Crandon Mining Company

P-70

Safe Storage of Tailings

Proven Cap-and-Liner Technology To Store Mine Tailings Safely

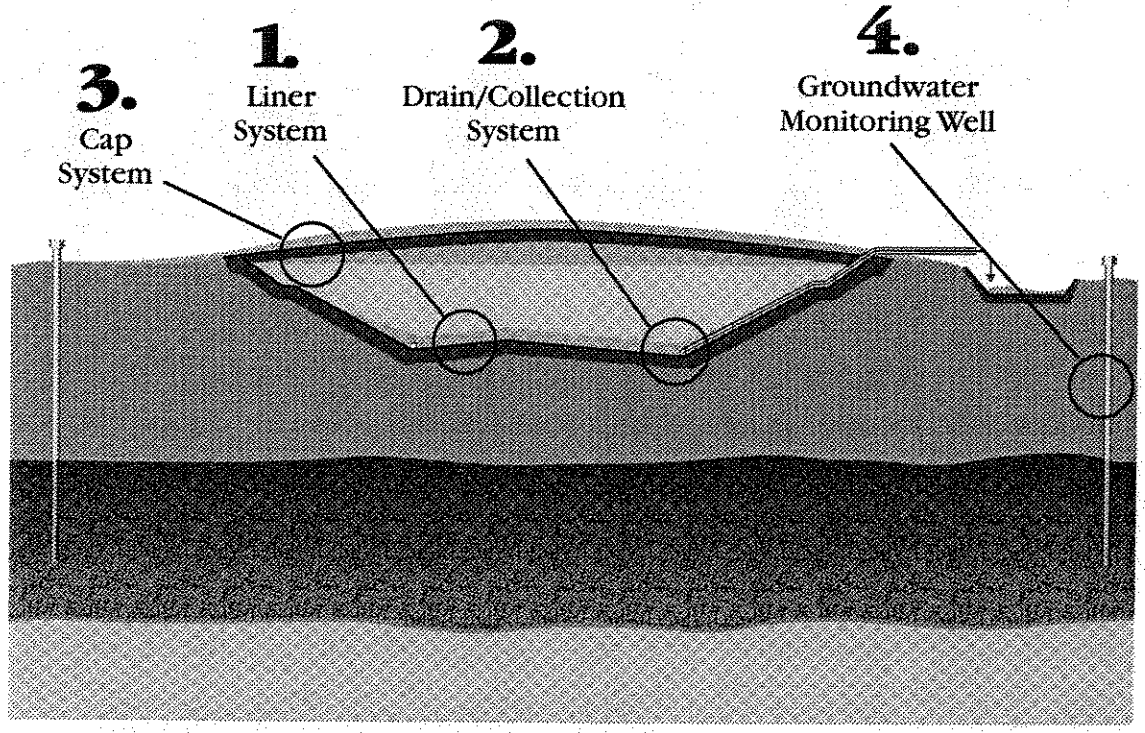
The Crandon mine tailings management area will use proven technology to permanently protect groundwater. Tailings will be placed in engineered basins with caps and liners similar to those used at landfills throughout Wisconsin and the nation. The tailings basins will have composite caps and liners, each featuring a layer of clay covered by a sheet of heavy-duty plastic called a geomembrane. In basic terms, here is how the technology works:

1. ***Liner System.*** The liner rests at the bottom of the basin, forming a protective barrier for groundwater. The liner does its most important work while the basin is being filled.

2. ***Drain / Collection System.*** Water that trickles through the tailings meet the liner, then flows down a sloping drain to a collection point. This water is then pumped out and sent to the treatment plant.

3. ***Cap System.*** The cap is the key to permanent environmental protection. When each basin is full, it will be covered with a composite cap that acts like an umbrella. The cap will seal out water and oxygen, severely limiting the processes that can cause acid to form.

4. ***Monitoring.*** The tailings basins will be surrounded by wells used to monitor groundwater to ensure that the cap-and-liner system is functioning properly.



Crandon Mining Company

Lake and Stream Level Protection

The Crandon mine will have minimal effects on lake and stream levels, and only in the immediate area of the ore-body. All private water supplies will be fully protected.

Underground mining may require removal of groundwater that collects in the mine. By Wisconsin law, this process — called dewatering — must not harm the commercial, recreational or private uses of any lake or stream. At the Crandon mine, all lakes and streams will be sustained at levels that protect fishing, boating, swimming, wild rice gathering and other uses.

Crandon Mining Company has conducted engineering studies using proven computer modeling techniques to predict how mine dewatering will affect lakes, streams and private wells. The DNR and the U.S. Army Corps of Engineers will independently test these studies for accuracy. Here is what CMC's studies have found:

- *The only lake that will be significantly affected by mine dewatering will be Skunk Lake, a shallow, six-acre lake located entirely on mine property that has no fish population. Effects on nearby streams will be minor.*

- *Dewatering may affect up to 12 private water wells. CMC will replace or deepen these and any other wells that may be affected.*

- *The effects of mine dewatering will also be temporary. Any water affected will return to normal levels within a few years after the mine closes.*

What if...

Suppose the effects of mine dewatering are greater than the studies predict. How will lake and stream levels be safeguarded?

During mine operation, CMC will monitor groundwater and surface water levels. If the effects of dewatering are greater than expected, the company would install mitigation systems to maintain lakes and streams at the necessary levels. If this proves ineffective, the DNR could order the mine shut down.

Effect of Mining on Lake Levels

Lake	Changes in Water Levels (Inches)		
	Expected Case	Practical Worst Case	Natural Variation
Duck	0.1	1.3	31.7
Deep Hole	0.2	4.7	26.8
Little Sand	0.8	5.8	31.9
Skunk	6.4	7.0	56.0

Effect of Mining on Stream Flows

Stream	Changes in Flow Rate (Cubic Feet/Second)		
	Expected Case	Practical Worst Case	Natural Variation
Swamp Creek	0.91	1.49	8 to 228
Hemlock Creek	0.31	0.52	2.4 to 53
Hoffman Creek	0.15	0.26	NA to 5
Creek 12-9	0.36	0.62	1.1 to 42
Upper Pickerel Creek	0.16	0.28	0.4 to 23

Crandon Mining Company

ACCOUNTABILITY

Accountability

State Laws, Local Agreements Hold Mining Company Accountable

If the Crandon mine is permitted, state laws and local agreements will hold the company accountable for operating and reclaiming the mine in an environmentally responsible manner.

1. ***Permitting Requirements.*** The mine must meet strict environmental standards set to protect air, surface water and groundwater. If the mine fails to meet those standards, the Wisconsin Department of Natural Resources cannot issue permits. Once permitted, the DNR also has the power to levy fines or shut the mine down.

2. ***Financial Guarantees.*** CMC must post a bond or other financial guarantee that the site will be reclaimed. The amount, set under a formula in state law, must cover all costs to return the site to an environmentally stable condition at any stage of the project.

3. ***Long-term Care.*** CMC must prove financial responsibility for long-term care of the site for 40 years after the mine closes. The DNR can extend that period if necessary. Long-term care includes maintenance of the site and monitoring of surface and groundwater to make sure the environment is being protected.

4. ***Perpetual Liability.*** Even after long-term care, CMC assumes perpetual environmental liability for the tailings management area. Wisconsin Statute 144.441 (2)(c) says, "...the owner's responsibility for the long-term care of an approved facility does not terminate." Liability continues "... regardless of reorganizations, mergers, consolidations or liquidation affecting the mining company."

5. ***Local Control.*** Local agreements signed by CMC with local governments establish a Citizens' Oversight Committee. This committee will include representatives from all local governments and has the authority to review citizen complaints and refer problems to local jurisdictions for appropriate action.

Surface & Groundwater Levels 2

The Crandon mine will have minimal effects on lake and stream levels and only in the immediate area of the orebody. All private water supplies will be fully protected.

Underground mining may require removal of groundwater that collects in the mine. By Wisconsin law, this process – called dewatering – must not impair the commercial, recreational or private uses of any body of water. At the Crandon mine, all lakes and streams will be sustained at levels that protect fishing, boating, swimming, wild rice gathering and other public uses as required by state law. All private water supplies will be fully protected.

- ✔ **The company has undertaken computerized studies (modeling) that predict the extent that mine dewatering will affect all groundwater and surface water levels in the area (see charts below). The DNR and the U.S. Army Corps of Engineers conduct independent verification of these studies.**
- ✔ **The Crandon modeling showed that mine dewatering will have no significant impact on area lakes except Skunk Lake, a small, shallow lake with no fish population entirely on mine property.**
- ✔ **Computer modeling is a proven technique used worldwide in environmental studies to predict the behavior of water systems.**
- ✔ **Dewatering may impact up to twelve private wells which Crandon Mining will replace. The Company has committed to deepen or replace all wells affected to ensure adequate water supply.**
- ✔ **The drawdown effects of mine dewatering will be temporary. Water levels will return to their normal levels within a few years after operations cease.**
- ✔ **Before, during and after mine operations, the company must conduct groundwater and surface water monitoring on and around the site to ensure that these resources are protected and that state regulations are being met.**

Effect of Mining on Lake Levels

Lake	Changes in Water Levels (Inches)		
	Expected Case	Practical Worst Case	Natural Variation
■ Duck	0.1	1.3	31.7
■ Deep Hole	0.2	4.7	26.8
■ Little Sand	0.8	5.8	31.9
■ Skunk	6.4	7.0	56.0

There will be no change in water levels as a result of mining on 13 lakes. These four, which lie close to the mine will be affected slightly.

Effect of Mining on Stream Flows

Stream	Changes in Flow Rate (Cubic Feet/Second)		
	Expected Case	Practical Worst Case	Low To High
■ Swamp Creek	0.91	1.49	8 to 228
■ Hemlock Creek	0.31	0.52	2.4 to 53
■ Hoffman Creek	0.15	0.26	NA to 5
■ Creek 12-9	0.36	0.62	1.1 to 42
■ Upper Pickerel Creek	0.16	0.28	0.4 to 23

The studies show flow reductions in the five creeks are minor, especially when compared to variations between low and high flows.

3 Comprehensive Regulations

Wisconsin's environmental laws are tough. Period. The laws and regulations that govern modern mining in Wisconsin demand mines meet the rigorous standards other industries in the State must meet ... and then some.

The laws and regulations that govern mining in Wisconsin are comprehensive and effective in protecting the environment. They demand mines in Wisconsin meet the rigorous standards other industries in the State must meet and then some. In addition to meeting the same standards as other industrial operations, mines must obtain a mine permit and are subjected to the scrutiny of the Master Hearing process during which testimony is taken under oath.

- ✔ Modern mining technologies ***must*** be applied in compliance with comprehensive regulations. The Crandon mine must earn more than *40* ***permits*** before it will be allowed to operate. State law ***requires*** the company to prove by scientific demonstration it can and will protect the environment (including air, ground and surface water), public health and safety, unique lands, and archaeological and cultural resources. (see *Section 144.80 to 144.836 and 144.85 to 144.937 Wis. Stats.*)
- ✔ A mining project ***must*** be subject to regular monitoring and on-site surveillance throughout all phases of the project. Long-term monitoring ***must*** continue after reclamation (see *ch. NR 132 and NR 182 Wis. Admin. Code.*)
- ✔ A company ***must*** provide financial assurances that include a performance bond that covers the full cost of reclamation at any time during the construction, operation and reclamation of the mine. (see *Section 144.86 Wis. Stats. and NR 132.09 Wis. Admin. Code.*)
- ✔ A company ***must*** be held responsible for the long-term care and environmental safety of a mine site. State law expressly provides that mining operators are ***responsible in perpetuity*** for the long-term care of a tailings disposal area. In addition, mining companies are responsible for any environmental damage forever. (see *Sections 107.30–107.35 and 144.441–144.442 Wis. Stats.*)
- ✔ Wisconsin has stringent groundwater protection laws targeted specifically to mining activities. These laws provide the same measure of protection as the laws applying to other activities. (see *NR 182.075 Wis. Admin. Code.*)

"The statement that the mining laws have been weakened is commonly made. However, it is incorrect. Over the past ten years there have actually been very few changes made to the mining law in Wisconsin, and the significant changes which have been enacted were all intended to strengthen the law."

– Wisconsin Department of Natural Resources, 1996

Harnischfeger Corporation

P&H

President

February 19, 1992

Representative Marc Duff
408 H
P.O. Box 8952
Madison, Wisconsin 53708

Dear Representative Duff,

Wisconsin's mining tradition is a long and proud one: From the lead miners who helped settle the southwestern part of our State, to the men and women in my Company who work to make the machines that serve modern miners; from the students who studied and researched mining technology at the Wisconsin School of Mining in Platteville to the men and women who worked on the reclamation of Inland Steel's Jackson County Mine which left that site a county park, Wisconsinites have long played a vital part in mining necessary metals. And today, our State's mining heritage continues and progresses: As modern miners bring state-of-the-art technology to environmentally responsible projects; and as the State extensively regulates the development and operation of those projects, Wisconsin citizens can realize the substantial economic benefits inherent to environmentally sound mining.

Wisconsin Manufacturers and Commerce Mining Committee, on which I serve as chairman, has been working over the past year to help foster public understanding regarding mining in Wisconsin. As part of that effort, the Mining Committee recently commissioned and released two important reports that, in their scope and style, provide Wisconsinites with a better understanding of Wisconsin's metallic mineral regulations and the economic benefits of mining in Wisconsin. **I am pleased to enclose WMC's reprints of those reports in the hope the documents will be of interest and use to you.**

The first report, **Wisconsin Metallic Mineral Regulation -- A Synopsis,** authored by Thomas J. Evans of the Wisconsin Geological and Natural History Survey, was prepared from the original 130-page report. The study offers insight into the extensive regulatory process necessary for any company to obtain approval to mine metallic minerals in Wisconsin and underscores the fact that all metallic mineral development is comprehensively and strictly regulated under Wisconsin's laws and rules.

The second report refers to a study conducted by Dr. Richard Green from the University of Wisconsin-Madison Business School. **The Economic Benefits of Mining in Wisconsin** considers the potential economic impact mining projects will have for citizens in Rusk and Oneida Counties. Dr. Green examines and puts into context income levels, employment patterns and overall economic health in both those areas and in doing so, reveals that the economic impact would be significant and positive.

On behalf of the WMC Mining Committee and its over 130 members, I thank you for your time and attention. Please do not hesitate to call on any of us if you need further information.

Sincerely,

HARNISCHFEGER CORPORATION

C. P. Cousland
President

Enclosures

Box 310
Milwaukee, Wisconsin 53201

Wisconsin Metallic Mineral Regulation

A Synopsis

Based on "An Overview of Metallic Mineral Regulation, Special Report 13 - 1991"
Thomas J. Evans, Wisconsin Geological and Natural History Survey.
Synopsis produced with the author's permission.

Prepared by Wisconsin Manufacturers & Commerce
November 1991

"The entire scope of metallic mineral development is regulated under Wisconsin's laws and rules. The regulations for mining are in addition to the regulations adopted by the Legislature and state enforcement agencies for the protection of the environment."

-- Thomas J. Evans

Wisconsin Metallic Mineral Regulation

ALL ASPECTS OF MINING ARE REGULATED IN WISCONSIN.

A Word From WMC

In October 1991, the Wisconsin Geological and Natural History Survey (WGNHS) of the University of Wisconsin - Extension released Special Report 13, providing a comprehensive look at Wisconsin's laws and regulations governing mining. In the pages that follow, Wisconsin Manufacturers & Commerce (WMC) provides a synopsis of the original 130-page report.

The original report provides a detailed summary of what aspects of mineral development are regulated, how the permitting process works, what additional features are covered within Wisconsin's regulatory framework and how Wisconsin's mining regulations compare to other state and federal regulations. It also includes copies of all the state statutes that cover mining regulation in Wisconsin.

This synopsis offers insight into the extensive regulatory process necessary for any company to obtain the right to mine metallic minerals in Wisconsin. Regulations cover all activities related to mining, from exploration and prospecting through all phases of mining, reclamation and long-term care. These regulations are intended to protect human health and safety and the environment and to ensure that the land will be restored either to its original condition or to some predetermined acceptable condition having long-term environmental stability.

It is our hope that this synopsis will begin to build understanding of an extremely complex issue. A full copy of the original report is available upon request.

An Overview

Wisconsin Metallic Mineral Regulation

An Overview

This synopsis focuses on three major areas of Mr. Evans' study, including:

1. **Regulated Aspects Of Metallic Mineral Developments**
2. **How The Permitting Process Works**
3. **Additional Safeguards Available Within The Regulatory Framework To Protect Wisconsin Citizens And The Environment**

In addition, this synopsis provides specific information about the necessary permits, recommended timing and public access to information throughout the regulatory process.

Please reference the Glossary on pages 14-15 for definitions of terms used in this synopsis.

ALL ASPECTS OF MINING ARE REGULATED IN WISCONSIN.

Exploration

All aspects of drilling activities for the purpose of searching for metallic minerals are regulated.

Licensing

A company wishing to explore for metallic minerals in Wisconsin must be licensed and bonded by the Department of Natural Resources (DNR).

Pre-Approval

The DNR must approve each drill site prior to any drilling activity. The construction of each drill hole and the filling and reclamation of each drill hole and drill site are considered prior to initiating any activity.

Oversight

When exploration is complete, drill holes must be filled with approved material and the drill site reclaimed before any part of the bond can be released and the exploration licensee's responsibility for the drill hole construction can be terminated.

Fees

Companies engaged in exploration must pay an initial $300 license fee, an annual $150 renewal fee in addition to a fee assessed for each drill hole. In addition, companies must post a reclamation bond and show proof of liability insurance coverage for personal injury and property-damage protection.

Prospecting

Wisconsin's regulation of prospecting requires extensive environmental evaluation and the acquisition of a permit to engage in prospecting. In effect, a prospecting activity is viewed as a "mini-mine"...

Defining

Prospecting, as defined by Wisconsin's statutes and administrative code, consists of the examination of an area for the purpose of determining the quality and quantity of ore. It involves obtaining an ore sample by some physical means such as excavating or trenching. Prospecting is common in many places in the United States and the rest of the world; however, because the potential for environmental impact is greater than that involved in exploration, the regulation of prospecting is more extensive.

Permitting

The laws regulating prospecting parallel those for mining in several respects. Obtaining the necessary permits to prospect requires filing a Notice of Intent to collect data to support a prospecting permit application, environmental analysis and monitoring in a fashion acceptable to the DNR, developing a prospecting and reclamation plan with special emphasis on protecting wetlands, posting of a reclamation bond, and meeting certain design and locational requirements. This process is subject to a formal hearing and prospecting operations are subject to on-site inspection.

Fees and costs

The cost of environmental analysis and review is the responsibility of the prospecting company. The permit fee is $1,000. In addition, the applicant must pay for all the necessary permit evaluations and review by the DNR.

Mining

The regulation of metallic mining operations includes the development of the mine itself, and all activities related to mining. A major aspect of metallic mining regulation is the provision for reclamation of the mining site.

Permitting

Typically, a company must acquire several state and federal permits before mining can begin in Wisconsin, including: **A Mining Permit ◆ An Air-Emission Permit ◆ Permits for Construction in or near Navigable Water ◆ A State Wastewater Discharge Permit ◆ A Dredge or Fill Permit for Activities affecting Navigable Streams or Wetlands.** In addition, formal DNR approval of plans such as **mine dewatering, wastewater-treatment systems and mine-waste disposal facilities** must also be obtained. An applicant must obtain all necessary local zoning and land-use approvals.

Location

The location of metallic mining operations is restricted on the basis of criteria designed to protect certain environmentally sensitive areas. Exemptions from these criteria are allowed only when such exemptions would not compromise any other state or federal law or rule. Disturbance of wetlands must be minimized.

Operations

In its application for a mining permit the applicant must include a comprehensive **mining plan** which contains details of all aspects of the mining operation, from how the ore is to be extracted to the disposition of all mining waste and refuse. In addition, an assessment of possible health and environmental hazards must be provided along with proposed remedial actions that would be implemented in the event of such an occurrence.

Waste Disposal

Separate regulations apply to the handling, treatment, storage and/or disposal of any mining wastes generated by a mining or prospecting operation. These regulations serve to maintain groundwater quality and minimize wetland disturbance. The owner of a mine-waste disposal facility is forever liable for the environmental integrity of the reclaimed facility.

Reclamation

Reclamation returns the mine site to its approximate original contours and provides long-term environmental protection after the mining operation is completed. The **reclamation plan** must be approved by the DNR and must include: a) detailed information on suggested reclamation procedures; b) evidence that the proposed reclamation will conform with DNR standards related to safety and protecting the environment, and c) an acceptable post-mining land-use must be identified and approved. The main objectives are to reestablish a variety of plants and animals indigenous to the area and to minimize the disturbance of wetlands.

$ Guarantees

State rules require a bond or other security conditioned upon faithful performance of all requirements of the Metallic Mining Reclamation Act. Please see page 11 for more information on financial guarantees.

The Permitting Process

From beginning to end -- from the Notice of Intent to decisions on permits -- a period of two and one-half to four years is required.

NOI

The process of obtaining mining permits begins with a **Notice Of Intent (NOI)** to collect data to support a prospecting or mining permit application. The NOI serves two fundamental purposes: (1) it gives notice to area residents and the DNR that an activity of economic and environmental importance is being proposed; and (2) it gives a preliminary description of the proposed activity. After an NOI is submitted, a public hearing is held to gather public comment about issues of local concern. The NOI usually leads to the development of a **Scope of Study**, which identifies the specific means by which data will be collected and analyzed. The DNR must approve the NOI before the applicant can proceed with further data collection.

EIR

The **Environmental Impact Report (EIR)**, prepared by the applicant, is an extensive description of the physical, biological and socioeconomic environment of the immediate area. It also includes a detailed description of the proposed project to aid in evaluating the relevance of the technical environmental data. The DNR verifies this data by conducting random field checks during data collection and uses its own consultants to crosscheck the data and conclusions. The EIR is intended to allow the DNR and the public to begin to reach conclusions about the potential impact of a proposed mining operation.

EIS

The **Environmental Impact Statement (EIS)** is prepared by the DNR and is based upon the Environmental Impact Report and other applications and the department's analysis of the data. It is a primary vehicle for public involvement in the permitting decision. Following the publication of a Draft EIS, a mandatory public hearing is held. The Draft EIS and the oral and written comments by the applicant, the public, and state and federal agencies form the basis of the Final EIS. This document reflects the DNR's conclusions about the potential impacts of the project.

MASTER HEARING

The **Master Hearing** is a formal legal proceeding at which the evidence and testimony about the environmental assessment process and all permits, plans and approvals are entered into formal record. The Master Hearing has two parts: an open period of public comment and a contested-case, or formal hearing, similar to a trial. Using the full record of the proceedings of the Master Hearing, the decision-maker - usually the hearing examiner - renders judgment on the findings of fact, conclusions of law, issuance of permits with necessary conditions and issues rulings on the adequacy of the environmental assessment process.

Regulatory Timeline

DNR - Wisconsin Department of Natural Resources

EIS - Environmental Impact Study

NOI - Notice Of Intent

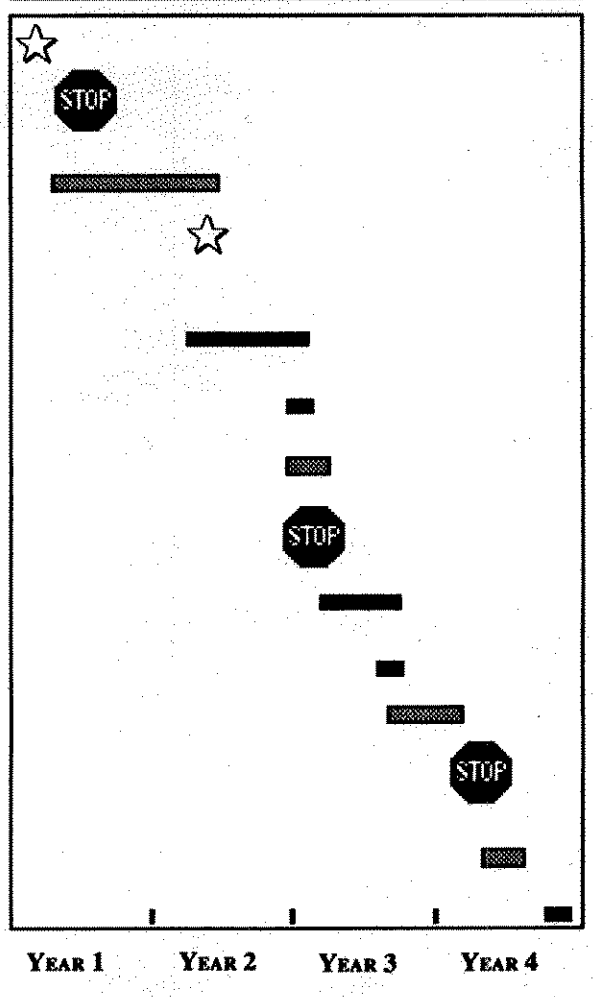
Applicant Action

Public/DNR Review

Applicant/Public Review

DNR Action

- Applicant submits NOI
- NOI informational hearing and EIS issue identification
- Applicant develops Scope of Study, gathers field data
- Applicant submits permit applications and EIR
- DNR prepares Draft EIS
- Draft EIS released
- EIS review period
- Public meeting about DRAFT EIS
- DNR prepares FINAL EIS
- FINAL EIS released
- Public review of Final EIS
- Master Hearing on permits and EIS
- Briefs filed by parties
- FORMAL DNR decision on permits and EIS



Regulatory Timeline

Criteria for Permit Decisions

If, in the judgment of the hearing examiner, the record of the Master Hearing shows that the six legislatively mandated criteria for granting permits are met, the DNR must issue the mining permit to the applicant.

CRITERIA 1

Are the mining plan and reclamation plan reasonably certain to result in the required reclamation of the site?

The basic thrust of metallic mining regulation is to ensure proper reclamation. The hearing examiner must determine whether the plans submitted in the mining permit application will result in the necessary reclamation.

CRITERIA 2

Will the proposed operation be in compliance with air, surface-water, groundwater and solid- and hazardous-waste management laws and rules?

Metallic mining operations must comply with the regulations protecting all other aspects of the environment.

CRITERIA 3

Is the proposed mine, if it is a surface mine, located in an unsuitable site?

Certain lands, because of their unique features, critical ecological importance or historical value, should not be mined because their unique value will be lost or diminished.

CRITERIA 4

Will the mine endanger public health, safety or welfare?

Metallic mining operations that fail the legal test of protection of public health, safety or welfare are not permissible.

CRITERIA 5

Will the mine adversely affect the economy of the area?

A metallic mining operation must be reasonably shown to pose "no net substantial adverse economic impact," with the term "economic" broadly interpreted to mean "socioeconomic."

CRITERIA 6

Does the proposed mine operation conform with applicable zoning ordinances?

A metallic mining permit may not be issued until all necessary local zoning approvals have been issued.

Additional Regulatory Safeguards

Additional aspects of Wisconsin's laws governing mining acknowledge local authority to regulate mining, provide opportunities for public involvement, require ongoing environmental monitoring, define enforcement options and provide financial guarantees.

Local Government

The role of local government over metallic mineral operations supplements state and federal regulations. A permit to prospect or mine will not be granted unless the company applying for the permit can show compliance with all local zoning and land-use ordinances. The statutes provide for an optional process, known as the local agreement, for clarifying an applicant's compliance with local controls. The local agreement may cover any approvals or permits required under zoning or land-use ordinances.

Public Involvement

The public is mandated full access to environmental analysis and permit reviews through formal and informal hearings and meetings. The Wisconsin Environmental Policy Act (WEPA) and the Metallic Mining Reclamation Act (MMRA) give citizens access to information about proposed metallic mining projects and provide opportunities for public input regarding the nature and scope of the environmental analysis and review of necessary permits and approvals. Formal public hearings are a part of the Notice of Intent process and the Environmental Impact Study process. The local mining-impact committees provide local education, information and input opportunities. In addition, numerous informal informational meetings can be held by civic organizations, public interest groups and local governments. The Office of the Public Intervenor of the Department of Justice is another means for public interest to be reflected in the regulatory process.

Environmental Monitoring

Monitoring plays a critical role in the state's regulatory program throughout the life of any metallic mineral prospecting or mining operation. Baseline conditions are established through pre-mining monitoring and evaluation. To determine compliance with all permits and plan approvals, monitoring continues throughout the mine operation. Finally, to ensure the environmental stability of a reclaimed mining site, monitoring of the environmental systems affected by the mining activity and reclamation is required for at least 40 years.

Additional Regulatory Safeguards (cont.)

Enforcement

Enforcement of metallic mineral regulations encompasses several options for action by the DNR and Wisconsin citizens.

Notice of violations and orders:
The DNR may provide notice to the operator about a particular violation and specify a time for a return to compliance, or it can require a hearing or request enforcement action by the Wisconsin Department of Justice.

Emergency stop orders:
A stop order requires the immediate cessation of mining, in whole or in part, and is issued for activities not in compliance with existing permits and that pose an immediate and substantial threat to public health and safety or the environment.

Citizen suits:
Any individual citizen can bring a civil action against the operator or the DNR if there is a belief that the DNR is not performing its duties as required by MMRA. Any six citizens can submit a complaint that will require a hearing on an alleged or potential environmental contamination.

Fines:
Those who violate any orders or rules issued under the MMRA will be notified about appropriate fines. Each day of violation is considered a separate offense.

Permit Revocation:
The DNR has the authority to revoke permits through its own Bureau of Environmental Enforcement and is backed by the Wisconsin Department of Justice. The circuit court of either Dane County or the county in which the operation exists has jurisdiction to enforce these regulations.

Additional Regulatory Safeguards (cont.)

$ Guarantees

The cost of the state's reviews of metallic mining projects is the responsibility of the mining permit applicant. Companies are also responsible for all future costs relating to reclamation and long-term care and are required to post a "bond or other security...conditioned upon faithful performance of all requirements of [the Metallic Mining Reclamation Act]." Special taxes are also required for companies involved in mining metallic minerals covering environmental effects, socioeconomic effects on local communities and the potential short-lived nature of the activity. A **net proceeds tax** on metallic mining is applied in order that the state may derive a benefit from the extraction of irreplaceable minerals and in order to compensate the state and municipalities for costs.

Liability

Liability requirements cover:

(a) Damage for mining-related injury made without regard to fault -- except that damages may be reduced to reflect negligence on the part of the injured party;

(b) Mining-related damages regardless of any change in the nature of ownership of the prospecting or mining site and of any reorganization, merger, consolidation, or liquidation affecting the prospecting or mining company.

Other Regulations

Metallic mineral prospecting and mining regulations complement and supplement (but do not replace) all other state environmental regulations. Mining operations must comply with all state regulations regarding surface water, wastewater discharge, air quality, wetlands and groundwater.

Federal Regulations

Wisconsin's environmental protection programs complement federal environmental programs, and in the case of water, air, and solid waste, the state is fully responsible for carrying out those programs in place of the federal enforcement agencies. Certain federal permits and approvals are still required for metallic mining operations in Wisconsin, however, and mining on federal land must be completed in conformance with state and federal mining regulations.

A Closing Statement From WMC

Wisconsin's regulatory framework recognizes that mining can be a responsible activity with potentially important economic contributions.

The definition of responsible mining is contained not only within compliance with state regulations protecting the environment, but also within special liability requirements for mining operations, additional taxes levied on mining to generate revenue for environmental mitigation and related public activities, and mandatory guarantees of financial capability before permitting mineral development.

In addition, local governments and citizens are instrumental in the decision-making process. The central role of local government and the local community is reflected in laws providing for optional negotiations about local issues that determine the acceptability of mining for local communities.

The guidelines are comprehensive and strictly enforced. The Jackson County Mine is an excellent example of environmentally-responsible mining in Wisconsin, showing that it is possible, in the words of Hearing Examiner David Schwarz, that "an economically viable mining operation can be established without environmental degradation."

Glossary Of Terms

Baseline Monitoring

(Sometimes called baseline testing) — Quantifying pre-mining physical, biological and hydrogeological conditions for identifying the possible effects of a mining operation.

Draft Environmental Statement

The first issuance of a proposed Environmental Impact Statement which is made available for government agency and general public review prior to submission of the final Environmental Impact Statement.

Environmental Impact Statement

An disclosure document prepared by a government agency on any of its major actions which may significantly affect the potential impacts of the human environment, and which is made available for public review prior to an agency finalizing its decision.

Exploration

Defined as the on-site geologic examination from the surface of an area by core, rotary, percussion or other drilling, where the diameter of the hole does not exceed 18 inches, for the purpose of searching for metallic minerals or establishing the nature of a known metallic mineral deposit, and includes associated activities, such as clearing and preparing sites for drilling.

Groundwater

Water beneath the earth's surface between saturated soil and rock that supplies wells and springs. For regulatory purposes, groundwater and surface water are regulated differently and are subject to different regulatory standards.

Glossary Of Terms

Hydrology	The study of the occurrence, movement and storage of water in the terrestrial environment; professionally referring to specialization in the study of surface water.
Ore	Rock in which a metal may be extracted in commercially profitable quantities, usually mixed with earthy or rocky material, known as waste, which must be removed prior to processing.
Overburden	Till, sandstone, gravels, clays and other materials that overlie the rocks which contain metals.
Prospecting	The extraction of a bulk sample for further testing and evaluation of an occurrence of metallic mineralization.
Reclamation	The process by which an exploration, prospecting or mine site is returned to its original contours and an acceptable use.
Surface Water	Water existing in open, ground level areas, such as lakes, streams and rivers.
Tailings	Fine-grained waste resulting from concentrating ore in a mill.
Waste Rock	Course non-ore materials resulting from the mining process.

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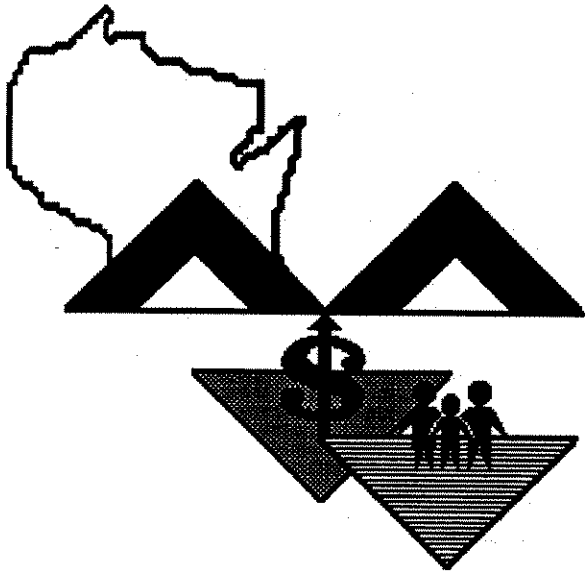


THE ECONOMIC BENEFITS OF MINING IN WISCONSIN

BY
DR. RICHARD GREEN
UNIVERSITY OF WISCONSIN-MADISON
BUSINESS SCHOOL

THIS SYNOPSIS PREPARED BY
WISCONSIN MANUFACTURERS & COMMERCE

EXECUTIVE SUMMARY

The mining projects contemplated for Rusk and Oneida Counties will have a significant positive economic impact on both counties.

The potential employment impact of the proposed Flambeau mine in Rusk County is enormous. The average number of people unemployed in the county each year could be reduced by as much as 15% to 20%. The county's unemployment could be reduced as much as 1.5 percentage points, and the total number of employed in the county could rise by 1.5 percent. This is particularly important considering that every year since 1985, unemployment in Rusk County has at some time exceeded ten percent, and during that time has been higher than the state of Wisconsin as a whole. It is also important because current per capita income in Rusk County is less than two-thirds of the per capita income of the state and appears to be falling further behind.

While the economic situation in Oneida County is better than Rusk County, mining will also have a positive impact. If the Noranda mine proceeds as currently planned, it will likely cut unemployment in the county approximately 15 percent.

If the proposed mines in Rusk and Oneida Counties begin to operate, they will also provide between one and five million dollars a year in revenue to the local units of government through the local portion of Wisconsin's net proceeds tax, royalties, property tax paid by the mines, guarantees, and other fees.

The most salient economic characteristic of the mining industry is that it produces a lot of value added, manifesting itself in high wages - higher wages than any other major industry classification in Wisconsin. For every dollar produced by the zinc and copper mine industry, nearly fifty cents goes to labor employed in the industry. Wages paid by other industries that provide immediate products to the mining industry add another forty cents to labor indirectly. Conservatively, each mine job creates at least one other local, non-mining job.

PREFACE

As a result of the renewed interest in mining in Wisconsin, the Wisconsin Manufacturers & Commerce (WMC) commissioned this investigation of the potential economic impact of mining in Wisconsin. The study focuses on how mining affects the economies of Rusk and Oneida counties, where mining is currently being planned or contemplated.

The study has three major components, including: 1) a survey of the economies of Rusk and Oneida Counties and their respective surrounding areas; 2) an assessment of the potential impact of mining on employment, wages, property values, and taxes in these areas; 3) some general comments about the implications of locating -- or not locating -- mines in these areas.[1]

Taking Stock: Where Two Economies Stand Today

Measuring economic performance is often not as straightforward as one might think. For example, most economists consider the best measure of economic performance to be per capita real gross product -- the inflation adjusted value of goods and services produced in a given area.

Unfortunately, gross product numbers are not available at the local level (indeed, the Commerce Department only recently began estimating gross products at the state level). We therefore must rely on other measures of economic performance and draw the best inferences we can from them.

Four measures, when taken together, can give us a reasonably good perspective on the health of a local economy. These measures are unemployment rate, employment growth, per capita income and wage levels.

[1] The data utilized in developing this report either comes from, or is entirely consistent with, national data on mining operations found in the Statistical Abstract of the United States and the Input-Output Tables of The United States, and includes information provided by the mining companies and data from official Wisconsin sources.

I. RUSK COUNTY

The task of analyzing the state of Rusk County's economy based on these four measures is not especially hard. Unfortunately, it is Rusk County's generally unsatisfactory performance that makes the analysis easy.

> "...UNEMPLOYMENT IN RUSK COUNTY HAS BEEN HIGHER THAN THE STATE OF WISCONSIN AS A WHOLE FOR EVERY MONTH SINCE JANUARY 1985."

Let us begin with unemployment. *Exhibit 1* demonstrates that unemployment in Rusk County has been higher than the state of Wisconsin as a whole. for every month since January 1985 (1985 was the year Wisconsin began emerging from the painful recession of the early 1980s). This in itself is problem enough. What we cannot yet see in this exhibit is that while its unemployment rate remained higher, Rusk County's labor force growth rate was lower than the state's. This means that despite the fact that it was absorbing fewer new workers, Rusk County continued to have a more chronic unemployment problem than Wisconsin.

Exhibit 1 reveals something else: unemployment in Rusk County is far more seasonal than it is statewide. Unemployment in Wisconsin follows a pattern of small hills and dales; in Rusk County, it is a pattern of sharp peaks and valleys. Many people who work in the summer in Rusk County cannot find work in the winter. In every year since 1985, unemployment in Rusk County has at some time exceeded 10 percent.

Unemployment: 1985-1991

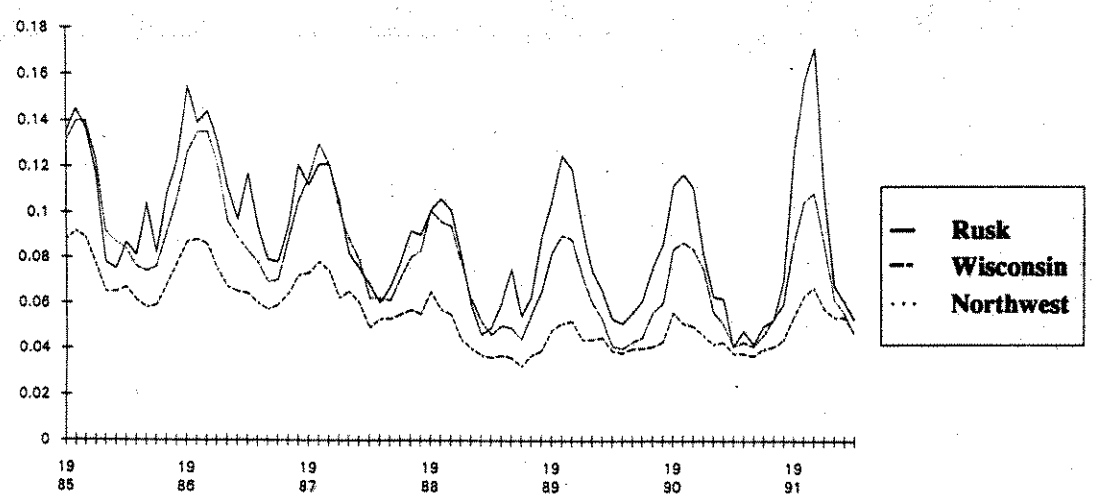


Exhibit 1

Seasonality in unemployment is not necessarily bad for an economy. For example, if a substantial number of workers earn good livings in the (highly seasonal) construction trades, they

can earn a good living during the months they do work, and live off the accumulated savings in the months they do not. Unfortunately, as we will see below, seasonal employment does present problems for Rusk County.

Before documenting the problems of seasonality for Rusk County, however, let us look at the mirror side of unemployment: employment growth. *Exhibit 2* shows precisely why, despite the fact it has not had to absorb many new workers, Rusk County's unemployment performance has been worse than the state's. From 1985 to 1991, average annual total employment in Rusk County has remained flat. When one considers that the county now has around the same number of jobs that it did in a year when the state was just emerging from recession, the county's difficulty in creating jobs becomes particularly obvious.

"FROM 1985 TO 1991, AVERAGE ANNUAL TOTAL EMPLOYMENT IN RUSK COUNTY HAS REMAINED FLAT."

Employment data tell us only part of what we need to know to analyze an economy. Income performance is also an important component of the analysis. For a number of reasons, income and employment performance do not always follow each other closely.

Total Employment 1985-91 (1985=1)

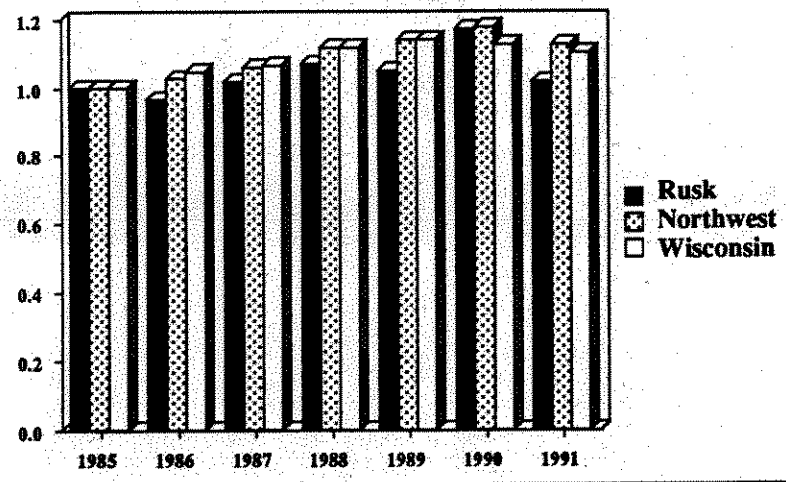


Exhibit 2

They do, however, in Rusk County. Income performance in Rusk County is like unemployment performance -- by Wisconsin standards it is substandard. Per capita income in the county is less than two-thirds of the per capita income in the state (*Exhibit 3*).

Price differences can probably explain part of the difference between state and county per capita incomes. Housing, for example, is much more expensive in Madison and Milwaukee than it is in rural areas. This means that in real terms, Rusk County's income performance

Nevertheless, standards of living in Rusk County are surely far lower than they are statewide. In the first place, it is highly unlikely that price differences could explain such a large income gap. Second, when compared with only its brethren non-metropolitan counties, Rusk County still fares poorly. Per capita income in Rusk County is 20 percent lower than it is in other non-metropolitan counties.

"PER CAPITA INCOME IN RUSK COUNTY IS LESS THAN TWO-THIRDS OF THE PER CAPITA INCOME IN THE STATE."

1985-89 Per Capita Income

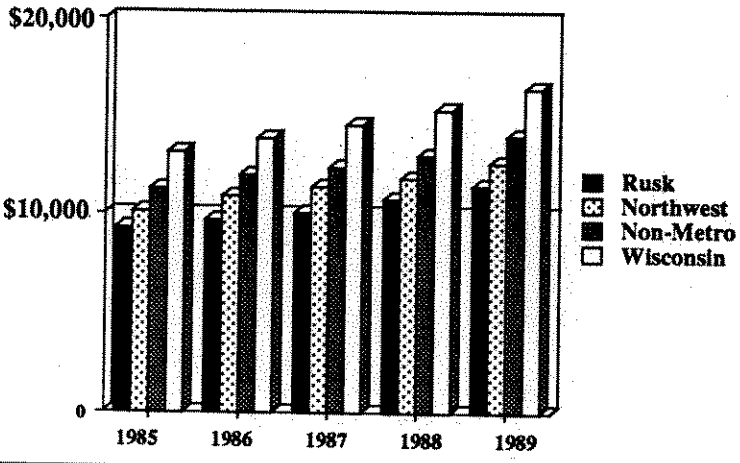


Exhibit 3

Perhaps even more distressing, Rusk County seems to be falling further behind. As *Exhibit 4* demonstrates, since 1989, income has grown less rapidly in Rusk County than it has either in non-metropolitan counties or in the state as a whole. Right now, only four counties in the state have lower per capita incomes than Rusk County.

Part of the reason incomes are, on average, so low in Rusk County is because of its chronically high unemployment rate. Just as important, however, are the wages the people who do work are paid: they are very low. *Exhibit 5* shows that wages paid in Rusk County are consistently lower than wages paid elsewhere. Ironically, Rusk County relies quite heavily on two industries -- durable goods manufacturing and government -- that

Total Income Growth (1985 = 1)

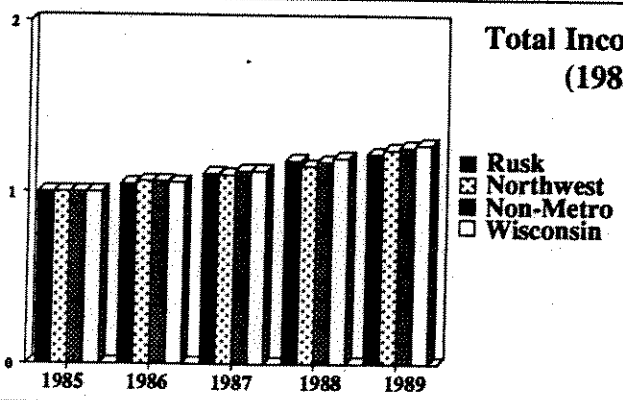


Exhibit 4

generally pay relatively high wages (for the county and state's relative reliance on various industries, see *Exhibits 6 and 7*). They don't pay high wages in Rusk County.

> "...WAGES PAID IN RUSK COUNTY ARE CONSISTENTLY LOWER THAN WAGES PAID ELSEWHERE."

Workers who are laid off in the winter likely struggle to get through the winter months. That seasonal workers in

1989 Average Wages by Industry
Rusk vs. Wisconsin

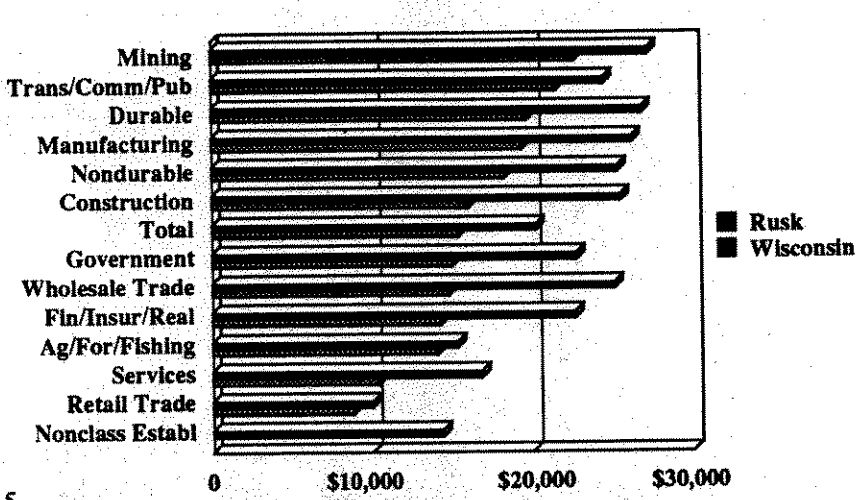


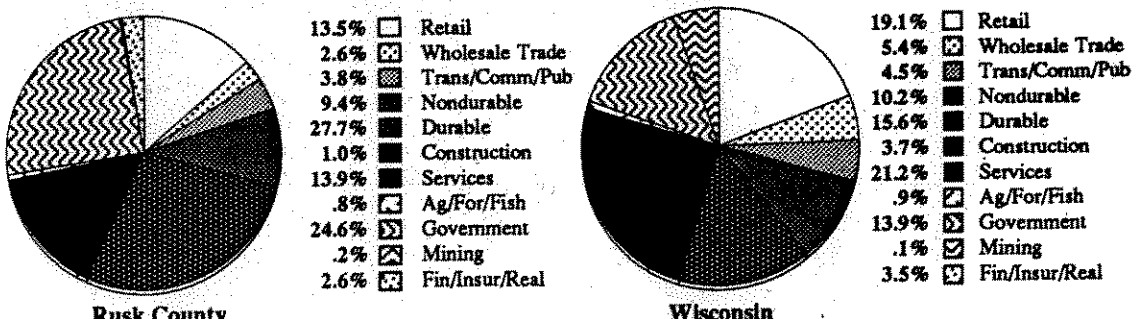
Exhibit 5

Rusk County are not particularly well paid is underscored by the fact that the seasonal jobs that generally pay best -- construction jobs -- are in short supply in the county. While 3.7 percent of Wisconsin workers are in the construction trades, only one percent of Rusk County workers do construction.

Rusk County is a place that has, by any standards, serious economic problems. While it is perhaps not poor by the standards of Appalachia, it is poor by any other American standards. Its unemployment rate is consistently and substantially higher than its state's, and its income levels are substantially lower (and Wisconsin is a state with income that is slightly below average by national standards).

Exhibits 6 & 7

Average Monthly Employment by Industry 1989



II. ONEIDA COUNTY

The economic news from Oneida County is far better than it is from Rusk County. While performance in Rusk County is substandard, Oneida County is in many ways nearly average by Wisconsin economic standards. Still, as we shall soon see, the county has considerable room for economic improvement.

"...EMPLOYMENT GROWTH IN ONEIDA COUNTY MIRRORS ITS UNEMPLOYMENT PERFORMANCE."

Oneida County's unemployment record, though, looks pretty good right now. As *Exhibit 8* demonstrates, after many years in which the unemployment rate in Oneida County generally exceeded unemployment rate in Wisconsin, it has in the last year become lower than the state rate.

Monthly Unemployment 1985-1991

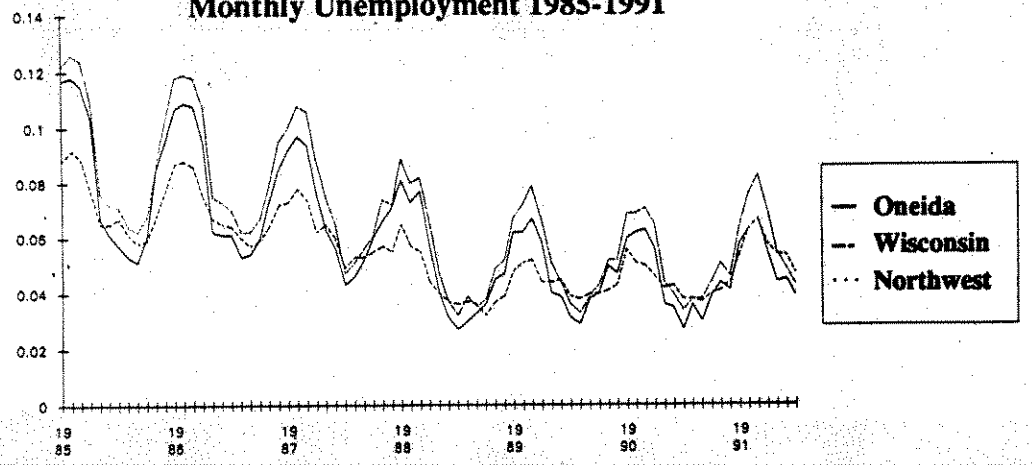


Exhibit 8

What is particularly interesting is that now even when employment in the county hits its "down" season (i.e., January and February), the unemployment rate is still no higher than it is statewide. During the rest of the year, unemployment in the county is now lower than it is in Wisconsin. This is no mean achievement. While Wisconsin's income performance lags the nation a bit, its unemployment performance has been substantially better for quite some time. Indeed, over the last year, Wisconsin's unemployment rate has consistently been more than a full percentage point lower than the nation's unemployment rate. Oneida County's even lower unemployment rate is therefore very impressive.

As was the case in Rusk County, employment growth in Oneida County mirrors its unemployment performance. Because unemployment performance in the county has improved relative to the state, and because its labor force growth has more than matched the state's, we can infer that employment growth in the county must have been more rapid than it was for the state since 1985. And so it was. *Exhibit 9* shows how total employment in Oneida County (as well as surrounding counties) grew faster than it did statewide.

In light of Oneida County's strong employment performance, its income performance is a little bit puzzling. It is true that as non-metropolitan counties go, income in Oneida County is a little better than average (see *Exhibit 10*). But while non-metropolitan counties make a useful basis for comparison, it is also important to note that Oneida County's per capita income falls well short of Wisconsin's. While once again, living costs can explain part of the difference, they most likely cannot explain all the difference (and, in fact, data from the Wisconsin REALTORS Association suggests that housing costs in the Oneida County area are high by the standards of rural Wisconsin). We should also reiterate that Wisconsin per capita income is not high by national standards.

Total Employment 1985-91 (1985=1)

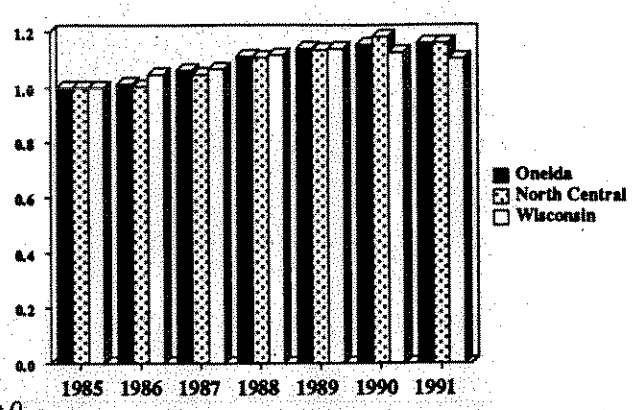


Exhibit 9

"ONEIDA COUNTY'S PER CAPITA INCOME FALLS WELL SHORT OF WISCONSIN'S."

The level of income in Oneida County, however, does not give us our real puzzle. Rather, it is income growth performance that is a little perplexing. Generally speaking, strong employment growth will bring on strong income growth. *Exhibit 11*, however, shows us that from 1985 to 1989, income in Oneida County grew more slowly than it did statewide. Some might argue that the county's laggard income growth is a function of the large number of people who retire to the area. But a look at wages and industrial mix gives us another explanation.

1985-1989 Per Capita Income

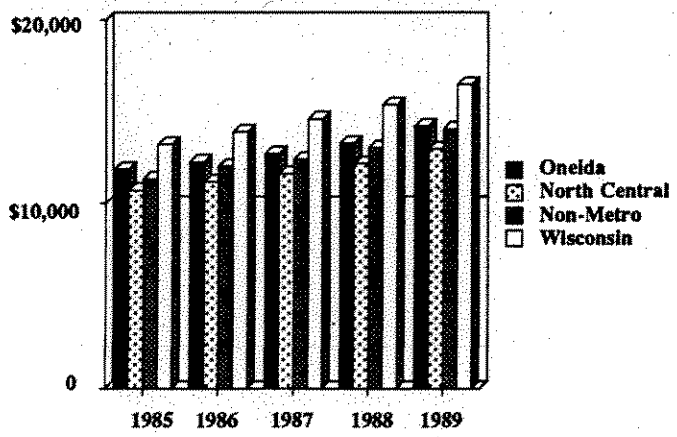


Exhibit 10

Like Rusk County, wages in Oneida County are generally lower than they are in Wisconsin as a whole (see *Exhibit 12*). Two factors explain why. First, with the exception of the non-durable

goods manufacturing and mining sectors, average wages paid in each sector of Oneida County are lower than they are statewide. Second, Oneida County has relatively heavy concentrations of employment in the services and retail trade sectors (see *Exhibits 13 and 7*). These sectors pay among the lowest wages. In fact, the retail sector pays the lowest wages of any of the major industrial categories.

Total Income Growth (1985 = 1)

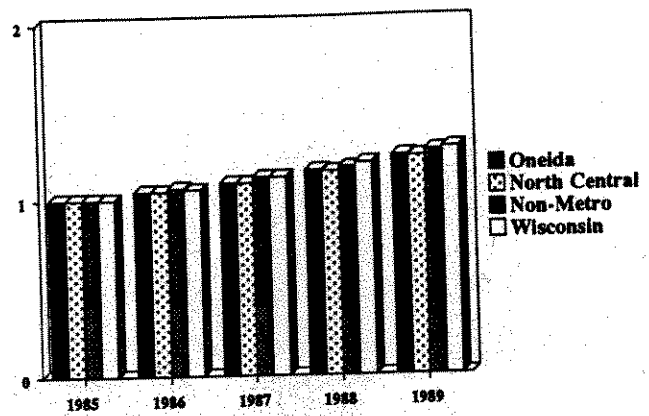


Exhibit 11

The industrial mix of Oneida County also affects incomes through mechanisms other than wages. Generally speaking, the retail and service sectors are not high "value added" sectors: most of the revenue generated by these sectors is returned to intermediate goods. High "value added" sectors are important because they generate the wealth required to support the other sectors. It is probably fair to say that the retail trade and service sectors of Oneida County are to a large extent supported by wealth generated outside the county. There is nothing wrong with this per se; it just goes a long way toward explaining why the county's income position does not match its employment position.

> "...WAGES IN ONEIDA COUNTY ARE GENERALLY LOWER THAN THEY ARE IN WISCONSIN AS A WHOLE."

1989 Average Wages by Industry: Oneida vs. Wisconsin

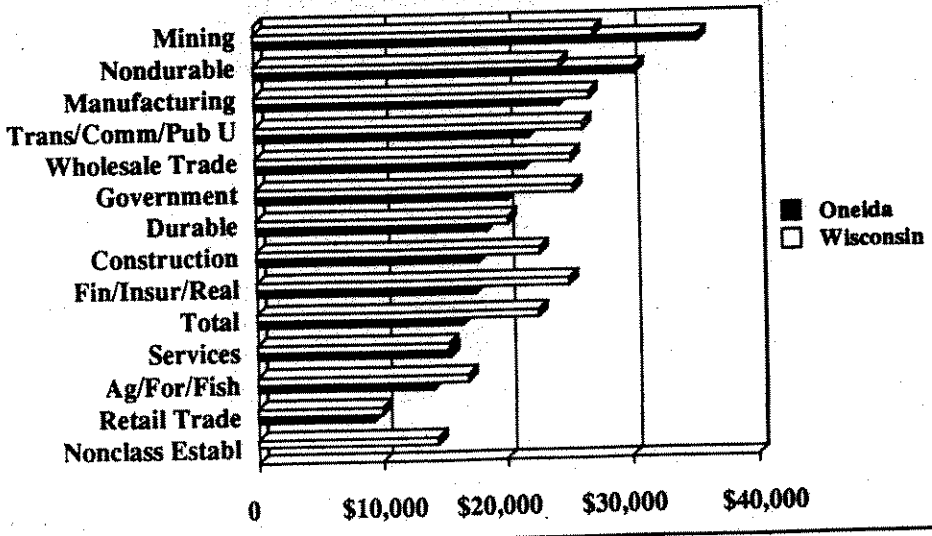


Exhibit 12

Average Monthly Employment by Industry: Oneida County 1989

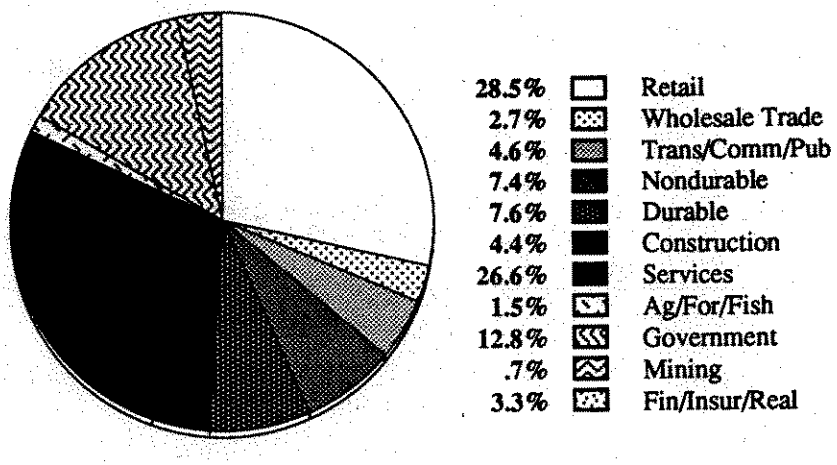


Exhibit 13

We finished the last section with a discussion of value added. Perhaps the most salient characteristic of the mining industry is that it produces a lot of value added. In fact, the *Substantial Abstract of the United States* reports value added statistics only for the manufacturing and mining sectors. One reason for this is arguably because these sectors produce so much more value added than do other sectors (another reason is because it is much easier to measure value added in these sectors).

One manifestation of high value added is often high wages. Because workers in manufacturing and mining generally produce substantial wealth, they are highly productive. Wages are a function of productivity -- in fact, in a competitive labor market, wages in an industry should just equal the marginal productivity of the last laborer employed in that industry.

"MINING PAYS HIGHER WAGES THAN ANY OTHER MAJOR INDUSTRY CLASSIFICATION IN WISCONSIN."

The productivity of workers in the mining industry is made plain in *Exhibit 14*. Mining pays higher wages than any other major industry classification in Wisconsin (notice, too, that the next highest paying industries are manufacturing and construction. Construction is another industry that adds wealth to an economy). Returning to *Exhibits*

1989 Wages by Industry - Wisconsin

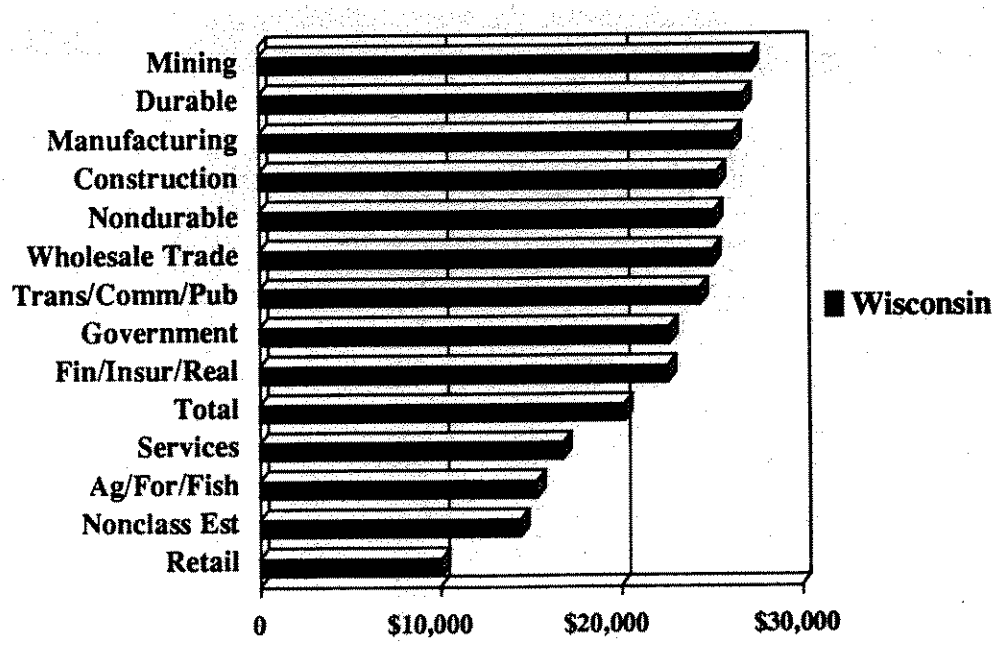


Exhibit 14

5 and *12*, we may also note that mining pays higher wages than any other industry in Rusk and Oneida Counties (we shouldn't take the Rusk County average too seriously yet, however, because very few people there are now employed in the mining sector).

"MINING ALSO CONTRIBUTES TO INDUSTRIES BEYOND THOSE THAT PROVIDE INTERMEDIATE GOODS."

Mining, moreover, returns much of its revenues to labor. According to the Input-Output Table of the United States, of every dollar produced by the zinc and copper mining industry, nearly 50 cents goes to labor employed in the industry. When we add the wages paid in the industries that provide intermediate products to the mining industry, we find another 40 cents goes to labor indirectly.

Beyond labor, mining, like every other industry, stimulates demand in other industries. Among those industries most affected by mining are utilities, the wholesale trade industry, the banking and insurance industry, real estate services, other services, auto services, transportation services, the electrical and non-electrical machinery industries (which are among Wisconsin's most important employers), and the residential construction industry. The amount of goods demanded from each industry per $100 of zinc and copper mining output is detailed in *Exhibit 15*.

Mining also contributes to industries beyond those that provide intermediate goods. As already noted, those employed in the mining industry earn good wages. They therefore have discretionary income they can use to support local retail, finance, insurance, real estate, and service sectors. This indirect impact of an industry, also known as the multiplier effect, is often overstated. Very often, if a particular industry in an area were to disappear, others would pick up the slack, and the impact on the retail and service sectors would be negligible. In the current context, however, we needn't worry too much about that problem. In Rusk County, the new jobs would allow the economy to absorb a number of unemployed workers, and the relatively high wages paid would give a boost to local wealth. In Oneida County, the high wages could help bolster the already important retail and service sectors.

Major Commodity Inputs Required Per $100 In Nonferrous Mining Industry Output

Chemicals and Chemical Products	$ 4.38
Repair and Maintenance Constr.	$ 1.40
Refined Petroleum	$ 4.44
Rubber & Plastic Products	$ 2.19
Primary Iron & Steel	$ 2.51
Engines and Turbines	$ 1.49
Fabricated Metal	$ 1.48
Constr. & Mining Equipment	$ 2.86
General Industrial Machinery	$ 1.55
Transportation & Warehousing	$ 1.99
Utility Services	$10.96
Wholesale & Retail Trade	$ 3.29
Finance & Insurance	$ 2.05
Real Estate & Rental	$ 5.09
Other Services	$ 3.87
Auto Repair & Services	$ 3.68

Exhibit 15

Putting together both the industry demands for intermediate goods, and the wage-earner demands for consumer goods and services, we

may estimate very conservatively that each mining job creates at least one other local non-mining job (a good case could be made that each mining job creates at least two non-mining jobs, but we are seeking to err on the side of understatement).

From this analysis, we may determine that the potential employment impact of the proposed Flambeau mine on Rusk County could be enormous. If two-thirds of the jobs created by the construction and operation of the mine are claimed by current members of the Rusk County labor force, the average number of people unemployed in the county each year could be reduced by as much as 15 to 20 percent. The county's unemployment rate could be reduced by as much as 1.5 percentage points, and the total number employed in the county could rise by 1.5 percent.

"...MINING COULD HAVE A SUBSTANTIAL FISCAL IMPACT ON RUSK AND ONEIDA COUNTIES."

The impact of the proposed Noranda mine in Oneida County would be smaller, for the simple reason that Oneida County's labor force is more than two and one-half times larger than Rusk County's. Nevertheless, under the assumptions described above, the Noranda mine would likely cut unemployment in the county by approximately 15 percent. The impact on the unemployment rate would, once again, be smaller, because of Oneida County's relatively large labor force.

Beyond wages and employment, mining could have a substantial fiscal impact on Rusk and Oneida Counties. First, every million dollars in ore extracted each year would indirectly push up property values in the counties by roughly $50,000 due to an increased demand for real estate resulting from the increased wealth brought into the county.

Second, and more important, if the mines begin to operate, they will provide between one and five million dollars a year in revenue to their local units of government through the local portion of Wisconsin's net proceeds tax, royalties, property taxes paid by the mines, guarantees, and other fees. (The range is a function of the wide range of potential future mineral prices. The top of the revenue range reflects proceeds arising from a "middle-case" ore price scenario). In the context of these counties current local tax base, this is a potentially enormous sum. According to the *Wisconsin Blue Book*, in 1987 all the taxing authorities put together in the two counties raised around $36 million in taxes. An additional one to five million dollars could bring property tax relief, help the counties develop the infrastructure required for further economic development, or both.

IV. A FINAL COMMENT

Up until now, this study has focused on economic statements about how things are, rather than how they should be. In the end, however, I feel it necessary to step out of the realm of positivism to discuss a potential implication of not allowing the Flambeau mine, which already has received a permit, to go forward.

In 1983, then-Governor Anthony Earl appointed a blue ribbon panel to determine the state of Wisconsin's economy and to develop strategies for Wisconsin's economic future. That panel, known as the Wisconsin Strategic Development Commission, found that one of the greatest problems then facing the state's economy at that time was the way regulations were being used in the state: to discourage business development.

"AS A CONSEQUENCE [OF WISCONSIN'S REGULATORY ATMOSPHERE] THE STATE NOW USUALLY PERFORMS WELL BOTH IN BUSINESS CLIMATE SURVEYS AND ENVIRONMENTAL QUALITY SURVEYS."

The commission did not particularly quarrel with the regulations themselves, but rather with the way they were being implemented. Perhaps because of the way regulation was put into operation in Wisconsin, the state at the time routinely finished at the bottom of various rankings of "business climates."

Since then, in part perhaps because of the work of that commission, the state has made great strides toward encouraging companies to locate and expand in Wisconsin. It has not done so through widespread deregulation; rather, it has worked with companies to find how they could prosper in Wisconsin's regulatory atmosphere. As a consequence, the state now usually performs well both in business climate surveys and environmental quality surveys.

Clearly, Wisconsin, although not without economic problems, is now in many ways in an enviable position. That position, which took many years for the state to acquire, is something that can be nurtured or destroyed. How Wisconsin handles mining will be part of the nurturing -- or destruction -- process.

DATA SOURCES FOR EXHIBITS

Wisconsin Department of Industry Labor and Human Relations: Exhibits 1, 2, 5, 8, 9, 12, and 14.

U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business: Exhibits 3, 4, 6, 7, 10, 11, and 13.

U.S. Department of Commerce, Bureau of Economic Analysis, Input-Output Table of the United States: Exhibit 15.

WISCONSIN
DEPT. OF NATURAL RESOURCES
George E. Meyer
Secretary

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Southern District Headquarters
3911 Fish Hatchery Road
Fitchburg, Wisconsin 53711
TELEPHONE 608-275-3266
TELEFAX 608-275-3338

June 3, 1994

Ms. Char Bergstrom
P.O. Box 289
Manitowish Waters, WI 54545

Dear Ms. Bergstrom:

Enclosed as requested is a copy of the draft report of the 1993 Spring/Summer Field Survey of the Southwestern Wisconsin Zinc-Lead Mining District. We are required to charge copying and mailing fees for this type of request. The fees are as follows:

Processing fee - time, etc.	$2.00
Sixty five pages @.10/page	$6.50
Third Class Postage	$1.56
	$10.06

PD. 6-15-94.

Please send me a check in the amount of $10.06 made out to the Department of Natural Resources.

This report has not yet received final review by various interested programs in the DNR.

The recommendations in this report, if implemented, will require significant expenditures of time and money to accomplish. Such projects will have to be evaluated and priorities established to finance and perform in comparison with our other routine and special projects.

Some limited actions may be able to be taken now, such as additional sampling, but extensive surveys or remedial actions will have to be further evaluated.

Sincerely,

Floyd F. Stautz

Floyd Stautz
Assistant District Director
Telephone: (608) 275-3316

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RESULTS OF THE 1993 SPRING/SUMMER FIELD SURVEY OF THE SOUTHWESTERN WISCONSIN ZINC-LEAD MINING DISTRICT

By: *Janet M. Blabaum* — *A.I.P.G. Certified Professional Geologist No. 9109*

Brenda L. Howald — *Chemist and DNR Environmental Specialist*

Thomas N. Harpt — *Registered Professional Engineer No. E-17974*

DRAFT

Janet M. Blabaum
CPG-9109

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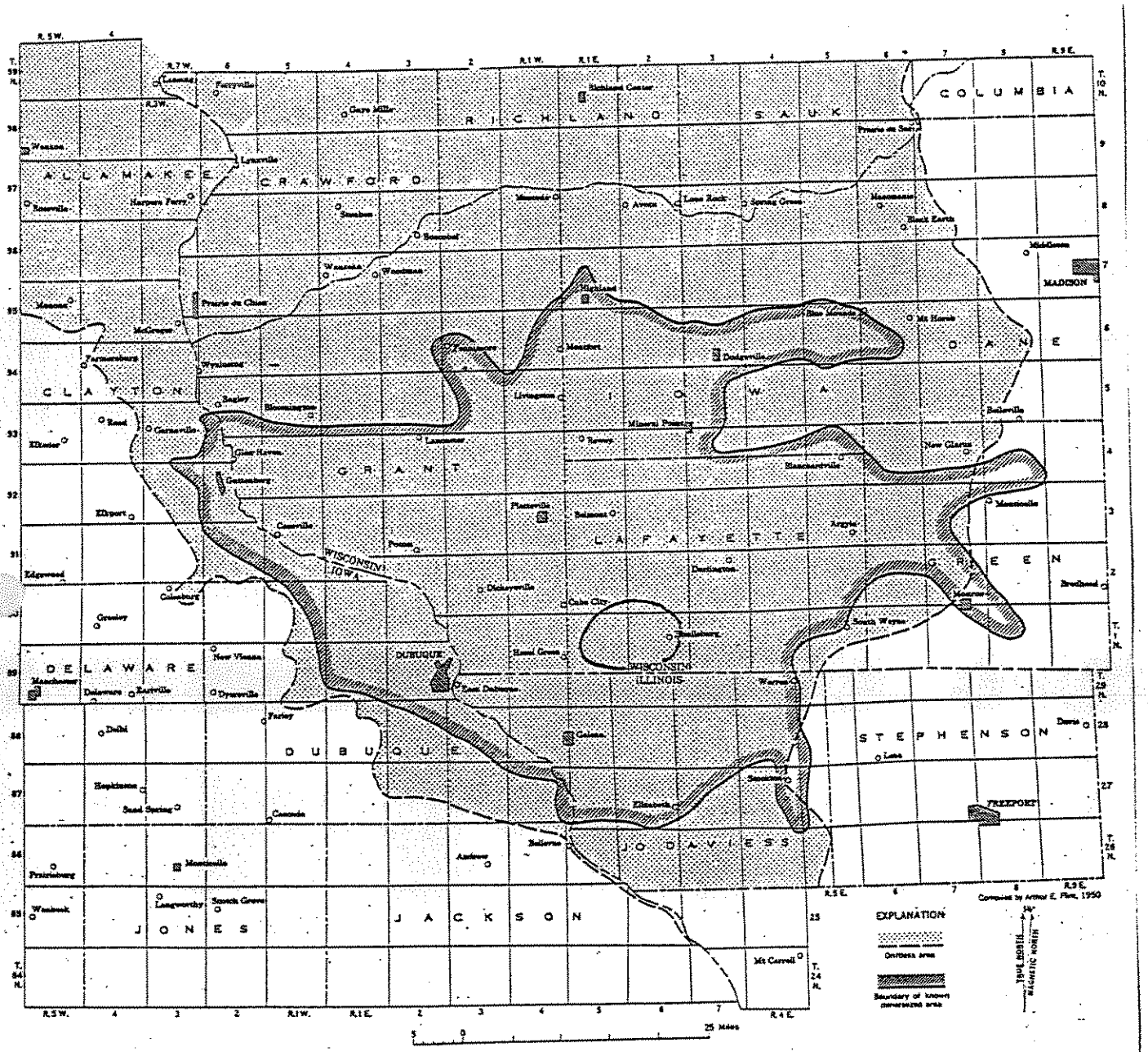

—Map of the Driftless Area of the upper Mississippi Valley zinc-lead district.

-Shows This Study Area.

-After Heyl, 1959.

System	Series	Group	Formation	Member
Devonian	Upper		Kenwood	
	Middle		Milwaukee	
			Thiensville	
			Lake Church	
Silurian	Cayugan		Waubakee	
	Niagaran		Racine	
			Manistique	
			Hendricks	
			Byron	
	Alexandrian		Mayville	
Ordovician	Cincinnatian		Neda	
			Maquoketa	
	Champlainian	Sinnipee	Galena	
			Decorah	
			Platteville	
			St. Peter	Glenwood
				Tonti
				Readstown
	Canadian	Prairie du Chien	Shakopee	Willow River
				New Richmond
			Oneota	
Cambrian	St. Croixan	Trempealeau	Jordan	Coon Valley
				Sunset Point
				Van Oser
				Norwalk
			St. Lawrence	Lodi / Black Earth
		Tunnel City	Lone Rock / Mazomanie	Reno
				Tomah
				Birkmose
		Elk Mound	Wonewoc	Ironton
				Galesville
			Bonneterre / Eau Claire	
			Mt. Simon	

Geologic column of Paleozoic rocks in Wisconsin.

Mines are found in the Decorah and Platteville Formations. Private wells are also completed into these formations.

From Stratigraphic Relations of Lower Paleozoic Rocks of Wisconsin. After Ostrom, 1978.

ABSTRACT

Surface waters, groundwaters, sediment, soil and rock specimens were collected in the Shullsburg-Benton-New Diggings, Wisconsin mining subdistrict during the spring and summer of 1993 in response to a citizen complaint of acid mine drainage being observed entering a feeder stream of the Galena (Fever) River. The samples were taken from underground mines, springs, public and private wells, seeps, roaster waste piles and rotary roasted jig tailings. These samples were analyzed for the following heavy metals: arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, silver, gold and zinc. These samples showed positive detections for all of these elements except for molybdenum which could be present but is in quantities below the instrumental detection limit. All of these elements are unmistakably linked with the minerals typical of the Southwestern Wisconsin-type (and similarly classed) zinc-lead mineral deposits. Other elements commonly linked with these types of mineral deposits include thallium, gallium, germanium, indium, iridium, selenium, tungsten, vanadium, yttrium and zirconium. While the elements which were detected are natural components of the ore deposit, they have been physically and chemically concentrated above and below ground in stored and abandoned blasted ore and various mine wastes. These elements have been rendered more chemically reactive and mobile as well as more biologically toxic by in-situ exposure in the highly jointed and fractured area bedrock, by mining and ore processing technologies used by the mines of a previous era in this mining district, and by exposure of these mining by-products to infiltrating, corrosive waters.

Because of the distinct possibility that chronic, low level exposure to these elements through ingestion or inhalation may negatively impact human health and because there are visible chemical and biological impacts to the local watersheds; it is prudent for the Department to take note of the findings of this study and to remedy the more urgent pollution problems which exist in the Southwestern Wisconsin Zinc-Lead Mining District.

INTRODUCTION

Purpose of Report:

The purpose of this report is to provide detailed documentation of the 1993 spring and summer field investigation by the DNR-Southern District Office Wastewater Section concerning a citizen complaint about acid mine drainage seen entering a feeder stream of the Galena (Fever) River in Lafayette County, Wisconsin during the year's intense rainfall events. This document includes background material in appendices so that the reader can examine the technical foundations that support this study and the final conclusions and recommendations of the authors.

Problem Statement and Delineation of Problem Components:

During the spring storm events of 1993, Tom Harpt (Industrial Wastewater Engineer/DNR Southern District) responded to a complaint from a local resident in the Shullsburg, Wisconsin vicinity. The complaint described feeder streams and branches of the Galena (Fever) River in Lafayette County as running red in color. Discussions with local citizens indicated the observed problem was a long standing one associated with the local mines. Citizens also observed that the "red water" has caused skin burns, extreme eye irritation and sometimes ulceration.

The Southern District Wastewater Section is responsible for regulating storm water run-off from industrial sites and surface water and groundwater impacts from industrial sources in Lafayette County, Wisconsin. Additionally, the Galena (Fever) River is classed (down to Buncombe Road in southern Lafayette County) as an "Exceptional Resource Water" as well as being an interstate waterway. Therefore, the complaint required that a field investigation be performed. This investigation looked at possible impacts to surface and groundwaters and sediment as well as mine waste composition and the chemical composition of the minerals commonly found in the mine waste piles.

Because the investigators had reviewed the published United States Geological Survey documentation (Heyl, 1959) of the chemical make-up of the local mineral deposits which were mined in the area of complaint and since the complaint entailed known run-off from residual mine wastes, it was decided to quickly screen a few accessible mine and mine waste sites which have obvious surface water and groundwater associations. The limited sampling included five surface water samples, two sediment samples, three mine waste pile samples, five mine groundwater samples, three public water supply samples, and five private well samples which had observable close proximity to known mined ore deposits. Heyl's paper was used as an analytical guide to the elements which would normally be present in the mine waste and therefore also in the run-off to surface waters and the leachate percolating into groundwaters.

Background information is included in the appendices. This is done so that the reader can understand the significance of the sample data results. Appendix A is a brief history of the mining and mining methods employed in the Southwestern Wisconsin Zinc-Lead mining district since these activities directly affect the type, physical occurrence, distribution, and strength of mine wastes that may be impacting sediments, surface waters and groundwaters in this investigation.

Appendix B contains a discussion of the reported and observed minerals from this mining area. Appendix C links the mineral species to the elemental chemistry of mineral deposits and the mine wastes. It also demonstrates the strong connection between locally abundant mineral sources and the elements found in the surface and groundwater samples.

The stability and solubility of these mineral species when exposed to both surface and groundwater are important concepts to review as well as the concepts of mobility and fate of the dissolved elements from these minerals. These topics are covered in Appendix D. Selected technical papers from other researchers listed in the GEO-REF database (compiled by the American Geological Institute) are included which demonstrate the fate of these elements under similar geochemical conditions from other mining districts both here in the U.S. and in other countries.

Finally, a review and list of generally available information on the toxicological effects of these elements on human, animal and aquatic systems makes up Appendix E. The authors do this to emphasize their concern that a further, more extensive study should be funded in order to ensure that human health and welfare are protected in the study area and to possibly mitigate negative impacts to the environment where economically feasible.

Study Procedures:

Initial sample testing was performed in response to a public complaint, for a range of common metals due to the previous mining history of the study area. When sample results showed significant concentrations of metals corresponding to the minerals found associated with the local mines, further sampling was suggested. The additional sampling points were targeted to mines and mine waste and associated surface water, groundwater, and sediments. The aim was to determine possible migration of metals from sources of contamination found at mining sites. These sources include roaster waste piles, jig tailings piles, waste rock piles and exposed mineralization within the underground mine workings, proper.

The heavy rainfall during 1993 resulted in the availability of a wide range of sample points for mine associated surface and groundwaters. Surface water run-off was associated with many of the mine waste piles. Also, a heavy influx of groundwater into abandoned mines through bore holes, tunnel collapses, and flow through fractures in the surrounding rock formations meant that many of the mines contained water. The data from the sampling performed is summarized in tables contained within the report.

Samples were taken using plastic bottles which were cooled with ice packs until delivery within 24 hours of sample collection to the lab for analysis. Some solid samples were collected in glass bottles. Aqueous samples were preserved with nitric acid to allow a sample holding time of six months for the analysis of the metals. The sample parameter list for metals analyses was composed of metals typically associated with the minerals found in the mining area - arsenic, barium, cadmium, chromium, cobalt, copper, gold, iron, lead, manganese, mercury, molybdenum, nickel, silver, and zinc.

The samples were analyzed at the State Laboratory of Hygiene using "Standard Methods, 17th Ed.", methods 3120 (ICP) and 3113B (FURNACE). The laboratory encountered interferences in the analytical methods when trying to analyze the solid samples of roaster waste, sediment and leachate. The high concentration of iron and manganese in these samples interfered with the determination of concentration for other metals in the samples. Quality control performed on these samples included replicate analyses and spiked samples. The recoveries of the known added concentrations in the spiked sample were outside of the acceptable quality control limits for spikes and ranged from 60 to 84 percent for the majority of metals and up to 115 percent for manganese. This indicates that the reported sample concentrations for roaster wastes are lower than the actual levels occurring in the sample, with the exception of manganese.

Study Results and Discussion:

Mine-Associated Groundwater Sample Results

The results of the chemical analyses of mine-associated groundwaters (samples 001, 004, GW-1, GW-2, GW-4) all show heavy metal impacts to groundwater. The suite of heavy metals detected is consistent with those previously reported by Heyl (1959) and others in the mining district's mineral compositions (see Appendices B and C).

The following comparisons are based on State designated drinking water preventative action limits and maximum contaminant levels because mine related groundwater is potentially a source of drinking water. Sax (1986) provides the animal, livestock, fish and aquatic toxicity limits. Also note that these samples did not contain visible suspended solids at the time of sampling and sample preservation. For references to the toxicological information cited here, please refer to Appendix E: Toxicology of the Elements Found in Southwestern Wisconsin Mining District Ores.

Sample 001 (SE¼, SE¼, of Section 2, Township 1N, Range 1 E) was a sample of spring water emerging from a buried orifice at the Etna Mine. The Etna Mine is centrally located between, and is connected to, the Pittsburg-Benton Mine and the Applebys (a.k.a. Looney Level) Mine (see Heyl, 1959, Plates 1, 5, 21). Considerable collapse of the upper shallow level of the Pittsburg-Benton Mine can be seen on the land surface with evidence of numerous coalescing sink holes. One of the pipes for either de-watering or venting can be seen in the midst of the collapsed area. According to the landowner, a portion of the Applebys Mine is also actively collapsing. A local farmer's tractor collapsed a portion during the spring of 1993 while the farmer was plowing over the buried access tunnel. The analytical results for sample 001 follow.

Arsenic was detected at 110 ppb (0.11 ppm) and was 2.2 times the maximum contaminant level of 50 ppb. Arsenic is a known carcinogen and is considered poisonous at concentrations equal to and greater than 0.01 ppm. This groundwater sample (when units are converted) represents a 0.11 ppm concentration and exceeds the known poisonous threshold by 11 times.

Cadmium was detected at 180 ppb (0.18 ppm) and was 18 times the maximum contaminant level of 10 ppb. Cadmium is a known bioaccumulator, is a carcinogen and has a "super toxicity rating" for humans. The chronic animal toxicity limit is 0.05 ppm. This sample represents a cadmium concentration of 0.18 ppm and exceeds the chronic animal toxicity limit by 3.6 times.

Cobalt was detected at 36 ppb (0.036 ppm) with no established maximum contaminant level. Cobalt has a naturally occurring radioactive isotope commonly used in medical applications (Fetter, 1993). Radioactive cobalt wastes usually require special disposal repositories classed for low level radioactive medical waste. Cobalt salts are known to be toxic to humans when ingested. One teaspoonful to one ounce may be fatal. Cobalt compounds are suspected carcinogens of the connective tissues and lungs. Cobalt is a known bioaccumulator. Livestock toxicity is 0.1 ppm. It is interesting to note that a treatise on mining technology from the 1500's mentions that the toxic effects of cobalt and arsenic bearing ores were known and much feared by miners and metal refiners of the time (see Agricola, 1556).

Lead was detected at 480 ppb (0.48 ppm) and was 32 times the preventative action limit of 15 ppb. Lead was also 9.6 times the maximum contaminant level of 50 ppb. Lead is a known bioaccumulator and has been found to cause nerve damage and measurable diminished mental capacity in humans, especially children.

Manganese was detected at 3600 ppb (3.6 ppm) and was 72 times the maximum contaminant level at 50 ppb.

Nickel was detected at 91 ppb (0.091 ppm) and was approaching the maximum contaminant level of 100 ppb. Nickel is known to be toxic to aquatic systems under certain chemical circumstances. Threshold acute hazard level for fish is 0.05 ppm. Chronic aquatic toxicity limit is 0.38 ppm. Airborne nickel is classed as a lung irritant. Humans can experience toxic effects but most usually are able to excrete ingested nickel compounds faster than they are absorbed into the system (Sax, 1986).

Zinc was detected at 91000 ppb (91 ppm) and exceeded the maximum contaminant level of 5000 ppb by 18.2 times. Zinc is most toxic to aquatic systems since it increases the susceptibility of salmonids and other fishes to lethal ulceration. Livestock toxicity is 5 ppm. Zinc is listed as an irritant to human beings and can be corrosive to the skin and gastrointestinal tract when concentrations reach 675 to 2280 ppm.

The pH for this mine spring was measured two months after the original sample was taken and was found to be 2.3. Sulfur-eating bacteria were collected from this spring and were identified as "Siderococcus" by the State Laboratory of Hygiene.

Sample 004 (SW¼, SW¼, Section 24, Township 1N, Range 1 E) was a spring sample originating from a seep from the Penna-Benton Mine. This mine-related groundwater discharges into the ditch line along State Highway W and into the New Diggings Branch of the Fever (Galena) River. The analytical results for sample 004 follow.

Arsenic was detected at 22 ppb (0.022 ppm) which was below the maximum contaminant level (MCL) of 50 ppb. Cadmium was detected at 29 ppb (0.029 ppm) which exceeded the MCL of 10 ppb by 2.9 times. Cobalt was detected at 190 ppb (0.19 ppm). Lead was detected at 260 ppb (0.26 ppm) and exceeded the action limit (15 ppb) by 17.3 times. Lead also exceeded the action limit (15 ppb) by 17.3 times. Lead also exceeded the MCL by 5.2 times. Manganese was detected at 7400 ppb (7.4 ppm) which exceeded the MCL of 50 ppb by 148 times. Nickel was detected at 140 ppb (0.14 ppm) which exceeded the MCL of 100 ppb by 1.4 times. Zinc was detected at 33000 ppb (33 ppm) which exceeded the MCL of 5000 by 6.6 times.

Sample GW-2 (N½, NE¼, Section 30, Township 1N, Range 1E) was taken at the Badger Mine which is part of the Shullsburg Mining Museum. The sample was taken while the mine was in a flooded condition and copious fracture flow could both be seen and heard back in the mine. The pH was read at the time of sampling as 7.4. Lead concentrations (42 ppb, 0.042 ppm) in this sample exceeded the 15 ppb action limits by 2.8 times. The lead concentration was approaching the 50 ppb MCL. Concentrations of the other metals did not exceed their respective action limits.

Sample GW-4 (S½, NW¼, Section 30, Township 1N, Range 2 E) was taken at an engineered orifice with a metal grate (part of a mine wastewater reclamation project initiated by Tom Hunt and the Bureau of Solid Waste) that directs mine-related groundwater out of the sealed entrance of the Thompson and Crawhall Mines on the east side of White Oak Road and just south of County Highway W. A prolific bloom of a filamentous algae was observed at the orifice while collecting the water sample. No exceedances of action limits or maximum contaminant levels were found. For example, there was less than 1 ppb arsenic found in this sample. Cadmium was found to be 0.22 ppb and lead was found to be 1.9 ppb. NOTE: This project should be reviewed as the water quality suggests the remediation methods used were successful.

Sample GW-1 (SW¼, SE¼, Section 32, Township 5N, Range 3 E) was taken outside of the study area and in the Mineral Point mining subdistrict. This location is known informally as the Piggy Sow Mine. The sample was taken in the mine shortly after a major flood storm event. The mine was flooded and copious fracture flow could be both seen and heard in the mine. There was evidence of recent rapid fluctuations of water levels in numerous scum lines on the walls of this mine. The entrance to the mine also showed signs of the mine filling to its roof line and overflowing at the entrance due to a thick accumulation of fine mud.

Old electrical wiring and ceramic light sockets were still in place in the mine ceiling and spiral-flighted piping was still in place in the floor. One of the historians from the Platteville Mining Museum indicated to Harpt that this pipe was commonly used both to drain groundwater from the mine, and later, to pump tailings "mud" back into the abandoned parts of the mine. Subaqueous disposal of mine tailings is still practiced today. See Subaqueous Disposal of Reactive Mine Wastes: an overview of the practice with case studies; by Pelletier and Birch; published in 1990 as a monograph by the Geological Association of Canada.

Mine water was clear and free of visible suspended solids. The pH was recorded at the time of sampling as 7.3. The analytical results for sample GW-1 follows.

Arsenic was detected at 120 ppb (0.12 ppm) and exceeded the MCL of 50 ppb by 2.4 times. Cadmium was detected at 1.1 ppb with no MCL exceedance. Cobalt was detected at 80 ppb with no established MCL. Nickel was detected at 210 ppb (0.21 ppm) and exceeded the MCL of 100 ppb by 2.1 times. Zinc was detected at 3300 ppb (3.3 ppm) with no exceedance of the MCL at 5000 ppb.

For a complete listing of detected elements for these mine-related groundwaters, please refer to Table 1-Mine Related Groundwater Samples.

TABLE 1

Mine Related Groundwater Samples
(ug/L)(ppb)

	MCL	GW-2	GW-4	GW-1	001	004
Arsenic	50	1.4	<1	120	110	22
Barium	1000	85	<40	40	<40	<40
Cadmium	10	0.04	0.22	1.1	180	29
Chromium	50	<1	<1	<1	-	-
Cobalt	-	<10	<10	80	36	190
Copper	1300	1.5	<1	61	360	18
Iron	300	<50	100	140	-	-
Lead	50	42	1.9	6.5	480	260
Manganese	50	<40	<40	<40	3600	7400
Nickel	100	<10	11	210	91	140
Zinc	5000	<10	330	3300	91000	33000
pH (s.u.)	-	7.4	7.4	7.3	2.3	-

GW-2 Badger Mine
GW-4 Thompson and Crawhall Mine Spring
GW-1 Piggy Sow Mine
001 Etna Mine Spring
004 Penna-Benton Mine Spring