels with both the shop doors open and closed were considerably less than the allowable level as extrapolated to both the nearest dwelling and the City of Gilbert. As with both traffic and shovel noise, truck shop noise does not constitute a noise pollution source

Conclusions

Background noise data is necessary to determine the potential impact of a new mining operation on residential noise receivers. Based on the results of the survey, each of the aforementioned activities including traffic noise, shovel noise and truck shop noise, is significantly lower than the Minnesota Pollution Control Standards for residential receivers. Therefore, the residents of Gilbert will not be negatively impacted from noise by the mining activites in the proposed Gilbert mine site, based on existing mining conditions and activities.

RESULTS

Table I: Truck Sound Levels at Various Distances from Intersection (i-s)

Distance from i-s	Sound Level (dBA)	Predicted Sound Level (dBA)	Description
20'	91	--	Upgrade
20'	88	--	Downgrade
500'	65	61	Combined
1000'	51	55	Combined
1500'	47	51	Combined
2000'	38	49	Combined

Table II: Shovel Sound Levels at Various Distances from Shovel

Distance from Shovel	Sound Level (dBA)	Predicted Sound Level (dBA)	Description
100'	82	--	Loading truck
100'	98	--	Bucket noise
500'	70	68	Loading truck
500'	80	84	Bucket noise
1000'	56	62	Loading truck
1000'	68	78	Bucket noise
1500'	56	58	Loading truck
1500'	60	74	Bucket noise
2000'	52	56	Loading truck
2000'	52	72	Bucket noise

RESULTS CONT'D

Table III: Truck Shop Sound Levels

Distance from Truck	Sound Level (dBA)	Predicted Sound Level (dBA)	Description
2'	107	--	Start up/door open
2'	96	--	Idle/door open
2'	80	--	Start up/door shut
2'	79	--	Idle/door shut
2000'	--	47	Start up/door open
2000'	--	36	Idle/door open
2000'	--	20	Start up/door shut
2000'	--	19	Idle/door shut

Table IV: Sound Levels at 2000' from Noise Source

Noise Source	Sound Level (dBA)	Predicted Sound Level (dBA)	Description
Haul Truck Noise	≤35*	--	Behind Berm
Haul Truck Noise	38	--	Without Berm
Road Traffic**	38	--	Hwy 135/Gilbert
Shovel Idling Noise	50	--	Without Berm
Shovel Loading Noise	52	--	Without Berm
Shovel Bucket Noise	52	--	Without Berm
Truck Shop Noise Start up/Shop door open	--	47	Without Berm

*Sound level at 1000' is 35 dBA so that the level at 2000' is less than or equal to 35 dBA.
**Road traffic or existing background noise at the nearest dwelling, which is 31000' from proposed mine site.

Appendix I

CHAPTER 7010
MINNESOTA POLLUTION CONTROL AGENCY
AIR QUALITY DIVISION
NOISE POLLUTION CONTROL RULES

7010.0100 DEFINITIONS.

For the purpose of all noise pollution control rules:

A. "ANSI" means the American National Standards Institute or its successor bodies.

B. "Agency" means the Minnesota Pollution Control Agency, its agent, or representative.

C. "dBA" is a unit of sound level. "dBA" is the weighted sound pressure level by the use of the A metering characteristic and weighting as specified in ANSI Specification for Sound Level Meters, S1.4 - 1971, which is hereby incorporated by reference. For the purpose of these parts, dBA is used as a measure of human response to sound.

D. "Daytime hours" are those from 7:00 a.m. to 10:00 p.m. (0700-2200).

E. "Decibel" is a unit of sound pressure level, abbreviated dB.

F. "Director" means the executive director of the Minnesota Pollution Control Agency.

G. "Impulsive noise" means either a single sound pressure peak (with either a rise time less than 200 milliseconds or total duration less than 200 milliseconds) or multiple sound pressure peaks (with either rise times less than 200 milliseconds or total duration less than 200 milliseconds) spaced at least by 200 millisecond pauses.

H. "L_{10}" is the sound level, expressed in dBA, which is exceeded ten percent of the time for a one hour survey, as measured by test procedures approved by the director.

I. "L_{50}" is the sound level, expressed in dBA, which is exceeded 50 percent of the time for a one hour survey, as measured by test procedures approved by the director.

J. "Nighttime hours" are those from 10:00 p.m. to 7:00 a.m. (2200-0700).

K. "Noise" means any sound not occurring in the natural environment, including, but not limited to, sounds emanating from aircraft and highways, and industrial, commercial, and residential sources.

L. "Nonimpulsive noise" means all noise not included in the definition of impulsive noise.

M. "Person" means any human being, any municipality, or other governmental or political subdivision, or any other public agency, any public or private corporation, any partnership, firm, association, or other organization, any receiver trustee, assignee, agent, or other legal representative of any of the foregoing, or any other legal entity, but does not include the Minnesota Pollution Control Agency.

N. "SLUCM" means the Standard Land Use Coding Manual (1969, United States Government Printing Office) which designates land activities by means of numerical codes.

O. "Sound" is an oscillation in pressure, stress, particle displacement, particle velocity, etc., in an elastic or partially elastic medium, or the superposition of such propagated alterations.

P. "Sound pressure level" is 20 times the logarithm to the base ten of the ratio of the pressure of a sound, p, to the reference pressure, p_r. For the purposes of these parts, the reference pressure shall be 20 micronewtons per square meter (20 $\mu N/m^2$). In equation form, sound pressure level in units of decibels is expressed as:

$$SPL\ (dB) = 20 \log_{10} p/p_r$$

Statutory Authority: *MS s 116.07 subds 2,4*

7010.0200 SEVERABILITY.

If any provision of any rule or the application thereof to any person or circumstances is held to be invalid, such invalidity shall not affect other provision or application, and to this end the provisions of all rules and the various applications thereof are declared to be severable.

Statutory Authority: *MS s 116.07 subds 2,4*

7010.0300 VARIANCE.

Whereupon written application of the responsible person or persons, the agency finds that by reason of exceptional circumstances strict conformity with any provisions of any noise rule would cause undue hardship, would be unreasonable, impractical, or not feasible under the circumstances, the agency may permit a variance upon such conditions and within such time limitations as it may prescribe for the prevention, control, or abatement of noise pollution in harmony with the intent of the state and any applicable federal laws.

Statutory Authority: *MS s 116.07 subds 2,4*

7010.0400 NOISE STANDARDS.

These standards describe the limiting levels of sound established on the basis of present knowledge for the preservation of public health and welfare. These standards are consistent with speech, sleep, annoyance, and hearing conservation requirements for receivers within areas grouped according to land activities by the noise area classification (NAC) system herein described. However, these standards do not, by themselves, identify the limiting levels of impulsive noise needed for the preservation of public health and welfare.

	Day (0700-2200)		Night (2200-0700)	
NAC	L_{50}	L_{10}	L_{50}	L_{10}
1	60	65	50	55
2	65	70	65	70
3	75	80	75	80

Statutory Authority: *MS s 166.07 subds 2,4*

7010.0500 NOISE AREA CLASSIFICATION SYSTEM ACCORDING TO LAND ACTIVITY AT RECEIVER.

Subpart 1. **In general.** Acceptable sound levels for the receiver are a function of the intended activity in that land area. The following noise area classifications are grouped and defined by the SLUCM numerical codes and descriptions.

Subp. 2. NAC-1. Noise area classification-1 (NAC-1) includes the following land activities:

NAC-1

11 Household units (includes farm houses)
12 Group quarters
13 Residential hotels
14 Mobile home parks or courts
15 Transient lodgings
19 Other residential, NEC*
397 Motion picture production
651 Medical and other health services
674 Correctional institutions
68 Educational services
691 Religious activities
71 Cultural activities and nature exhibitions
721 Entertainment assembly
7491 Camping and picnicking areas (designated)
75 Resorts and group camps
79 Other cultural, entertainment, and recreational activities, NEC

Subp. 3. NAC-2. Noise area classification-2 (NAC-2) includes the following land activities:

NAC-2

4113 Railroad terminals (passenger)
4115 Railroad terminals (passenger and freight)
4122 Rapid rail transit and street railway passenger terminals
4211 Bus passenger terminals (intercity)
4212 Bus passenger terminals (local)
4213 Bus passenger terminals (intercity and local)
429 Other motor vehicle transportation, NEC
4312 Airport and flying field terminals (passenger)
4314 Airport and flying field terminals (passenger and freight)
4411 Marine terminals (passenger)
4413 Marine terminals (passenger and freight)
46 Automobile parking
4721 Telegraph message centers
492 Transportation services and arrangements
51 Wholesale trade
52 Retail trade -- building materials, hardware, and farm equipment
53 Retail trade -- general merchandise
54 Retail trade -- food
55 Retail trade -- automotive, marine craft, aircraft, and accessories
56 Retail trade -- apparel and accessories
57 Retail trade -- furniture, home furnishings, and equipment
58 Retail trade -- eating and drinking
59 Other retail trade, NEC
61 Finance, insurance, and real estate services
62 Personal services
63 Business services
64 Repair services

APPENDIX E: Best Management Practices (BMPs) For Water Quality Maintenance

This appendix provides a brief description of Best Management Practices (BMPs) useful for maintaining water quality in areas where the natural landscape has been modified. Many of the BMPs described have been developed in response to construction activities in urban areas. These practices are useful and may be adopted directly or adapted to the specific requirements of a mining project with minor modifications.

Two categories of BMPs are described. Temporary practices would be used during the construction phase. Permanent practices would be put into effect for those activities associated with actual operation of the mine.

Each BMP is briefly described, its purpose identified, and an estimate of its overall effectiveness given.

Mine Construction and Haul Road/Transmission Line Construction

Construction can harm water quality because the disturbed and exposed soil surfaces can easily erode. The following practices should be considered and the most appropriate one(s) implemented to control construction-related NPS pollution. Many of these practices would also be appropriate for long-term water quality protection after construction ends.

1. Temporary Sediment Basin

Description and Purpose -- A temporary sediment basin is an impoundment that temporarily stores sediment-laden runoff and releases it at a reduced rate. During the time that the runoff is detained, sediment settles out and is trapped in the basin. This prevents the sediment from being transported off-site.

Effectiveness -- Sediment basins are relatively effective for trapping medium- and coarse-grained sediment particles. However, fine silts and clays that are suspended in runoff are very difficult to trap. Overall trapping efficiencies of approximately 70 percent can be achieved with typical sediment basin designs. If higher trapping efficiencies are desired, larger pool volumes and slower discharge rates can be used. However, the value of increased sediment basin size diminishes rapidly once a certain size is reached. For this reason, special methods such as chemical flocculation may be needed to achieve a very high level of control.

2. Temporary Sediment Trap

Description and Purpose -- A temporary sediment trap is a small temporary ponding area formed by constructing an earthen embankment with an outlet across a swale. Temporary sediment traps are intended to detain sediment-laden runoff from small disturbed areas long enough to allow the majority of the sediment to settle out.

Effectiveness -- Temporary sediment traps provide good control of coarse sediment and are moderately effective for trapping medium-sized sediment particles. However, they have a relatively low trapping efficiency for fine silt and clay particles suspended in runoff. If a higher trapping efficiency is desired, a temporary sediment basin with a larger storage volume and longer detention time should be used.

3. Silt Fence

Description and Purpose -- A silt fence is a temporary sediment barrier consisting of a filter fabric which is attached to supporting posts trenched into the ground. Sediment-laden runoff ponds uphill from the silt fence and runoff is filtered as the water passes through the fabric.

Silt fences are intended to intercept and detain small amounts of sediment from disturbed areas in order to prevent sediment from leaving the site. Silt fences can also prevent sheet erosion by decreasing the velocity of runoff.

Effectiveness -- The effectiveness of silt fences for trapping sediment is mainly a function of the apparent opening size (AOS) of the fabric. The AOS relates opening sizes to those of standard sieves.

As the AOS value (and sieve number) gets larger, the opening size decreases. The AOS of a filter fabric should be large enough (with openings small enough) to effectively trap sediment. However, The AOS should also be small enough to maintain an acceptable flow rate. For most soils, a fabric with an AOS of 70 will trap more than 90 percent of the sediment in runoff.

4. Straw Bale Sediment Trap

Description and Purpose -- A straw bale sediment trap is a row of entrenched and anchored straw bales which are installed so that they detain and filter sediment-laden runoff.

This type of sediment trap is intended to remove coarse sediment from small amounts of runoff before it leaves the site. It provides short-term sediment control for sheet flow from disturbed areas less than 2 acres in size.

The use of straw bales for a sediment trap is not generally recommended in areas of concentrated flow.

Effectiveness -- Straw bales are moderately effective for trapping medium- and coarse-grained sediment particles. They are generally not effective for trapping fine silt or clay particles in runoff. However, if straw bales are improperly installed, they can actually increase the amount of erosion by concentrating runoff and causing gully erosion.

NOTE: Straw bale sediment traps are effective sediment control practices only when they are used in appropriate locations and installed properly. In many cases, one or both of these conditions are not met and the practice fails.

This practice is only recommended when proper planning is used and adequate construction supervision is available to ensure that the structure is installed correctly.

5. Storm Drain Inlet Protection

Description and Purpose -- Storm drain inlet protection is a sediment barrier placed around a storm drain drop inlet. This structure is used to trap sediment before it enters an operational storm sewer. This will prevent sediment from being transported to lakes or streams and can also prevent clogging problems in conveyance pipes caused by heavy sediment loads.

Effectiveness -- Storm drain inlet protection provides relatively good removal of coarse- and medium-sized sediment from runoff. However, most fine silt and clay particles will pass through gravel filters on these structures. The Type A sediment barrier will perform better for removing fine silt and clay from runoff.

6. Flotation Silt Curtain

Description and Purpose -- A flotation silt curtain is a silt barrier for use within a lake or pond. The flotation silt curtain consists of a filter fabric curtain weighted at the bottom and attached to a flotation device at the top. This structure is used to isolate an active construction area within a lake or pond to prevent silt-laden water from migrating out of the construction zone.

Effectiveness -- Flotation silt curtains are effective for limiting the migration of suspended sediment within a lake or pond. This practice will not reduce the amount of disturbance from work performed in water, but it will minimize the area that is affected.

7. Temporary Rock Construction Entrance

Description and Purpose -- A temporary rock construction entrance is a stone pad where vehicles leave a construction site. The purpose of the stone pad is to provide an area where mud can be removed from vehicle tires before the vehicle leaves the site. The stone pad consists of clean rock designed in such a way that vehicle tires will slightly sink in. This helps remove mud from the tires as the vehicle passes over the pad. If a wash rack is used, it provides an area where vehicle tires can be washed with water when needed.

Effectiveness -- The effectiveness of temporary rock construction entrances for trapping sediment depends largely upon its length, depth of rock, maintenance, and type of structure used. A newly installed rock construction entrance meeting the recommendations included here will be relatively effective for removing mud from construction vehicle tires before they leave the site. However, once the rock voids become clogged with mud, the practice will not serve its intended purpose until the rock is replaced. Washing vehicle tires with pressurized water over a wash rack is very effective for removing mud from tires.

8. Diversion

Description and Purpose -- A diversion is constructed across a slope with a supporting ridge on the lower side. Diversions are used to intercept runoff and divert it to stabilized outlets at non-erosive velocities. This reduces the length of a slope for erosion control or protects downslope areas from runoff.

Effectiveness -- Diversions can be very effective for erosion control on steep or long slopes. Diverting runoff will reduce slope lengths or eliminate concentrated flow that would make establishment and maintenance of vegetation difficult. This can prevent long-term erosion problems.

The erosion-control benefit from a diversion will depend upon the length of slope and type of soils in the area being protected.

9. Temporary Diversion

Description and Purpose -- A temporary diversion is a temporary ridge of compacted soil, a channel, or a combination of these located across a slope above a disturbed area.

Temporary diversions prevent erosion by diverting runoff away from unprotected slopes to a stable outlet. Temporary diversions can also be used to direct sediment-laden runoff to a sediment-trapping structure.

Effectiveness -- Although temporary diversions will not control the detachment of soil particles from raindrop impact, they will reduce the amount of runoff flowing over a disturbed area. This will limit the potential transport of these particles by runoff.

Temporary diversions can also be effective for controlling rill and gully erosion by preventing concentrated runoff from flowing over erosion-prone areas.

10. Temporary Right-Of-Way Diversion

Description and Purpose -- A temporary right-of-way diversion is a ridge of compacted soil, loose rock, or gravel placed across a disturbed right-of-way or a similar long sloping area that is disturbed. This ridge is used to divert water onto stabilized areas and to shorten the length that runoff will flow down a long sloping area. This reduces the runoff's erosion potential.

Effectiveness -- The effectiveness of temporary right-of-way diversions for controlling erosion depends upon the land slope and soil erodibility. In most cases, this practice will provide good control of rill and gully erosion in the disturbed right-of-way area.

11. Stormwater Conveyance Channel

Description and Purpose -- A stormwater conveyance channel is a permanent waterway, shaped and lined with appropriate vegetation or structural material that can carry stormwater runoff. This practice provides a means of transporting concentrated surface runoff without causing damage from erosion or flooding.

This practice generally applies to channels, including road ditches, that are constructed as part of a development to transport surface runoff. This practice does not apply to major, continuously flowing natural streams.

Effectiveness -- Properly designed stormwater conveyance channels are effective for preventing erosion caused by concentrated flows. They can significantly reduce or eliminate sediment loads originating in the channel area. Also, if vegetation is used for a lining, stormwater conveyance channels can help reproduce pre-development hydrologic conditions by promoting infiltration and slowing runoff velocities. For information about other possible water quality benefits from vegetated channels, see Vegetated Swales (No. 7, Mine Operations).

12. Subsurface Drain

Description and Purpose -- A subsurface drain is perforated pipe, tubing, or tile installed below the ground surface to intercept and transport water.

Subsurface drains can be used to remove excess water from wet soils where vegetation must be established to provide ground cover. This practice can also be used to prevent seepage from slopes, which may cause unstable conditions and sloughing. In some cases, subsurface drains can serve as an outlet for detention areas or structures with small drainage areas.

Effectiveness -- Subsurface drains alone do not control erosion problems; however, they may be needed with other practices. For example, a vegetated channel in wet soil conditions may not have a satisfactory stand of grass without subsurface drainage. Because this practice is actually a component of other measures, the effectiveness of subsurface drains for sediment control is difficult to quantify.

13. Temporary Slope Drain

Description and Purpose -- A temporary slope drain is a flexible conduit extending from the top to the bottom of a disturbed slope and serving as a temporary outlet for a diversion. Temporary slope drains convey runoff from the top to the bottom of the disturbed slope without causing erosion on or at the bottom of the slope. These are temporary structures which typically are used for up to two years.

Effectiveness -- Temporary slope drains can eliminate gully erosion problems on a disturbed slope that would have resulted from concentrated flows discharged at a diversion outlet.

14. Grade Stabilization Structure

Description and Purpose -- A grade stabilization structure is a permanent structure or series of structures designed to drop water to a lower elevation without erosion. Grade stabilization structures are commonly used when discharges from a stormwater conveyance channel or diversion must be dropped to a lower elevation receiving channel. These structures can also be used within channels to flatten the channel grade, thereby reducing velocities.

Effectiveness -- Grade stabilization structures can prevent gully erosion caused by overfalls or unstable grade in channels. This will prevent sediment loadings to downstream areas that would have resulted if this erosion were not controlled.

15. Outlet Protection

Description and Purpose -- Outlet protection is the use of measures to prevent erosion at the outlet of pipes or paved channels. These structures are intended to protect soil from turbulence and high velocities, which can otherwise cause scour erosion.

Effectiveness -- Outlet protection can prevent scour erosion in channels which will reduce the effects of turbidity and sedimentation downstream.

16. Temporary Stream Crossing

Description and Purpose -- A temporary stream crossing is a temporary road crossing constructed over a flowing stream for use by construction traffic. This will provide a way for construction traffic to cross a flowing stream without disturbing the channel or entering the water.

Effectiveness -- Temporary stream crossings prevent turbidity and streambed disturbance caused by construction traffic crossing a stream. However, improperly designed or installed structures can actually increase sediment loads if the crossing washes out or causes scour erosion in the channel.

17. Riprap

Description and Purpose -- Riprap is a permanent, erosion-resistant protective layer made of loose stones. It is intended to protect soil from erosion in areas of concentrated runoff. Riprap may also be used to stabilize slopes that are unstable because of seepage problems.

Effectiveness -- When properly designed and installed, riprap can prevent virtually all erosion from the protected area.

18. Structural Streambank Protection

Description and Purpose -- Structural streambank protection is the stabilization of streambanks with permanent structural measures. Structural materials that can be used include riprap, modular concrete blocks, or gabions.

These measures are commonly used in streams where banks have become unstable due to changed hydrologic conditions or disturbance from construction.

Effectiveness -- When properly installed, structural streambank protection can prevent virtually all erosion from the area treated. This can be important because all sediment created by streambank erosion is delivered to the stream.

19. Temporary Seeding

Description and Purpose -- Temporary seeding is the establishment of temporary vegetative cover on disturbed areas by seeding with suitable fast-growing annual vegetation. This is intended to provide a temporary vegetative cover relatively quickly that will protect the soil from erosion until permanent stabilization.

This practice is normally used to stabilize construction areas that will be inactive for more than 45 days but less than one year. Applicable areas include topsoil stockpiles, rough graded areas, sediment basin dikes, and temporary earthen structures.

Effectiveness -- Temporary seeding is effective for erosion control only when vegetation is established. After it is established, a good stand of vegetation will protect soil from erosion by raindrop impact and will also slow runoff to prevent rill erosion. The vegetation can also act as a filter trapping coarse sediment particles carried by runoff. After establishment, temporary seeding can reduce sheet erosion by approximately 90 percent (SCS, 1976).

20. Permanent Seeding

Description and Purpose -- Permanent seeding is the establishment of perennial herbaceous vegetation on a disturbed area. It is intended to stabilize disturbed areas in a manner compatible with the intended use. This practice is used when vegetation is desired to permanently stabilize the soil and in construction areas where vegetative cover is needed for more than one year.

Effectiveness -- Permanent seeding is very effective for controlling soil erosion once it is established. Until it is established, mulching should be used to provide protection. Permanent seeding protects soil from erosion by raindrop impact and overland flow. Vegetation also maintains the infiltration capacity of soil, thereby reducing the volume of runoff that will occur. Once established, permanent seedings can reduce soil erosion rates by 99 percent (SCS, 1976).

21. Sodding

Description and Purpose -- Sodding is the stabilization of a disturbed area with permanent vegetation by laying sod. Sodding provides immediate erosion protection to soil, which is desirable in cases where the erosion potential would be high during vegetative establishment from seed.

Effectiveness -- Sodding can provide effective protection from erosion immediately after it is laid. The sod protects soil from erosion by raindrop impact and overland flow. The sod also slows runoff and can trap coarse sediment particles carried by it. Sodding can reduce erosion rates by as much as 99 percent (SCS, 1976).

22. Mulching

Description and Purpose -- Mulching is the application of plant residues or other suitable materials to the soil surface. Mulch prevents erosion by protecting soil from raindrop impact and by reducing the velocity of overland flow. Mulching will also promote the germination and growth of seedlings by preserving moisture, providing protection for temperature extremes, and controlling weeds. Mulching is normally used for temporary erosion protection, to protect newly seeded areas, and to provide favorable growth conditions around trees and shrubs.

Effectiveness -- Mulching is very effective for preventing soil erosion caused by raindrop impact on soil. Mulching also helps maintain the infiltration capability of soil, thereby reducing the volume of runoff flowing over the soil surface. Proper application of mulch can reduce sheet erosion by approximately 94 percent (SCS, 1976). Wood fiber or straw blankets can be effective for the control of gully erosion also.

Mine Operation

After the early stages of the pit and the haul road/transmission line have been constructed, some of the temporary construction-site BMPs would be removed. Others would remain in place to mitigate long-term NPS pollution. However, additional permanent runoff BMPs would be needed to minimize NPS pollution reaching area lakes and the Pike River. These permanent BMPs may include, but are not limited to, the following practices.

1. Detention Pond

Description and Purpose -- Detention ponds are impoundments that have a permanent pool of water and also have the capacity to temporarily store stormwater runoff until it is released from the structure. This capability to hold runoff and release it at lower rates than incoming flows has made the detention pond a popular practice for flood control and stormwater management. If the detention pond will be used for water quality improvement as well as flood control, additional planning and design considerations will need to be incorporated. These considerations, which involve the size and shape of the permanent pool, are explained below.

Target Pollutants -- Detention ponds are used to interrupt the transport phase of sediment and pollutants associated with it, such as trace metals, hydrocarbons, nutrients, and pesticides. When designed according to the recommendations given next, detention ponds can also provide some removal of dissolved nutrients. Detention ponds also reduce the amount of bacteria and oxygen-demanding substances in runoff.

Effectiveness -- Detention ponds are one of the most effective BMPs available for treatment of nutrient-rich runoff. During a storm, polluted runoff enters the detention pond basin and displaces "clean" water until polluted runoff reaches the outlet of the structure. When the polluted runoff does reach the outlet, it will have been diluted by the water previously held in the basin. This reduces the pollutant concentration of the outflow.

After the storm, fine suspended solids in the pond will have a relatively long period of time to settle out until the next storm occurs. In addition to efficient settling, this long detention time also allows some removal of dissolved nutrients through biological uptake (Walker, 1987). These nutrients are mainly removed by algae and aquatic plants. After the algae die, the nutrients can settle to the bottom of the pond and become part of the sediments.

This process results in good pollutant removal from small storm events. Runoff from larger storms will receive treatment, but not to the same level of treatment as runoff from smaller storms. Studies have shown that because of the frequency distribution of storm events, good control for these small storms is very important to long-term pollutant removal.

2. Extended Detention Basins

Description and Purpose -- Extended detention basins are stormwater detention basins that are designed to temporarily hold stormwater for an extended period of time. Extended detention basins rely upon this detention time to allow physical settling of pollutants. They are different than detention ponds because they can be normally dry, have a shallow marsh, or have a permanent pool. This type of detention pond is effective for removing particulate pollutants from urban runoff as well as reducing peak discharges. In many instances, dry ponds designed as flood control structures can be modified to meet the criteria of an extended detention pond for a relatively low cost.

Target Pollutants -- Sediment and the pollutants associated with it, such as trace metals and nutrients, are the pollutants most effectively controlled by extended detention basins. If the outlet is designed as a flotable skimmer, floating debris and organic matter can also be effectively trapped. If a permanent pool or shallow marsh area is included in the design, some removal of fine sediment and soluble nutrients can be achieved. In addition to these pollutants, extended detention basins are very effective for controlling peak discharges, which can reduce downstream streambank erosion and sediment loads.

Effectiveness -- Extended detention basins can be fairly effective for removing particulate pollutants from nutrient-rich runoff. The efficiency of an extended detention basin depends largely upon the detention time that runoff is held in the basin. Laboratory studies have shown that the majority of runoff sediments settle out within the first six hours while the remaining fine sediments may take several days to settle (OWML, 1983). This study was based upon a settling depth of 4 feet. Longer detention times are desirable because ideal settling conditions usually do not develop in the basin for several hours.

3. Infiltration Basin

Description and Purpose -- An infiltration basin is a water impoundment constructed over permeable soils. The purpose of the basin is to temporarily store surface runoff for a specific design frequency storm and allow it to infiltrate through the bottom and sides of the basin. This infiltration removes many pollutants, provides groundwater recharge, reduces the volume of runoff, and reduces peak discharges.

Target Pollutants -- Infiltration basins are very effective for removing fine sediment and pollutants associated with it. This includes sediment, trace metals, nutrients, bacteria, and oxygen-demanding substances. Coarse sediment is effectively controlled, but should be removed from runoff before it enters an infiltration basin. Coarse sediments can clog the basin and take up storage volume. Dissolved pollutants are effectively controlled for storm events less than the design frequency, but these materials may not be removed from the runoff as it infiltrates.

Effectiveness -- Infiltration basins can be designed to provide total control of pollutants in surface runoff for the design runoff volume. For storms larger than the design storm, effectiveness will be reduced, but will be similar to those reported for detention ponds of similar size. Although infiltration basins are very effective for controlling pollutants in surface water, certain soluble substances can be expected to move to the groundwater. Chloride from road salt is an example of a soluble material that will not be removed during the infiltration process.

4. Infiltration Trench

Description and Purpose -- An infiltration trench is a shallow excavated trench, usually 2 to 10 feet deep and backfilled with a coarse stone aggregate, which allows temporary storage of runoff in the void space between stones. Stored runoff then infiltrates into the surrounding soil.

Target Pollutants -- Infiltration trenches effectively control the pollutants in the surface runoff that enters them. They are not intended for control of coarse sediment or heavy concentrations of fine sediment because these materials can clog infiltration trenches. This practice should not be used to control soluble pollutants that can affect groundwater quality.

Effectiveness -- The effectiveness of infiltration trenches depends upon their design. When runoff enters the trench, 100 percent of the pollutants are prevented from entering surface water. Water that bypasses the trench will not be treated. When runoff enters infiltration trenches, many pollutants will be trapped or treated as they pass through the soil. However, certain soluble substances, such as chloride from road salt, will not be treated during infiltration and will end up in groundwater. This practice can be very effective for reducing the volume of runoff from a site of limited area.

5. Wetland Treatment

Description and Purpose -- Wetland treatment involves passing runoff through a natural or constructed wetland to remove or treat pollutants. Wetlands provide favorable conditions for removal of pollutants from runoff through sedimentation and also provide an intense pool of biological activity to use nutrients during the growing season. Although wetlands are effective for removing pollutants, certain drawbacks limit their use as a BMP. The major problems with wetland treatment are the environmental damage that may be done to natural wetlands, and the large land area required for constructed wetlands.

Target Pollutants -- Wetland treatment is very effective for removing sediment and pollutants associated with it (such as trace metals, nutrients, and hydrocarbons), oxygen-demanding substances, and bacteria from runoff. Wetlands can also be effective during the growing season for removal of dissolved nutrients as well as those adsorbed to sediment.

Effectiveness -- The effectiveness of wetland treatment systems for the removal of pollutants will depend upon the physical characteristics of the system, such as the ratio of wetland size to watershed size, runoff residence time in the wetland, and water budget. In general, as the wetland to watershed ratio increases, the average runoff residence time increases, and the effectiveness of the wetland for pollutant removal also increases. The effectiveness of wetlands for removing nutrients depends heavily upon the season. During the summer when biological activity is maximized, nutrient uptake will be the greatest (Nichols, 1983; Brown, 1985).

6. Flotable Skimmers

Description and Purpose -- As the name implies, flotable skimmers are devices used to retain floating debris and oil in detention areas. The floating debris and oil eventually sinks to the bottom of the detention area and becomes part of the sediments or is removed from the surface through regular maintenance.

Target Pollutants -- Flotable skimmers are effective for trapping floating organic matter and oils. These materials contain nutrients, oxygen-demanding substances, and hydrocarbons.

Effectiveness -- The effect of flotable skimmers on water quality will depend upon the amount and type of floating material transported by runoff. Typically, a well-designed flotable skimmer can trap virtually all floating debris that reaches it. In an area with large loadings of floating leaves, trash, or oil, this can provide significant water quality benefits.

7. Filter Strip

Description and Purpose -- Filter strips consist of grass or other close-growing vegetation designed to receive overland flow. The vegetation slows the runoff and traps particulate pollutants.

Target Pollutants -- Filter strips can be used to trap solids such as sediment, trash, and organic matter from runoff. Filter strips can be effective for soluble pollutant removal, but only to the extent that runoff infiltrates into the soil.

Effectiveness -- The effectiveness of filter strips for pollutant removal is a function of the length and slope of the filter strip, soil permeability, the size of the drainage area, and the type and density of vegetative cover. Also critical to the performance of filter strips is the distribution of water flowing over it. If water is allowed to concentrate because of poor grading or uneven runoff distribution, the filter will be short-circuited and have only minimal benefit. When properly designed and operated, filter strips can trap 30 to 50 percent of sediment (Nonpoint Source Control Task Force, 1983).

8. Vegetated Swale

Description and Purpose -- Vegetated swales are broad shallow channels with a dense stand of vegetation that are designed to promote infiltration and trap pollutants. The combination of low velocities and vegetative cover provides an opportunity for pollutants to settle out or be treated by infiltration. In addition to pollutant removal, this practice can result in reduced volumes of runoff and peak discharges.

Target Pollutants -- Vegetated swales are most effective for removal of coarse sediment and pollutants associated with it. Fine sediment and soluble pollutants are not treated unless they are part of runoff that infiltrates through the swale.

Effectiveness -- Several studies have been conducted to determine the effectiveness of vegetated swales for improving water quality. One study concluded that they are somewhat effective for removing certain pollutants from stormwater runoff (Oakland, 1983). Trace metals were the pollutants with the highest rates of removal by the vegetated swale. The rates ranged from 42 percent removal for dissolved cadmium to 65 percent removal for total lead. Other removal rates were 25 percent for COD, 33 percent for total residue, 51 percent for ammonia, and 32 percent for nitrate-nitrite nitrogen. Decreases in BOD, turbidity, organic nitrogen, and total phosphorus were not significant. Bacteria levels in the swale actually increased, but were attributed to animal activity in the swale.

The study mentioned above was for one location with a vegetated swale designed specifically for water quality benefits. Another study looked at the effectiveness of three swales that had steeper grades of 2 to 5 percent. That study found that statistically there was no difference in water quality between runoff from the swales and runoff from curb and gutter (NVPDC, 1983). This indicates that lowgradient grass swales are best suited to providing water quality benefits. Check dams can be used in higher gradient swales to impound water and slow velocities, but are impractical in steeper swales because of the close spacing required.

APPENDIX F: References

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