Foth & Van Dyke

REPORT

Environmental Impact Report for the Kennecott Flambeau Project

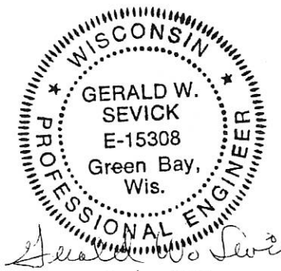
Scope I.D.: 87K10

Volume I - Report Narrative

Kennecott Minerals Company
Ladysmith, Wisconsin

April 1989

VOLUME 1
ENVIRONMENTAL IMPACT REPORT
FOR THE
KENNECOTT FLAMBEAU PROJECT



Gerald W. Sevick
4/1/89

Prepared for:

KENNECOTT MINERALS COMPANY

Prepared by:

FOTH & VAN DYKE and Associates Inc.
and Contributors
2737 S. Ridge Road
P. O. Box 19012
Green Bay, Wisconsin 54307-9012

APRIL 1989

Foth & Van Dyke
2737 S. Ridge Road
P. O. Box 19012
Green Bay, Wisconsin 54307-9012
414/497-2500

Kennecott Minerals Company
1515 Mineral Square
P.O. Box 11248
Salt Lake City, Utah 84147
Telephone (801) 322-8460
FAX (801) 583-3129

April 3, 1989

Kennecott

87K10-61

Kathy Curtner, Acting Director
Wisconsin Department of Natural Resources
Bureau of Environmental Analysis and Review
P. O. Box 7921
Madison, WI 53707

Dear Ms. Curtner:

RE: Kennecott Flambeau Project
Environmental Impact Report

Kennecott Minerals Company (Kennecott) is pleased to provide the Wisconsin Department of Natural Resources (WDNR) with 40 complete copies of the report and appendices titled *Environmental Impact Report for the Kennecott Flambeau Project* prepared by Foth & Van Dyke.

As per a previous understanding developed with Mr. Robert Ramharter of your staff, it is our understanding that the WDNR will be responsible for the distribution of the final EIR to appropriate state and federal agencies. Kennecott will distribute the document to appropriate local officials.

This Environmental Impact Report has been prepared and is submitted to support the Mining Permit Application for the Kennecott Flambeau Project which has been simultaneously submitted to Mr. Gordon Reinke, Bureau of Solid Waste Management, WDNR.

Kennecott requests that the Wisconsin Department of Natural Resources initiate the following action on the documents being filed:

1. Prepare and finalize a draft and final Environmental Impact Statement (EIS) for the proposed Project described in the EIR and Mining Permit Application.

2. Coordinate with federal agencies to assure that the Department's EIS will be responsive to the needs of federal agencies that have permitting jurisdiction over the proposed Project.

3. Review and approve all permit applications, license applications, and similar documents regarding the proposed Project that are filed with and require approval of the Department.

If you or your staff have any questions regarding the final EIR please contact me at your convenience.

Sincerely,

KENNECOTT

Lawrence E. Mercando

Lawrence E. Mercando
Director, Process Development

Enclosure

TABLE OF CONTENTS

PAGE
3.6-

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

PROJECT SUMMARY

Kennecott Minerals Company (Kennecott) has a long history of metal exploration in Wisconsin, beginning in the early 1950s. The relatively small Flambeau copper deposit, located approximately one mile southwest of Ladysmith in Rusk County, was discovered in 1968. In 1974, after delineation drilling of the deposit and environmental baseline studies had been completed, the company submitted an Environmental Impact Report (EIR). During the next two years Kennecott submitted an addendum report to the EIR and a detailed mine permit application to the Wisconsin Department of Natural Resources (WDNR). In 1976, an Environmental Impact Statement (EIS) prepared by the WDNR was approved. However, later that year Kennecott withdrew the mine permit application and postponed plans for developing the project until 1987.

Kennecott has revised its original mine development plans which were used as a basis for the 1976 EIS. The project has been scaled down to its current scope and a carefully engineered plan has been developed to achieve the proposed action with minimal impact to the local community natural environment. Evaluation of the proposed plan and alternatives to this plan were heavily influenced by lengthy public discussions. Public concerns, as well as positive input during the 1976 EIS process and negotiation of the 1988 Local Agreement with local municipalities provided Kennecott with invaluable local opinion. At the same time, Notice of Intent (NOI) to collect data and Scope of Study (SOS) documents were filed with the WDNR. After discussions with the WDNR, as well as input through a public hearing, Kennecott received the WDNR's concurrence and approval to proceed with a new and updated environment baseline data collection program. Submittal of the EIR, mining permit and reclamation plan have been made in accordance with Wisconsin Statutes.

The attached 1989 EIR, the Mining Permit Application with Reclamation Plan, and various support permits and documents are a result of extensive data collection, synthesis of this data through corporate deliberations, and consideration of public input over the past 20 years. The result is a comprehensive mine development plan, carefully thought out and conceived to co-exist within the surrounding environment without adverse long range impacts.

The steeply dipping Flambeau deposit is tabular in shape and has been delineated by over 100 diamond drill core holes. A like number of soil borings and groundwater monitor wells have determined the depth of burial of the deposit and hydrogeologic conditions. The top 225 feet of the deposit has been enriched in copper values through actions of an ancient fluctuating

groundwater table, and it is this portion of the deposit that will be mined. The lower portion of the deposit that contains lessor copper values has been evaluated and judged by Kennecott to be uneconomical based upon projected metal prices.

The proposed action as described in detail within the Mining Permit is substantially reduced in scope and size from the original 1976 proposal. It will take approximately one year to construct the various surface facilities to service the mine as well as to expose the deposit. Mining will occur, over a six year period, within a small, 32-acre open pit using conventional shovel and truck hauling methods. The open pit will be safely located approximately 140 east of the Flambeau River and 600 feet west of STH 27. Ore will be crushed to approximately 12 inches in size and shipped via rail for out-of-state processing at an existing mill. Average daily ore production rate will be 1300 tons for a yearly total of 320,000 tons of ore. Mining will normally occur five to six days per week, eight hours per day although construction activities will probably occur around the clock.

Total waste materials to be excavated over the construction and mine production life will be about 17,500,000 tons. These materials will be carefully segregated for temporary, short-termed surface storage based upon sulfur content. Extensive waste rock and overburden characterization testing indicate that certain waste rock containing over one percent sulfur are referred to as Type II material will be stored in a lined stockpile with leachate collection system. This material will be stored in a managed stockpile covering about 27 acres south of the pit. Contact water from this stockpile and from the open pit will be directed to a wastewater treatment plant. Waste rock and overburden containing less than one percent sulfur referred to as Type I material, can be safely stored on an unlined 40 acre stockpile located north of the open pit. Water from this stockpile will be directed by gravity to a series of settling ponds for clarification. The stockpile heights will range from 60 to 70 feet. A third stockpile for the topsoil will cover about seven acres and serve as a public observation post as well as a vegetated buffer between the pit and STH 27.

Various other ancillary buildings such as a maintenance shop, administration office, guard house, etc. will be positioned south of the pit between the ore crusher and wastewater treatment plant. The entire mine site will be enclosed within a security fence except for the railroad spur east of STH 27.

At the end of the mining operation, the waste rock and overburden will be sequentially returned to the open pit in the order that they were excavated together with settling pond and wastewater plant precipitates. In this fashion, the open pit will be returned to its approximate original contour. There will be sufficient waste rock and overburden to refill the open

pit since a rock swell factor increases the solid rock volume when broken and compacted during mining and backfilling respectively. In addition 160,000 cubic yards of material such as sand, gravel and concrete bought on-site during construction will also be backfilled into the open pit. All ancillary facilities will be removed during site reclamation unless requested to be left by local governments. The backfilling operation is anticipated to take approximately two years.

Several alternatives to the project were considered before selection of the preferred action described above. Primary considerations during the alternative evaluations were the placement of various project components as closely around the open pit as possible and out of the 1,000-foot set back from STH 27. However, these alternatives, including in-pit storage of waste rock, were found to be impractical since the east end of the pit intrudes within the setback as well as for various environmental and economic reasons.

A comprehensive environmental baseline data collection program was completed in 1987 and 1988 to cover a full 12-month period. During this intensive data collection period, information was gathered from the regional and local areas including archeological background, climate and ambient air quality monitoring, geology, waste rock characterization testing, surface and groundwater monitoring, river sediment studies, aquatic and terrestrial biology, ambient noise, land use and socio-economics. This baseline data is supplemented by much of the previous baseline data collected from 1968 to 1974 and by additional monitoring work conducted by Kennecott in part of the period between the two EIR documents.

Impacts of the preferred alternative were carefully evaluated and generally found to be insignificant due to the short term, and small scaled nature of the operation. In general, the decline in groundwater levels near the pit that were predicted by a 1983 modeling program using a considerably larger and deeper open pit is not expected to affect any private well water levels surrounding the project area more than that expected as a result of normal groundwater fluctuations. Regardless, private well owners south of the Flambeau River that surround Kennecott land are protected under the terms of a Local Agreement. In this agreement, Kennecott guarantees a water supply to any significantly affected residential well located in agreed-upon areas provided the affected well in question was impacted by the mining operation.

Bedrock groundwater conditions similar to those existing before mining will be returned after reclamation. As a precaution, lime for neutralization of contact water will be added as the waste rock is backfilled into the open pit.

Protection of surface water quality and quantity has also been an integral part of the project design. A complete water control system will be employed once mining commences to direct all non-contact water, i.e. water that does not come into contact with ore or Type II materials, to ponds for settling. Once suspended solids in the water settle, the water will be decanted either to a nearby wetland or to the Flambeau River. Contact water from within the open pit and Type II stockpile will be directed towards the wastewater treatment plant. Here the water will be neutralized and treated to meet desired effluent quality. There will be no long termed impacts to the quantity of either the surface or groundwater resources.

The socio-economic impact is very positive as the potential economic benefit to local governments and the state is predicted to be about $36 million over the life of the project. Local units of government (Rusk County, City of Ladysmith, and Town of Grant) will receive approximately $2,400,000 to $4,400,000 million as well as $720,000 in property taxes. The existing infrastructure of the community can readily accept a project of this size. Fifty to 60 jobs will be created in an area of Wisconsin where unemployment is running well above the state average. Kennecott has guaranteed that 75 percent of the jobs during mining operation will be given to residents in or within ten miles of the Rusk County border. The fiscal impact will be significant with an estimated total labor cost of over $14,000,000 including fringe benefits. Approximately $11,000,000 of the payroll not including benefits will significantly stimulate the local economy through increased sales and saving deposits. Infrastructure within the city of Ladysmith is more than adequate to handle a project the size of the Flambeau mine project.

Total suspended particulate from the project has been calculated to be a maximum of 53 tons per year for the entire project area. This is well below the 250-tons-per-year rate at which the Clean Air Act would require a Prevention of Significant Deterioration review and permit. Likewise, noise levels from the crusher and truck haulage operations were carefully studied and modeled. Results from those studies showed that four Kennecott-owned residences would be subjected to noise levels of between 6 to 15 dBA. However, noise levels would not exceed levels acceptable for residential areas outside of lands owned by Kennecott.

A temporary effect on the local area will be changes in land use. However, by careful site selection the entire operation has been confined to an area less than 180 acres including the spur line. Through careful siting of the plant facilities, disturbance to the wetlands has been minimized to 8.3 acres. A wetland located northwest of the open pit will be preserved during the operation by additions of water. The largest wetland in the vicinity of the open pit, located east of STH 27, is perched and therefore will not be impacted by the project. None

of the wetlands inventoried serve any unique functions nor are they uncommon in the region. Mitigation of wetlands during and after the operation will result in essentially no long term loss of this land type because of the mining operation.

A total of 66 acres of agricultural land will be temporarily taken out of production, however, none of this agricultural land falls within the Rusk County Farmland Preservation Plan. No currently habitated farms or residences will be affected by the project.

Another impact of the mining operation will be the removal of the open pittable portion of the deposit. However, extraction of this ore would result in a local mineral reserve becoming a long term useable resource to the nation. Copper can remain in use for over a century through continued use as in electric wiring or through recycling. Backfilling of the open pit will be conducted in such a fashion as not to preclude extraction of the deeper mineralization should future metal prices determine this resource to be economical.

Finally, the small area affected by the project is not known to support or to play an important role in the life cycle of any rare, threatened or endangered aquatic or terrestrial species listed by the State of Wisconsin or U.S. Fish and Wildlife Service.

Mitigation plans for this project area started many years ago with the planting of thousands of trees by Kennecott. Many of these trees, plus naturally occurring forests will be left in place during the operation to serve as visual screens and buffer areas between the mine and the public. Kennecott plans to move many natural and company planted trees out of the mine site to temporary on-site nurseries. Upon conclusion of mining and backfilling and grading of the mine site most of these trees will be planted over the reclaimed area. Additional trees, shrubs and ground cover seed will be planted to complete the reclamation job.

Monitoring of the reclaimed site is the final responsibility that Kennecott will fulfill in its obligation to operate and return the project area to close to its original condition.

Under terms of the Local Agreement long range monitoring will be conducted over a 30-year period. During this time, Kennecott will monitor surface and groundwater quality, assess and bolster the reclamation process as necessary and manage the site in a prudent and conscientious manner. While the mine is in operation a bond to a maximum amount of $6,041,000 will be posted as a guarantee to the state that sufficient funds are available to complete the reclamation plan.

HOW TO USE THIS ENVIRONMENTAL IMPACT REPORT

This Environmental Impact Report (EIR) concerning the proposed Flambeau mining project near Ladysmith, Wisconsin, is one of a number of documents which Kennecott Minerals Company (Kennecott) is submitting in order to fulfill the requirements of the mine permitting process in the state of Wisconsin. In addition to the EIR, Kennecott is submitting a Mining Permit Application pursuant to NR 132, which provides a detailed description of the proposed mining operation. Other permit applications and documents being submitted in connection with this mining proposal, in accordance with applicable portions of Wisconsin and Federal regulations, include the following:

- Air Pollution Control Permit
- Industrial Wastewater Treatment Plant Permit
- Wisconsin Pollution Discharge and Elimination System Permit
- Water Quality Certification
- Groundwater Withdrawal Approval
- Water Regulatory Permits under Wisc. Stat. ch. 30
- Water Regulation Permit under Section 404 of the Federal Clean Water Act
- Permit to Excavate and/or Fill on Highway Right-of-Way
- Railroad Spur Grade Crossing
- Private Entrance
- Request for Storage of Explosives
- Notice of Blasting

All of these documents are related to the project and each provides information concerning the proposed project as it pertains to that particular permit or approval. The documents cross-reference each other where necessary. For these reasons, the documents should be read together in order to comprehend the scope of the entire project. The EIR and the Mining Permit Application, in particular, should be considered as companion documents.

Overview of Environmental Impact Report

The EIR is divided into major sections as described in the following paragraphs:

Section 1.0, *Introduction,* accomplishes three tasks: 1) it summarizes the history of exploration of the Flambeau deposit; 2) it states the purpose of this EIR; 3) it describes the specific actions which are requested of the Wisconsin Department of Natural Resources.

Section 2.0, *Alternatives,* describes the process by which the reasonable alternatives to the project have been considered, and a preferred project configuration chosen.

Section 3.0, *Description of Environmental Setting,* discusses the background environmental setting of the proposed project. This section is divided into thirteen subsections, each of which describes the physical environment of the project in terms of a particular environmental discipline.

Section 4.0, *Environmental Impacts*, discusses both the environmental impacts of the proposed project and the impacts which would occur if other alternatives are selected.

Section 5.0, *Mitigation of Impacts*, describes Kennecott's plans for minimizing impacts to the environment both during and after mining operations.

Section 6.0, *References*, lists all references used in the compilation of this EIR in a standard bibliographic format. References generally available in the scientific literature are given as such. Reports written by consultants working on the EIR are generally referenced as appendices attached to the EIR. Unpublished materials not attached as appendices to the EIR have been placed into the Kennecott Flambeau Project file at the Wisconsin Department of Natural Resources, Madison, Wisconsin, where such materials are available for public viewing.

Section 7.0, *Appendices*, contains all appendices for the EIR. The appendices are in order by section. The appendix identification number has been assigned by giving it the second-level section number followed by a letter to designate the individual appendix. For instance, the first appendix to Section 3.5 (Geology) is Appendix 3.5-A; the second is Appendix 3.5-B, and so on.

A glossary of commonly-used terms, abbreviations, and acronyms is provided in this front matter of the report, before the Table of Contents.

Area Definitions

Throughout the EIR, there are references to the "project area," the "mine site," and the "study area." These terms have specific meanings, as follows:

- Project Area - This is defined as the area east of the Flambeau River, west of State Highway 27, north of the south line of Section 9, and south of Blackberry Lane. Also included is a 24 to 36-foot wide corridor east of State Highway 27 on which the railroad spur line is to be constructed. (Refer to Figure No. 2.4-1 in Section 2.4.2.1.)

- Mine Site - This is defined as an area within the project area which will be enclosed by a security fence and which encompasses the proposed open pit, stockpile sites, plant area, and other ancillary surface facilities.

- Study Area - This is a term which is uniquely defined by each specific environmental discipline within the EIR. It denotes the area within which the discipline was studied for this project. The study areas for different disciplines differ in size and emphasis.

Figures and Tables

Numbering of figures and tables is similar to that described above for appendices. Identification numbers have been assigned to figures and tables by giving them their second-level section number followed by another number to designate the individual figure or table. For example, the first figure in Section 3.5 (Geology) is Figure No. 3.5-1; the second is Figure No. 3.5-2, and so on. Numbering of tables is exactly the same as for figures. The first table in Section 3.5 is Table No. 3.5-1.

LIST OF CONTRIBUTORS

Following is a list of companies and individuals which have contributed in a significant way to the Flambeau Project Environmental Impact Report.

BP Minerals America, Inc.
P.O. Box 11248
Salt Lake City, UT 84147
(801) 322-8460
Mr. Lawrence E. Mercando
Director, Process Development

Call & Nicholas, Inc.
3625 E. 42nd Stravenue
Tucson, AZ 85713
Mr. Richard D. Call
President

Ford, Bacon, and Davis, Inc.
Engineers - Constructors
375 Chipeta Way
P.O. Box 8009
Salt Lake City, Utah 84108-8009
(801) 584-7558
Mr. David J. Krohn
Project Manager

Foth & Van Dyke and Associates Inc.
2737 S. Ridge Road
P.O. Box 19012
Green Bay, WI 54307-9012
(414) 497-2500
Mr. Gerald W. Sevick, P.E.
Division General Manager
Geosciences and Environmental Management

Globo De Plomo Enterprises
P.O. Box 872
Douglas, AZ 85607
Mr. Sidney A. Williams
Geologist

Golder Associates (Western Canada), Ltd.
Consulting Geotechnical and Mining Engineers
224 West 8th Avenue
Vancouver, British Columbia
Canada V5Y IN5
(604) 879-9266
Mr. P.F. Stacey, P. Eng.
Principal

Mr. David A. Lee
Consulting Forester
1217 River Avenue, E.
Ladysmith, WI 54848
(715) 532-3453

James Askew Associates, Inc.
5600 S. Quebec Street, Suite 312 A
Englewood, CO 80111
(303) 290-0103
Mr. Edwarde R. May
Principal Geological Engineer

Midwest Engineers
3149 Venard Road
Downers Grove, IL 60515
(312) 969-4307
Mr. V. Rajaram, P.E.

ORTEK
Oneida Environmental Technology Center
2496 West Mason Street
P. O. Box 12435
Green Bay, WI 54307-2435
(414) 498-2222
Dr. David E. Turriff, Ph.D.
Director

Pincock, Allen & Holt, Inc.
12345 W. Alemeda Parkway
Lakewood, CO 80228
(303) 986-6950
Mr. Ernest L. Bohnet, P.E.
President

Rusk Surveying
115 West Second Street, South
Ladysmith, WI 54848
(715) 532-5757
Mr. Larry F. Gotham, R.L.S.
President

Swanson Environmental Inc.
3490 N. 127th Street
Brookfield, WI 53005
(414) 783-6111
Mr. George C. Kandler, Jr.
Field Services Manager
Mr. Timothy Young
Environmental Specialist

Thomas A. Prickett & Associates
6 G.H. Baker Drive
Urbana, IL 61801
(217) 384-0518
Mr. Thomas A. Prickett
President

Thresher & Son, Inc.
2828 Regent Street, Jr.
Madison, WI 53705
(608) 233-2097
Mr. John E. Thresher, Jr.
Soil Chemist

Uniplan Associates
2826 Viking Drive, Apt. 20
P. O. Box 2816
Green Bay, WI 54304
(414) 494-7073
Mr. Steve R. Milquet, P.E., A.I.C.P.

Winnebago Archaeological Surveys
810 Paynes Point Beach Road
Neenah, WI 54956
(414) 722-2255
Dr. Margie L. Staab, Ph.D.
Archaeologist

Yanko Environmental Services, Inc.
3303 Paine Avenue
Sheboygan, WI 53081
(414) 459-2500
Mr. James C. Bird
Vice President

List of Laboratories

Laboratories Providing Analytical Services
For the Kennecott Project

Laboratory	Wisconsin Certification No.
ORTEK Oneida Research and Technology Center 2496 West Mason Street P. O. Box 12435 Green Bay, WI 54307-2435	405099530
Northern Lake Services 400 North Lake Avenue Crandon, WI 54520	72102640
Enviroscan 303 West Military Road Rothschild, WI 54474	737053130
McCoy and McCoy 85 East Hoel Avenue P. O. Box 907 Madisonville, KY 42431	No Wisconsin Certification Quality Control for Uranium Analysis Certified through U.S. EPA- Las Vegas

Glossary of Terms

The Kennecott Environmental Impact Report

Term	Definition
A-weighted	A frequency weighting network which corresponds to the A Scale on a standard sound level meter. The A Scale suppresses frequencies below 1,000 hertz (cycles per second).
Acoustical	Pertaining to hearing or sound.
Algae	A class of plants including microscopic, single-celled, and more complex, such as seaweed. Occurring in water or on land.
Amphibians	Cold-blooded vertebrate animals with gilled larvae but air-breathing adults.
Anaerobic	The absence of oxygen.
Anuran	Frogs and toads; an order of amphibians; "without tails".
Anomalous	Abnormal.
Aquifer	A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield economical quantities of water to wells and springs.
Archaeological	The study of historic or prehistoric areas or peoples by analysis of their artifacts and other remains.
Artesian	A well or spring deriving its water from a confined aquifer in which the water level stands above the ground surface.
Artifact	An object made by man to be used for some purpose.

Assay	To analyze a material or mineralization for one or more specific components.
Avian	Pertaining to birds.
Bench Mark	A permanent natural or artificial object with a known elevation. Used by surveyors to determine other elevations.
Benthic	All bottom terrain, from a shoreline to the greatest depth of a water body.
Boomshocking	Use of an electric shocking device, mounted on a long pole, to collect live fish.
C-weighted Scale	A frequency network which corresponds to the C Scale on a standard sound level meter. The C Scale provides even responses through the entire audible spectrum.
Canopy Species	A species of tree forming the uppermost, spreading, branchy layer of a forest.
Carnivorous	Flesh-eating.
cfs	Cubic feet per second.
Chert	A compact siliceous rock formed of interlocking quartz or grains generally not discernable under a microscope.
Colluvial	Consisting of rock fragments and soil.
Composite Sample	A sample created by combining a number of individual samples.
Covariate	A variance according to a fixed mathematical relationship.

Creel Census	Fish sampling data compiled from a census of fishermen.
CTH	County Trunk Highway.
dBA	Decibels, A-weighted.
dBC	Decibels, C-weighted
Decibels	A logarithmic unit which expresses the ratio between two sound pressures. A ratio of 10 in root-mean-square pressure corresponds to a difference of 10 decibels.
Deposit	A term used to designate a natural occurence of a useful mineral or collection of minerals in sufficient extend and degree of concentration to invite mining.
Detritus	Material that is produced by the disintegration of rock and has been moved from its site of origin.
Demographics	Population statistics.
Diatom	A microscopic, single-celled plant which grows in marine or fresh water.
Direct Shear Test	A soil or rock test in which a normal, perpendicular stress is applied to the face of the sample and a shear force is applied parallel to the face of the sample.
Durable Manufacturing	The making of permanent or lasting goods.
EIR	Environmental Impact Report.
EIS	Environmental Impact Statement.
EMT	Emergency Medical Technician. A professional certified as an ambulance attendant.

Endangered Species	Species, listed by a federal or state agency, that are in danger of extinction throughout all or significant portions of their ranges.
Energy-averaged	A mean obtained by conversion of sound levels in decibels to correspond to sound pressures on a logarithmic scale.
Ericad	A family of plants.
Evapotranspiration	Loss of water from a land area through plant transpiration and soil evaporation.
Gamma-logged	A method of logging boreholes by detecting the natural radioactivity of the rock.
Geomechanical	Combining structural geology with the response of natural earth materials to applied deforming forces.
Genus, s.; Genera, pl.	The major subdivision of a class of plants or animals, including more than one species.
Gill Netting	A fish sampling method which uses nets to capture fish by their gills.
Gley	A blue-grey soil developed under moisture.
Gossan	A yellow to reddish deposit of hydrated iron oxides produced near the surface by the oxidation and leaching of sulfide minerals.
gpd	Gallons per day.
gpm	Gallons per minute.
Ground-truthing	Confirmation by field observation of information interpreted from aerial photography.

Groundwater Table	The subsurface boundary between the saturated and unsaturated zones.
Habitat	The environment which supplies the life needs of a plant or animal.
HDPE	High density polyethylene. A lining material commonly used to seal areas that contain leachates and prevents escape to the environment.
Herbivorous	Plant-eating.
Hydraulic Gradient	The rate of change of total groundwater head per unit of distance of flow in a given direction.
Hydric	Refers to a soil subject to relatively consistent saturation.
Hydrophytic	Pertaining to a plant that grows in water or in wet soil conditions.
ICP	Inductively Coupled Plasma. A spectrophotometer used in the analysis of metals using atomic emissions.
Intermittent	Alternately ceasing and starting again. A stream or lake where water flows only part of the time.
Jointing	Discontinuous fractures in rock along which no appreciable movement has occurred.
Lacustrine	Pertaining to lakes.
Leaching	To wash or drain by percolation. Also, to dissolve minerals out of rock, soil or other solid materials.
Lithology	The character of a rock formation.
Littoral	Occurring near the shoreline.
Macrophytes	Large vascular plants.

Macroinvertebrates	Macroscopic animals without backbones.
Mean	Average.
Median Household Income	The middle income point, where an equal number of incomes fall above it and below it.
Mesophyte	A plant that grows in well-balanced moisture conditions.
Metamorphism	The altering of rocks by pressure, heat, and introduction of new chemical substances.
ml	Milliliter. One thousandth of a liter; equivalent to a cubic centimeter.
MSL	Mean sea level.
Net Fiscal Balance	The difference between total government revenues and total government expenditures.
Nonassessed	Land which is not assessed for property tax purposes.
Nondedicated Revenues	Revenues that have not been assigned to specific uses.
Omnivorous	Plant- and flesh-eating.
One-hundred-year Flood	The flood elevation of a river, such that the level is encountered, on the average, only once every 100 years.
Ore body	A volume of rock containing extractable mineral commodities which can be mined and sold at a profit.
Ornithology	The study of birds.
Orthogonal	Intersecting or lying at right angles.

ORTEK	Oneida Environmental Technology Center; a Foth & Van Dyke affiliate providing laboratory services.
OSHA	Occupational Safety and Health Administration.
Outwash	Sand and gravel removed or washed out from a glacier by meltwater streams.
Overburden	Loose friable material, which, for this project includes soil, gravel, till, sandstone and saprolite materials which can be readily ripped by a bulldozer and which overlies the unrippable bedrock.
Own-source Revenues	Revenues coming from local sources, not from intergovermental transfers.
Palustrine	Pertaining to material deposited in a swamp environment.
Perched	Groundwater separated from an underlying body of groundwater by an unsaturated zone.
Periphyton	Aquatic biotic community living on a submerged, fixed substrate.
Permeability	The capacity of rock or soil to transmit water.
pH	The unit used to indicate the acidic-basic balance of a substance.
Phytoplankton	Floating plants, such as diatoms.
Piezometer (PZ)	A special type of groundwater observation well, finished so as to permit the measurement of the water level in a particular stratum or zone.
Pleistocene	A period starting about one million years ago, characterized by widespread glacial ice and the appearance of humans.

Precambrian	Pertaining to the earliest era, which the earth's crust was formed.
Prehistoric	Prior to recorded history.
psi	Pounds per square inch.
PVC	Polyvinyl chloride.
Pyrite	Iron disulfide, (FeS_2).
Quadrant	A quarter of a circle.
Raptors	A species of predator birds with claws and bills adapted for seizing their prey.
Rhombic	Shaped like an oblique-angled parallelogram.
Riffle	A shallow extending across a stream bed; a short rapid.
Riverine	Pertaining to a river.
Saprolite	A soft, earthy, clay-rich, thoroughly decomposed rock and is characterized by preservation of structures that are present in the unweathered rock.
SEM	Scanning electron microscope.
Slurry	A thin mixture of water or liquid and other substances, such as clay particles.
Sociocultural	Pertaining to the interaction of social and cultural elements.
Socioeconomic	Pertaining to the interaction of social and economic factors.
Sorption	Includes both absorption and adsorption; important to removing pollutant particles.
Sparging	Agitation of a liquid by means of compressed gas entering through a pipe.

Species	The basic category of biological classification of plants and animals; the major subdivision under the genus.
Sphagnum	A soft moss found mainly on the surface of bogs.
STH	State Trunk Highway.
Swale	A slight, marshy depression or drainageway in level land.
Taxanomy	The orderly classification of plants and animals according to their presumed natural relationships.
Threatened Species	Species, listed by a federal or state agency, which are likely to become endangered unless measures are taken to restore the population.
Till	A very poorly sorted mixture of gravel, sand, silt, and clay that was deposited by glacial ice without reworking by meltwater or gravity flow.
Titration	A chemical test to determine the quantity of a constituent in a solution.
Transducer	A device that transmits energy from one system to another.
Translocation	A transfer from one place to another.
Transect	A sampling area in the form of a long, continuous strip.
Triangulation	A surveying technique which uses triangles to establish the distance between points, or their positions.

Triaxial Compression Test	A cylindrical specimen of soil or rock encased in an impervious membrane, subjected to continuing pressure, and loaded externally to failure.
Tricone Bit	A drill bit consisting of three rollers that exert a crushing and chipping action on the rock or sediment.
TSP	Total Suspended Particulates. Entrained particules in the ambient air.
TSS	Total suspended solids in water or other liquid. Those particles that have not settled out of the water column.
ug/g	Microgram per gram; equivalent to parts per million.
ug/m^3	Microgram per cubic meter.
Uniaxial Compression Test	Application of normal stress in a single direction.
Understory	The plants of a forest undergrowth.
USDA	United States Department of Agriculture.
USDOT	U.S. Department of Transportation.
USEPA	U.S. Environmental Protection Agency.
USGS	U.S. Geological Survey.
USH	U.S. Highway.
VPD	Vehicles per day.
VPH	Vehicles per hour.
Vertical Hydraulic Gradient	The flow of a fluid in a vertical direction.
WASS	Wisconsin Agricultural Statistics Service.

Watershed	The contained area which drains by gravity into a given river.
Water Table	See Groundwater Table.
WDNR	Wisconsin Department of Natural Resources.
WDOA	Wisconsin Department of Administration.
Wetlands	(See Appendix 3.8-B.)
WITC	Wisconsin Indianhead Technical College.
Xerophyte	A plant with low water requirements.
Zooplankton	Animal forms of plankton which consume phytoplankton.

1.0 INTRODUCTION

Kennecott Minerals Company (Kennecott) has a long history of metals exploration in Wisconsin, beginning in the early 1950s. The relatively small Flambeau copper-gold deposit was discovered using airborne geophysical techniques in 1968. It is located approximately one mile southwest of Ladysmith and lies between the Flambeau River and State Highway 27.

The size and quality of mineralization at the Flambeau site was determined by over 100 core holes drilled from the surface. In 1974, Kennecott submitted a comprehensive Environmental Impact Report to the Wisconsin Department of Natural Resources (WDNR) in support of a proposed project to develop the deposit. An addendum was filed the following year. In 1976, Kennecott submitted a detailed mine permit application to the WDNR, also in support of the project. An Environmental Impact Statement addressing the project was prepared by the WDNR in 1976 and was approved. That same year, however, the mine permit application was withdrawn by Kennecott, and plans for developing the deposit were indefinitely postponed.

Kennecott has revised its original plans and now proposes to mine the upper portion of the Flambeau deposit. The revised mining plan is substantially reduced in scope and size from the original plan proposed in the 1970s. As described in the accompanying Mining Permit Application, the deposit will be mined from a small 32-acre open pit, and the ore will be shipped out-of-state for processing at an existing mill. At the completion of mining, the open pit will be backfilled and the mine site reclaimed to its approximate original state. Figure No. 1.0-1 illustrates the proposed site plot plan for the project.

In July 1987, Kennecott filed a document titled *Notification of Intent to Collect Data - Kennecott Flambeau Project* with the WDNR, in accordance with NR 132.05. The document was prepared to notify the WDNR of Kennecott's intent to collect data in support of a mining permit application for the Flambeau deposit.

An additional document was filed in October 1987, titled *Scope of Study for the Kennecott Flambeau Project,* in accordance with NR 132.05(7). This second document outlined the proposed scope of the environmental studies to be performed, and incorporated comments received from the WDNR and those generated by the general public during a September 9, 1987 Notice of Intent public hearing held in Ladysmith. Subsequent to the public hearing the WDNR approved a Scope of Study plan.

On August 1, 1988, Kennecott signed a Local Agreement with Rusk County, the Town of Grant, and the City of Ladysmith for

development of the Kennecott Flambeau Mine and was issued a *Conditional Land Use Permit.*

1.1 Purpose of the Environmental Impact Report

This Environmental Impact Report is submitted in fulfillment of the applicable regulatory requirements and in support of the accompanying Mining Permit Application and additional necessary permits.

1.2 Action Requested of the Wisconsin Department of Natural Resources

Kennecott requests that the Wisconsin Department of Natural Resources initiate the following action on the documents being filed:

1. Prepare and finalize an Environmental Impact Statement (EIS) for the proposed Project described in the EIR and Mining Permit Application.

2. Coordinate with federal agencies to assure that the Department's EIS will be responsive to the needs of federal agencies that have permitting jurisdiction over the proposed Project.

3. Review and approve all permit applications, license applications, and similar documents regarding the proposed Project that are filed with and require approval of the Department.

Figures for Section 1.0

NOTES:

1. SITE LOCATION: SECTIONS 9, 10, 15 & 16, T34N, R6W, RUSK COUNTY, WISCONSIN.
2. TOPOGRAPHIC BASE MAP PREPARED FROM AERIAL SURVEY BY SURDEX CORPORATION, CHESTERFIELD, MISSOURI. DATE OF PHOTOGRAPHY - APRIL 24, 1970. ROADS, TREES AND BUILDINGS WERE UPDATED AS PER AERIAL PHOTOGRAPH TAKEN BY MARKHURD CORPORATON, MINNEAPOLIS, MINNESOTA. DATE OF PHOTOGRAPHY - SEPTEMBER 14, 1987.
3. ELEVATIONS BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS TWO FEET.
4. HORIZONTAL DATUM BASED ON PROJECT SITE GRID SYSTEM. SITE GRID COORDINATES CORRELATION TO STATE PLANE COORDINATES DERIVED AS FOLLOWS:

SITE GRID COORDINATES CONTROL MONUMENT F-1	STATE PLANE COORDINATES
40000 N =	587,357.8887 N
40000 E =	1,713,516.1229 E

THE ANGULAR ROTATION FROM STATE PLANE BEARINGS TO SITE GRID BEARINGS IS 359°-13'-23" RIGHT WITH CONTROL POINT F-1 AS THE BASE POINT.

5. MINE FACILITIES DESIGN BY FORD, BACON & DAVIS, INCORPORATED, SALT LAKE CITY, UTAH AND PINCOCK, ALLEN & HOLT, INCORPORATED, LAKEWOOD, COLORADO.

LEGEND

- —1100— EXISTING CONTOUR
- EXISTING PAVED ROADWAY
- EXISTING TRAIL/GRAVEL SURFACE
- TREES AND/OR BRUSH
- FENCE
- F-1 CONTROL MONUMENT

0 300' 600'
SCALE

FOTH & VAN DYKE
GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION
GREEN BAY, WISCONSIN

FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

KENNECOTT MINERALS COMPANY
165 MINERAL SQUARE
SALT LAKE CITY, UTAH
84112

FIGURE NO. 1.0-1
SITE PLOT PLAN

MICROFILM | JOB
DRAWING NO. | REV.
DIVISION DRAWING NO.
SCALE | SEE BAR SCALE

REFERENCES	DWG. NO.	DESCRIPTION

NO.	DATE	REVISIONS	BY	CHK'D	ENGR	ENGR MGR.

PROJ. ENGR	BY	DATE
MGR. PROCESS ENGR		
ENGR MGR.		

	BY	DATE
DESIGN		
DRAWN	MCO	3/89
CHK'D	TSW	3-89
DES. ENGR		
SEC. ENGR		

3.0 DESCRIPTION OF ENVIRONMENTAL SETTING

3.1 Location

The project area will be all of that part of Section 9, Township 34 North, Range 6 West, Rusk County, Wisconsin lying east of the Flambeau River and south of Blackberry Lane; and the area required for a one-mile (approximately) long railroad spur line located in the southwest quarter of Section 10, Township 34 North, Range 6 West, Rusk County, Wisconsin, lying west of the main line of the Wisconsin Central Ltd.

The proposed project area may be reached from the north by traveling south on State Highway 27 (STH 27) from its junction with U.S. Highway 8 (USH 8), a distance of 1.6 miles.

Ladysmith, the county seat of Rusk County, is located in northwestern Wisconsin, approximately 130 miles east and north of Minneapolis-St. Paul; 240 miles north and west of the Wisconsin state capitol at Madison; and approximately 400 miles north of Chicago. It is at the junction of major north-south (STH 27) and east-west (USH 8) highways and a major Wisconsin Central, Ltd. railroad junction.

3.2 Regional and Local Setting

Rusk County is an area of 579,840 acres, with a population of 15,456, according to 1988 estimates by the Wisconsin Department of Administration (WDOA). The county is predominantly rural in nature, with approximately 91 percent of land in the county classified as forest land or agricultural land.

The area was almost completely logged of its original white pine, hemlock, and hardwoods by the beginning of the 20th century. Its major industries deal primarily with wood, but most of the wood used is from sources outside of Rusk County. Dairying is the largest agricultural source of income; relatively few small grains and seed crops are grown.

Within 40 miles of Ladysmith there are numerous lakes, rivers, creeks, and streams, although few lakes are present in the near vicinity of Ladysmith. The city is situated between three major river flowages, Lake Flambeau, three miles northeast, Lake Chippewa, 35 miles north, and Lake Holcombe, 17 miles to the south.

Fishing, hunting, and other outdoor activities are popular forms of recreation within the county. The recreation, resort, and tourist trade is served by facilities in Ladysmith and, to a lesser extent, in other areas within the county.

The county is sparsely settled. Population declined during the period from 1950 through 1970, but has gained slightly during the 1980s. Unemployment within the county is high relative to the rest of the state, and there have been recent losses in jobs in the area.

3.3 Historical and Archeological Background

Several historical and archeological studies have been undertaken in the project area. A historical survey was conducted in 1976 by the State Historical Society. That survey examined whether any existing structures in the study area could have special historic or other cultural significance (Smith, 1976). The study concluded that none of the buildings on-site had any historic or otherwise special cultural significance. Mr. Smith's letter is included in this report as Appendix 3.3-A.

During the 1970s, two separate archeological surveys were also conducted. Reports of these surveys were titled *Report of the Archeological Site Survey Conducted at the Bear Creek Mining Flambeau Project Site, Rusk County, Wisconsin* (McHugh and Gregg, 1973) and *Archaeological Survey of the Flambeau Mining Corporation's Proposed Copper Mining Project, Rusk County, Wisconsin* (Tiffany, 1976).

In 1988, a third archaeological survey using accepted techniques was conducted by Dr. Margie Staab in order to be certain that all of the potentially affected property had been reviewed by a professional archaeologist, and to survey the area to the north of the proposed pit that had not been covered in the first two investigations. Dr. Staab's report is given in Appendix 3.3-B. All three surveys concluded that there is no evidence of prehistoric occupation of any portion of the project area.

Each of the reports discuss a local collection of miscellaneous artifacts discovered by local farmers, known as the Drum collection, which is located outside of the project area. The reported location of the source for this collection is about one-half mile east-northeast of the project area, between Meadowbrook Road and the Wisconsin Central Limited Railroad. This area is located to the north of the proposed railroad spur right-of-way.

Most of the artifacts from the Drum collection were reported by Mr. A. Drum to have come from the areas he farmed around the now-filled ancient lake in the W 1/2, SW 1/4, NE 1/4 of Section 10, T34N,R6W. The overwhelming majority of artifacts in this collection are projectile points which indirectly suggest that a substantial amount of prehistoric hunting activity occurred around the shores of this small lake. Projectile point typology indicates the presence of Late Archaic (2,000 BC - 1,000 BC), Early Woodland (1,000 BC - 500 BC), Middle Woodland (500 BC - AD 500), and Late Woodland (AD 500 - AD 1,400) activity around this small prehistoric lake. Several of the small points in the collection are made of locally-available quartzite, but the others are made of chert, and are foreign to the project study area.

Previous physical surveys of selected parts of the surrounding region, located several small collections of miscellaneous artifacts. The archaeological surveys of the project area determined that prehistoric cultural activities have left no traces in the form of artifacts on the project area. Dr. Staab specifically states that "...no evidence of any prehistoric or significant historic occupation was discovered within the Project Area..." (Staab, 1988).

3.4 Climatology, Meteorology, and Air Quality

3.4.1 Field and Laboratory Methods

3.4.1.1 Station Locations

Monitoring stations consisting of high-volume air samplers for total suspended particulates (TSP) and particulates equal to or less than ten microns in diameter (PM10) were placed at two sites in the vicinity of the mine site. A meteorological station, consisting of wind speed and direction sensors and a precipitation gauge, collected data concurrently with the particulate samplers.

The sampling sites being used are in close proximity to those that were used by Kennecott during an air monitoring program conducted in the late 1970s. A description of the TSP sampling sites is as follows:

North Sampling Site:

Property Owner:	Rusk County Community Hospital
Location:	Southwest corner of the intersection of Highway 27 and College Avenue West.
General Description:	Samplers are located on the roof of the hospital. The face plate of each sampler is 45.2 feet from the ground. Two roads are located approximately 400 feet from the samplers. One runs on the north side of the hospital complex, the other runs along the east side. The Flambeau River flows 200 feet to the south. There are woods and adjacent hospital buildings to the west.

South Sampling Site:

Property Owner:	Kennecott
Location:	Northeast corner of the intersection of Jansen Road and State Highway 27 (STH 27).
General Description:	The face plate of each sampler is seven feet from the ground. The area is predominantly low and clear with a tree stand approximately 100 feet away along the east shoulder of STH 27. There is an old silo approximately 100 feet to the

northeast. These are far enough away to prevent interference. STH 27 is 150 feet to the west and Jansen Road 100 feet to the south.

Meteorological Site:

Property Owner: Kennecott

Location: The location of the meteorological station is on STH 27 approximately one mile south of the south particulate sampling site. The station is situated on a 35-foot tall tower at the northwest corner of Highway 27 and County Road P.

General Description: The meteorological tower is sited in the southeast corner of a large hay field. There are two roads nearby, County Road P to the south and STH 27 to the east. Both are more than 100 yards away. Scrub trees and an old silo were removed, so there are no obstructions within 100 yards of the meteorological station.

The locations of the TSP/PM10 sampling stations and the corresponding mining operation are shown on Figure No. 3.4-1.

3.4.1.2 Monitoring Schedule

The high-volume samplers were operated every second day from May through July 1988 (24 hours on, commencing at midnight, and 24 hours off). The sampling schedule was extended to every third day during the August through October sampling period. Filters were removed one day after the operating day to avoid nonrepresentative particulate loading.

The meteorological instruments operated continuously 24 hours per day throughout the monitoring period. Meteorological data were collected on a hourly basis.

3.4.1.3 Instrumentation

3.4.1.3.1 Total Suspended Particulates

Each of the two air sampling sites was equipped with a TSP Hi-Volume sampler consisting of the following:

- Sierra-Anderson Hi-Volume air sampler (motor and enclosure).
- Pressure transducer flow recorder.
- Combined flow controller/digital timer-programmer.

- Glass fiber filter media.
- Wooden support platform.

The Hi-Volume air sampler is equipped with a flow controller so that a desired flow can be achieved. The flow was adjusted to approximately 50 cubic feet per minute (CFM) so as to be within the required range of 40 to 60 CFM.

3.4.1.3.2 PM10 Particulates

Each of the two sampling sites was equipped with a PM10 Hi-Volume sampler consisting of the following:

- Sierra-Anderson Hi-Volume air sampler (motor and enclosure).
- PM10 size selective sampling inlet.
- Pressure transducer flow recorder.
- Combined flow controller/digital timer-programmer.
- Glass fiber filter media.
- Wooden support platform.

The Hi-Volume sampler, which is equipped with a flow controller, was adjusted to the desired flow of 40 CFM.

3.4.1.3.3 Meteorological Sensors

Meteorological sensors consisted of wind sensors and a precipitation gauge. The wind sensors were located approximately 35 feet off the ground where they would be free of air turbulence caused by ground-level obstructions such as buildings and trees. The wind sensors continuously recorded hourly wind speed and direction on an analog strip chart recorder and data logger. The following wind sensors were employed:

	Model	Accuracy	Range	Threshold
Wind direction	Natural Power 01503	±3% Degrees	0-360 Degrees	2.0 MPH
Wind speed	Natural Power 01503	±1.2 MPH	0-125 MPH	1.3 MPH

Signals from the wind instruments were recorded on a Climatronics recorder mounted in a weatherproof enclosure at the base of the tower. A precipitation gauge having the following characteristics was implemented:

- Natural Power Model No. A70-R
- Type - tipping bucket
- Sensitivity - 1 tip per 0.01"
- Resolution - 0.01"
- Accuracy - 1% at 3"/hr.

Precipitation amounts were recorded on an externally-mounted digital strip chart recorder and data logger.

3.4.1.4 Analytical Procedures

Prior to the start of the TSP and PM10 sampling program, sampling and analysis equipment was calibrated. Laboratory calibration activities included checking of the analytical balance, relative humidity indicator, elapsed time meter, on-off timer, and flowrate transfer standard. The calibration procedures followed those outlined in Section 2.2.2, U.S. Environmental Protection Agency (USEPA) document 600/4-77-027a, *Reference Method for the Determination of Suspended Particulates in the Atmosphere (High Volume Method) (EPA, 1983).*

Each high volume sampler also required calibration. The samplers have within them a flowrate measurement device (orifice) capable of indicating total sampled volumetric flow. A pressure recorder is interfaced with the orifice to provide a continuous record of daily flow.

Calibration of the high volume samplers required calibration of these flow indicators so that they provide accurate flowrate data. The samplers were calibrated for the average temperature and pressure conditions at the sampling sites.

High volume sampler flowrate devices were calibrated at:

- Prestart-up, 3-22-88
- After maintenance, 7-23-88 and 10-8-88
- Prior to shutdown, 2-18-89

TSP and PM10 ambient concentrations were determined following procedures outlined in USEPA document 600/4-77-027a, Section 2.2. Details of the sampling and determination of particulate levels are outlined in the *Ambient Air Monitoring Quality Assurance Plan* (F&VD, 1988). This plan, dated May 1988, was approved by the WDNR. The WDNR also conducted calibration audits before and after the sampling period and verified and validated the equipment used in the program.

3.4.1.4.1 Chemical Analysis of Particulate

As a means of characterizing the metallic components of TSP caught by the filter media, chemical analysis was undertaken. The analysis involved the testing of composite samples from each of the monitoring stations. Composites included filter material from each two-month period. A total of three composites were obtained from each site during the TSP monitoring study.

The chemical analysis was performed by a State of Wisconsin Certified Laboratory (NR 149). Methods employed for the determination of metal components in the TSP included atomic

absorption (flame, HGA graphite furnace, and cold vapor) and inductively-coupled plasma. Specific methods for the determination of each metal are listed in Table No. 3.4-1.

Samples were prepared by cutting individual filters into 1/4-inch square pieces. A two-gram sample was then digested in a 20-ml solution of HNO_3 employing microwaves as an energy source. After digestion, the sample was diluted to 100 ml with deionized water and analyzed.

Blanks were analyzed along with the TSP samples to screen any possible false readings resulting from the filter media or analytic methods. The blank filters were subjected to the pre-treatment, digestion, and dilution and then analyzed on the instrument that the associated samples were analyzed by. Table No. 3.4-2 lists the results of the analysis of metals. This data is analyzed and discussed in Section 3.4.3.2.

3.4.1.4.2 Particle Size Distribution

As part of the particle characterization study, filters with particulate loadings equal to or in excess of 75 micrograms per cubic meter (ug/m^3) were subjected to microscopic analysis. The analysis included sectioning the filter and examining the detached piece (subsample) microscopically to determine the size distribution and particle shape.

The particulate was categorized in diameter ranges of 0 to <5, 5 to <10, 10 to <20, 20 to <30 and greater than 30 microns. In addition, particles were categorized by shape. Designations included platy, rhombic, pollen, and rounded.

The filter subsamples were cut from the central portion of each filter. Two one-centimeter-diameter sections were collected from each subsample with a core bore and mounted on an aluminum stub. The mounted samples were coated with carbon and examined with a scanning electron microscope (SEM).

Random photographs were taken from each of the two SEM mounts, totalling ten per mount. Each photograph was taken at a magnification of 1130X as determined by measuring a calibrated grid. Three representative photographs, which contain a minimum of grain overlap, were selected for particle counting, determination of diameter, and shape categorization. Each of those photographs was examined three times and particles counted to calculate a mean value on a size basis.

3.4.2 Climatology-Meteorology

Data on precipitation, wind speed, wind direction and daily high and low temperatures were collected for the months May through October 1988.

TABLE NO. 3.4-1

Metals and Methods of Analysis for
TSP Composite Samples

Component	USEPA SW-846 Method No.	Method	Detection Limit (ug/g)
Antimony	7041	G	0.25
Arsenic	7060	G	0.15
Barium	7080	F	4.00
Beryllium	6010	ICP	0.05
Cadmium	7131	G	0.015
Chromium	7191	G	0.15
Cobalt	7200	F	2.0
Copper	7210	F	0.50
Lead	7421	G	0.1
Manganese	7460	F	0.55
Mercury	7471	CV	0.1
Molybdenum	6010	ICP	1.5
Nickel	7520	F	1.5
Selenium	7740	G	0.15
Thallium	7841	G	0.10
Tin	6010	ICP	3.4
Zinc	7950	F	0.55

G - Graphite Furnace
F - Flame
CV - Cold Vapor
ICP - Inductively Coupled Plasma

TABLE NO. 3.4-2

Gross Chemical Results of Particulate Samples

Element	Concentration in ug/g						
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Average[1]	Blank
Antimony	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.25	<0.25
Arsenic	0.40	0.25	0.30	0.40	0.35	0.30	0.33	<0.15
Barium	7.1	4.5	4.2	11.	4.4	4.7	6.0	4.3
Beryllium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05
Cadmium	0.31	0.26	0.25	0.26	0.19	0.88	0.36	0.10
Chromium	0.80	0.75	0.55	1.0	0.85	0.68	0.77	0.55
Cobalt	<2.	<2.	<2.	<2.	<2.	<2.	2.	<2.
Copper	48.	69.	37.	52.	100.	48.	59.	1.1
Lead	6.2	2.7	2.7	4.4	2.8	3.1	3.7	0.35
Manganese	9.3	7.7	5.3	15.	9.1	6.7	8.8	<0.55
Mercury	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
Molybdenum	3.6	1.8	<1.5	1.9	<1.5	<1.5	2.0	<1.5
Nickel	<1.5	<1.5	<1.5	1.5	<1.5	<1.5	1.5	1.5
Phosphorus	330.	320.	210.	310.	340.	200.	285.	97.
Selenium	0.35	0.30	0.25	0.40	0.40	0.20	0.32	<0.15
Thallium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10
Tin	5.4	<3.4	<3.4	<3.4	<3.4	11.	5.0	6.8
Zinc	19.	10.	15.	16.	11.	13.	14.	4.4

1. Wherever a non-detect was reported for any test result, the detection limit was used to calculate the average value.

Three monitoring stations were included in the study to compile the necessary data: the primary site, operated by Kennecott, located south of the project area; the Ladysmith Ranger Station; and the National Weather Service Station at Eau Claire County Airport.

3.4.2.1 Precipitation

Precipitation data was accumulated at both the Kennecott meteorological station (MET) and the Ladysmith Ranger Station. Figure No. 3.4-2 illustrates data from the MET Station for total rainfall (in inches) for each of the monitoring months. Because the summer of 1988 was unusually dry and might not be representative of local conditions during the life of the mine, data collected at the Ladysmith Ranger Station for the years 1982 through 1986 is also included in this document to provide precipitation information that is more representative of typical conditions. Figure No. 3.4-3 is a graphical representation of the additional data.

3.4.2.2 Wind Velocity and Direction

Wind velocity and direction data were acquired from all three meteorological stations. Five years of meteorological data are required to enable an accurate assessment of the impact of the proposed mining operation on the surrounding area. Only the NWS Station at Eau Claire had sufficient data to accommodate this assessment. Because Eau Claire and Ladysmith are separated by 60 miles, a comparison of measurements taken at Eau Claire with those at the Ladysmith Ranger Station and Kennecott MET Station was undertaken. Figure Nos. 3.4-4 and 3.4-5 illustrate those comparisons. Examination of the figures suggests that the NWS data is representative of the conditions at Ladysmith and can be used with a high degree of confidence.

Figure No. 3.4-6 depicts the wind velocity and direction at the Eau Claire NWS Station for the years 1982 through 1987 in the form of a wind rose. The wind rose indicates that the primary wind direction is from the south and west.

3.4.2.3 Temperature

High and low ambient surface temperatures were recorded at both the NWS and Ladysmith Ranger Stations during the sampling period. The high and low temperature data collected are depicted in Figure No. 3.4-7.

3.4.3 Background Air Quality

Air monitoring was conducted for the months May through October 1988 at two sites in the vicinity of the project area as described above. Following is a discussion of the results.

3.4.3.1 Ambient Air Particulate Concentration

Ambient particulate concentrations were determined in order to provide data for establishing background levels. These levels are to be used to establish a baseline. Because of the importance of establishing the "true" background level, careful scrutiny was given to discount days on which unnatural phenomena created excessively high TSP levels.

At present, the WDNR Bureau of Air Management considers a particulate level of greater than 150 ug/m^3 an "excursion." TSP and PM10 levels at the two monitoring stations varied considerably from one day to the next. However, on only one occasion, was an excursion seen to occur. On May 19, 1988, an excursion was noted at the hospital monitor. This excursion can be attributed to demolition activity at the STH 27 bridge adjacent to the monitoring station. It should be noted that a new PM10 standard is expected to replace the existing TSP standard.

Unique or unnatural phenomena observed during the monitoring study and which contributed to elevated TSP concentrations included: demolition of a concrete bridge adjacent to the hospital property; reconstruction of the roadbed on STH 27; and new construction on a nursing home building across from the hospital. These events occurred during one of the driest summers on record, and were specific to the summer of 1988, the period during which the ambient air monitoring took place. Because these were unique and nonrecurring events, the elevated particulate levels which could be attributed to these sources were discounted as they were not truly representative of "normal" background levels. This conclusion is further supported by the ambient air monitoring data collected at the site in the late 1970s and early 1980s.

Figure Nos. 3.4-8 and 3.4-9 depict the results of the TSP sampling study for the Jansen Road and hospital sites, respectively. Additional TSP and PM10 data analysis is presented in the *Ambient Air Monitoring Report Phase II* (March 1989). It should be noted that monitoring data showed that background PM10 values were within acceptable levels.

In an attempt to screen out nonrepresentative TSP values, potential generators of TSP were questioned on days that high levels were observed. Construction activity, batch processing of cement, and gravel mining were found to be evident during the days for which elevated TSP was observed. In addition, wind direction was found to influence the level of TSP found at the monitoring stations. In-depth details of the analysis are presented in the *Ambient Air Monitoring Report Phase I* (November 1988).

Because background or ambient levels in the vicinity of the mine site should be consistent, a further analysis compared the TSP levels at both sites. Solutions were sought for the discrepancies for days when high readings were recorded at one monitoring station but not the other. Figure No. 3.4-10 illustrates the TSP comparison.

Analysis of the data sampled at the two monitoring stations indicated that neither site consistently showed higher TSP values than the other on the same day. Peaks at one of the monitoring stations without a corresponding peak at the other was concluded to be the result of isolated activity at or near the site. Based on discounting these random peaks as time-specific, nonrepresentative ambient data, the background level was determined to be 60 ug/m^3. The 60 ug/m^3 value represents the high second high value for particulate with 120 ug/m^3 as the high.

3.4.3.2 Particle Characterization

Particulate characterization included determination of the chemical composition and particle size distribution. Samples from days on which TSP values exceeded 75 ug/m^3 were used to establish a distribution based on particle diameter. A 75 ug/m^3 setpoint was established by the WDNR. Composite samples of particulate for each two-month period were analyzed for designated metal constituents. Table No. 3.4-3 lists the sample dates designated for the respective analyses. Table Nos. 3.4-4 and 3.4-5 give results of the characterization study.

Particulate was categorized by shapes, which included: platy, rhombic, pollen, and rounded grain. Platy grains are considered to be clay minerals but may not include other phyllosilicates such as chlorite or micas. The rhombic grains include cleavage fragments of hexagonal carbonates and are probably calcite and dolomite. Rounded grains with diameters in the zero to five micron range were found to have a high degree of sphericity and are typically formed as a result of condensation. Rounded grains with diameters larger than five microns are less well rounded and less spherical than are their smaller counterparts.

Examination of the data from the microscopic analysis of entrained particulate captured at the two monitoring sites concluded that:

- More than 50 percent, and with the exception of one sample, more than 70 percent, of the grains counted had rounded shapes.
- In general, the samples taken at the Jansen Road station contained more rhombic-shaped particles than the hospital site. The larger percentage of rhombic shapes is suggestive of road construction activity conducted along STH 27, adjacent to the Jansen Road monitor.

TABLE NO. 3.4-3

Sample Dates Used in Particulate Analysis for Hospital Site

Sample	Date
0001	5-19-88
0027	6-14-88
0049	7-6-88

Sample Dates Used in Particulate Analysis for Jansen Road Site

Sample	Date
0008	5-25-88
0014	5-31-88
0050	7-6-88

TABLE NO. 3.4-4

Particle Size Distribution by Percent

Sample No.	Particle Size 0-<5	5-<10	10-<20	20-<30	>30	Total
Hospital						
0001	96.6	3.0	0.4	0	0	100.0
0027	93.5	4.9	1.4	0.2	0	100.0
0049	97.8	2.0	0.2	0	0	100.0
Jansen Road						
0008	91.6	6.9	1.5	0	0	100.0
0014	95.0	4.0	1.0	0	0	100.0
0050	91.2	6.0	2.5	0.3	0	100.0

TABLE NO. 3.4-5

Particle Shape Characterization by Percent

Sample No.	Platy	Rhombic	Pollen	Rounded	Total
Hospital					
0001	8.0	4.6	0.1	87.3	100.0
0027	17.8	7.9	0	74.3	100.0
0049	5.9	2.0	0.2	91.9	100.0
Jansen Road					
0008	37.8	10.0	0.2	52.0	100.0
0014	8.5	17.6	0.3	73.6	100.0
0050	15.6	4.0	0.3	80.1	100.0

- More than 90 percent of the grains counted in all of the samples are in the 0 to 5 micron range. A significantly smaller percentage was found to be within the 10 to 20 and 20 to 30 micron ranges and virtually none were counted which exceeded 30 microns in diameter.

In comparison to the Jansen Road monitoring station, the hospital site contains a slightly larger percentage of rounded particles. This could be due, in part, to a hospital incinerator located near the monitor.

Jansen Road samples contained a slightly higher percentage of platy and rhombic shaped particles in comparison to the hospital site. This is indicative of road construction activity near the monitoring station.

Chemical analysis of composite particulate samples from the two monitoring stations indicated that the major constituents within each sample were copper, lead, manganese, phosphorous, and zinc. The component with the highest net concentration was phosphorous at 188 ug/g. Table No. 3.4-2 lists the chemical components and their respective net concentrations within each of the six samples.

Ambient concentrations of each component within the TSP were arrived at by calculating the product of the TSP level of 60 ug/m^3, which has been established as the background level, and the arithmetic averaging for each component of the six samples. The results of these multiplications are also included in Table No. 3.4-6.

TABLE NO. 3.4-6

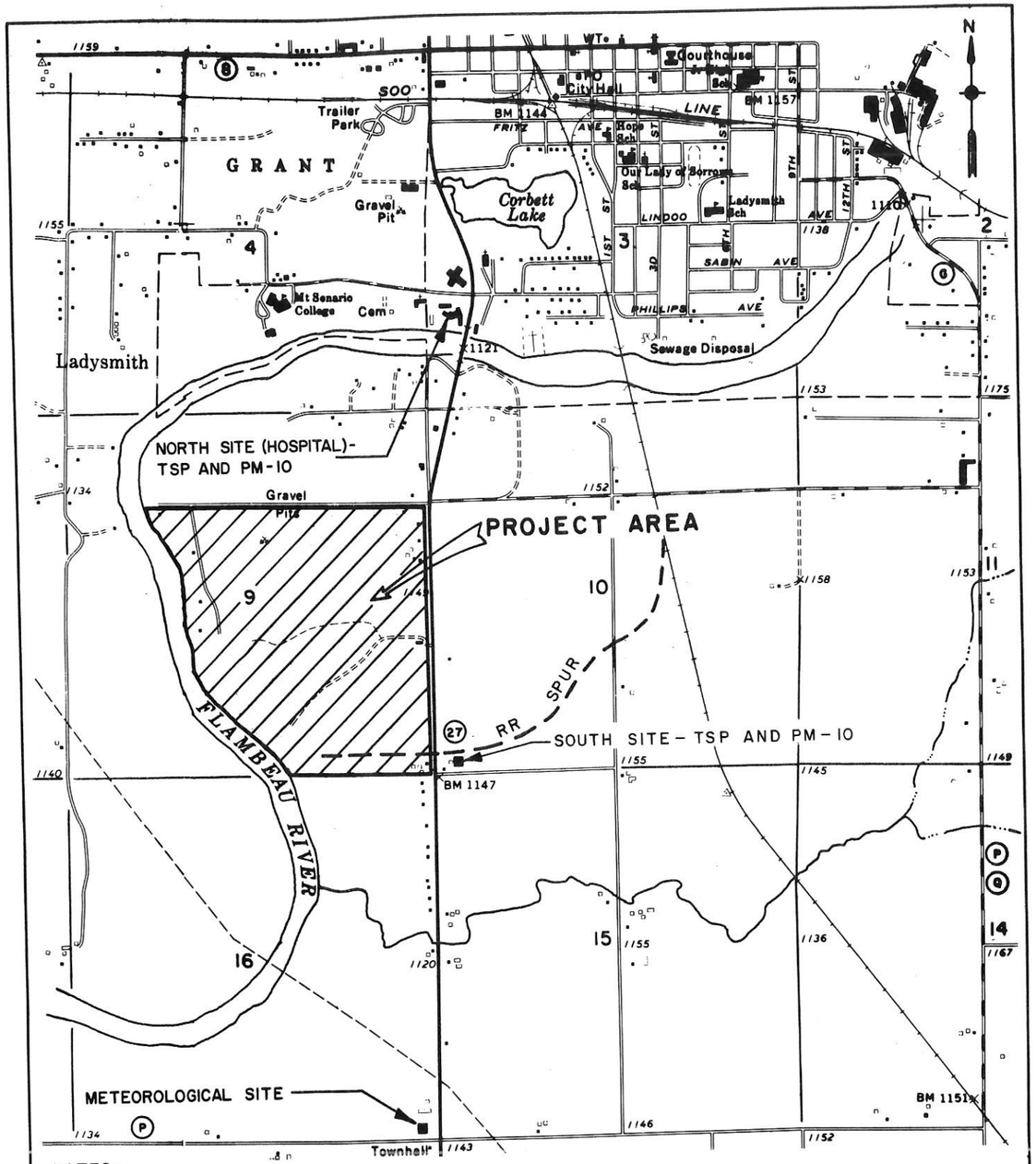
Net Chemical Results of Composite Particulate Samples

Element	Net[1] (ug/g)	TSP_{amb}[2] (ug/m^3) x10^6
Antimony	0.00	0
Arsenic	0.18	11
Barium	1.7	100
Beryllium	0.00	0
Cadmium	0.26	16
Chromium	0.22	13
Cobalt	0.	0
Copper	57.9	3470
Lead	3.4	200
Manganese	8.3	500
Mercury	0.0	0
Molybdenum	0.5	30
Nickel	0.00	0
Phosphorus	188.	11,300
Selenium	0.17	10
Thallium	0.00	0
Tin	0.0	0
Zinc	9.6	580

[1]Net is equal to the difference between the "average" and "blank" values shown on Table No. 3.4-2.

[2]TSP (ambient) equals "net" concentration times the established background particulate level of 60 ug/m^3.

Figures for Section 3.4

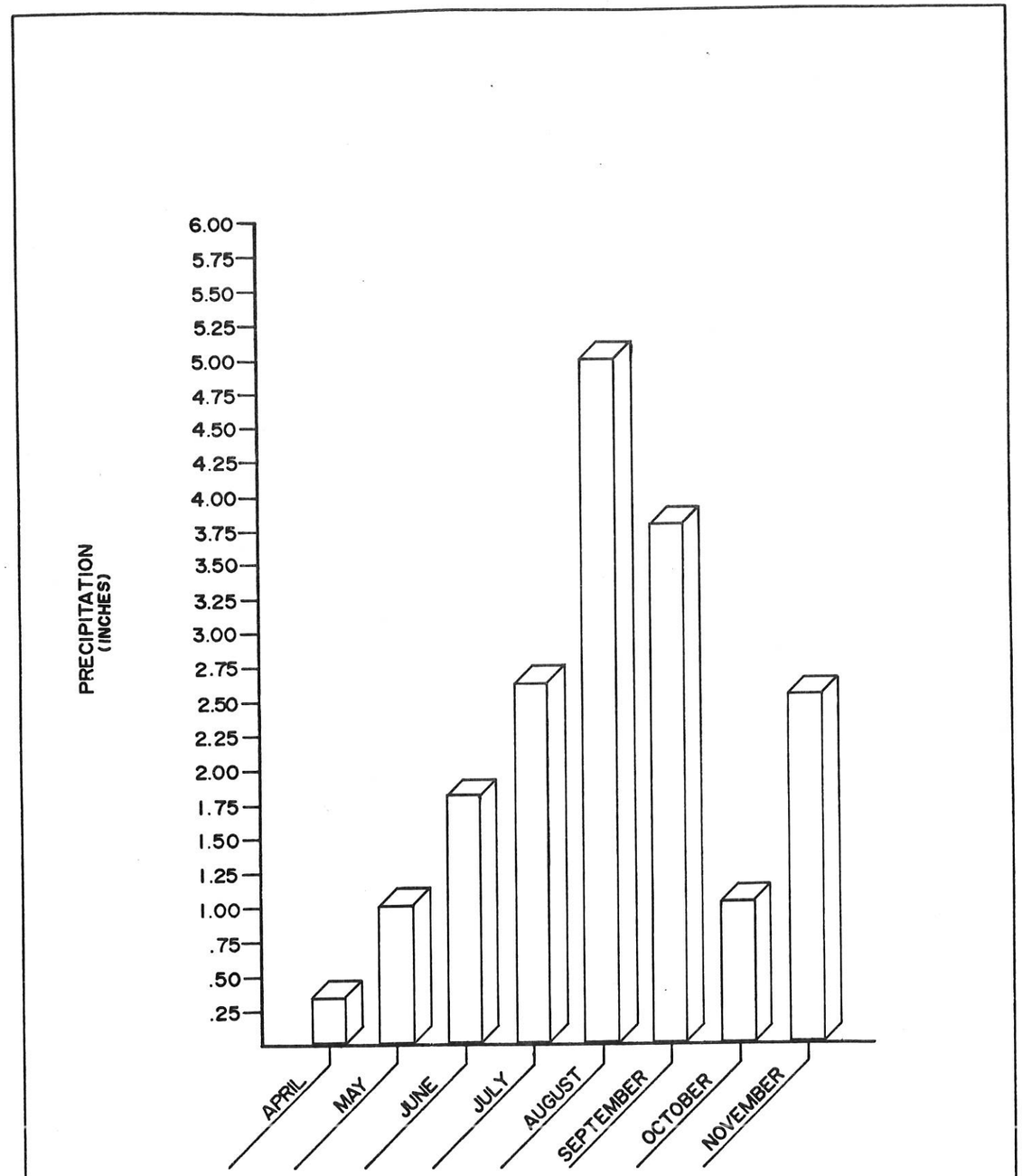


NOTES:

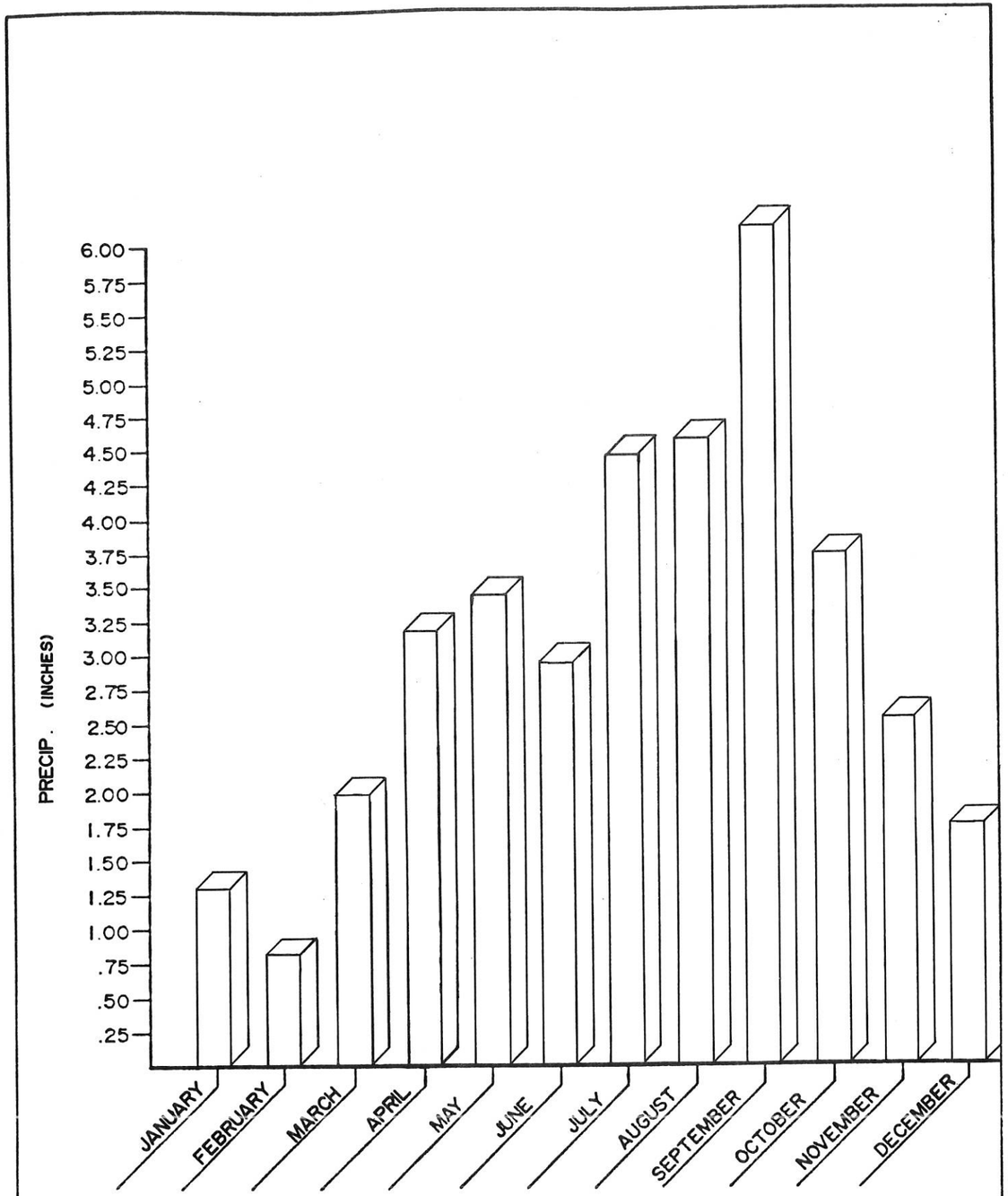
PROJECT AREA INCLUDES A 36 FOOT WIDE CORRIDOR ALONG RAILROAD SPURLINE EAST OF STH 27.

BASE MAP PREPARED FROM U.S.G.S MAPS 7.5 MINUTE SERIES, LADYSMITH AND THORNAPPLE WI. QUADRANGLES

FOTH & VAN DYKE GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION GREEN BAY, WISCONSIN			KENNECOTT MINERALS COMPANY FLAMBEAU PROJECT LADYSMITH, WISCONSIN
NOTES	APPROVAL	DATE	FIGURE NO. 3.4-1 AMBIENT AIR MONITORING LOCATIONS
	DESIGNED BY		
	DRAWN BY MWB	1/89	
	CHECKED BY RLP	3/89	
	APPROVED BY		
	CAD No. SCALE 1"=2000'		Job No / Dwg No / REV



FOTH & VAN DYKE GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION GREEN BAY, WISCONSIN			KENNECOTT MINERALS COMPANY FLAMBEAU PROJECT LADYSMITH, WISCONSIN
NOTES	APPROVAL	DATE	FIGURE NO. 3.4-2 PRECIPITATION AT KENNECOTT MET STATION (1988)
	DESIGNED BY		
	DRAWN BY SDL	2/89	
	CHECKED BY RLP	3/89	
	APPROVED BY		
	CAD No. SCALE		Job No / Dwg No / REV



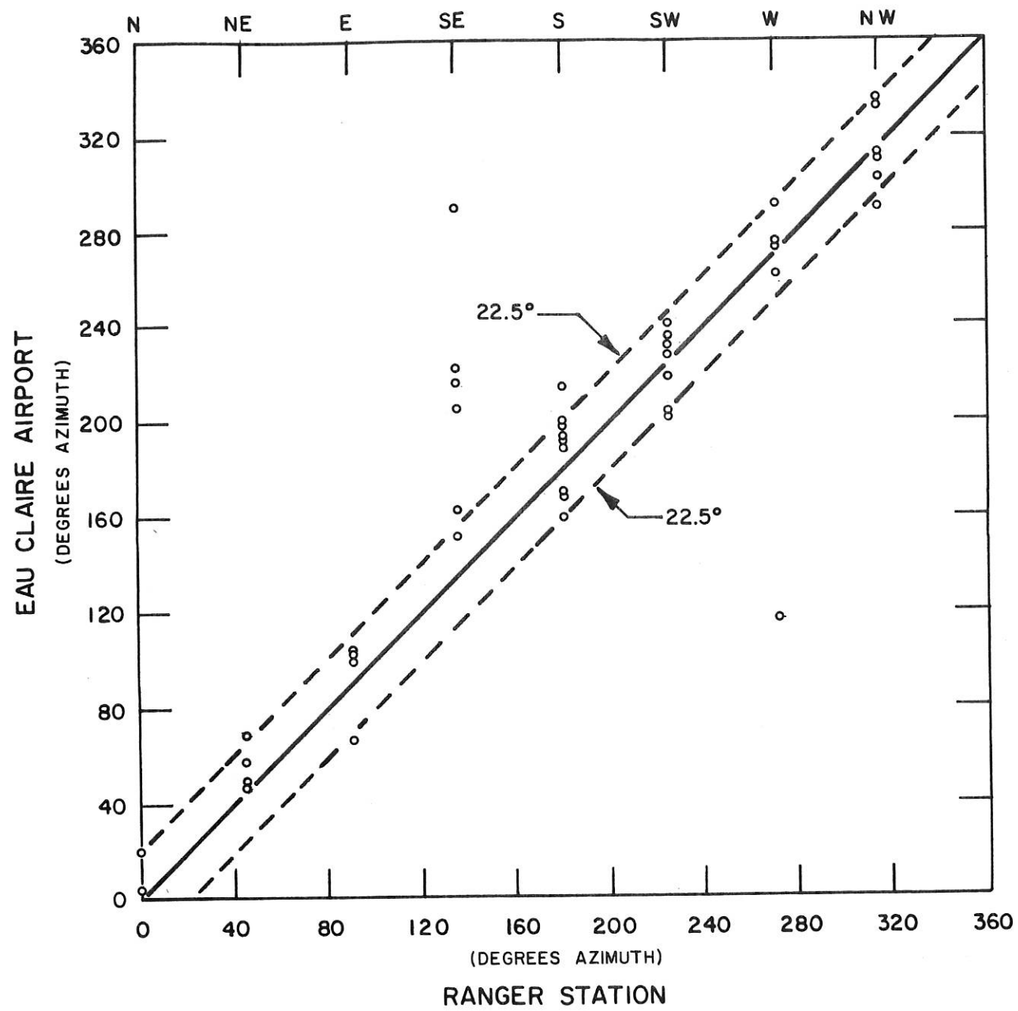
FOTH & VAN DYKE
GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION
GREEN BAY, WISCONSIN

KENNECOTT MINERALS COMPANY
FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

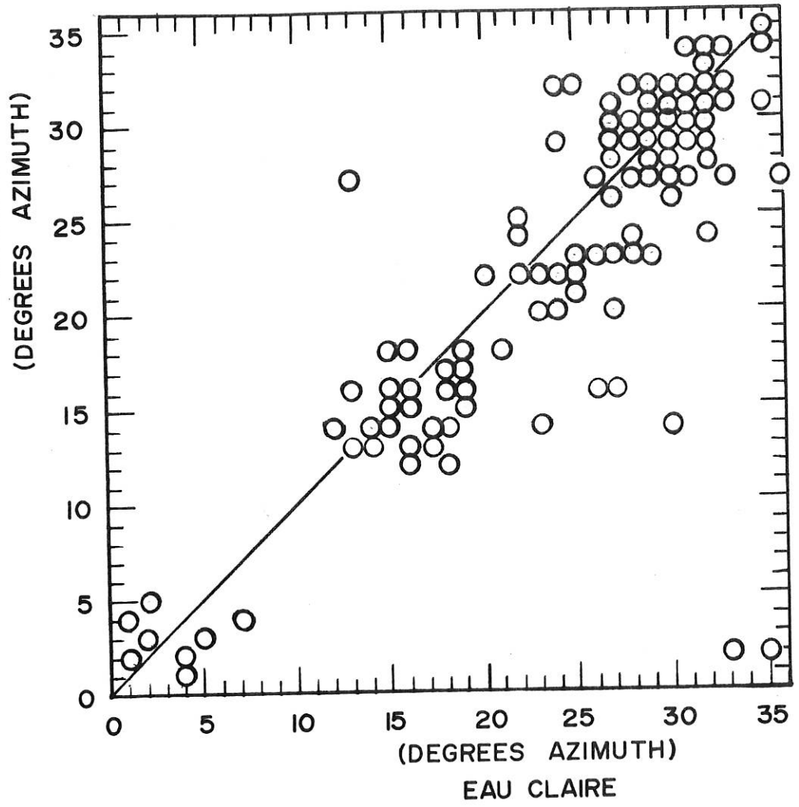
FIGURE NO. 3.4-3
PRECIPITATION AT LADYSMITH RANGER STATION (1982 – 1986)

NOTES	APPROVAL		DATE
	DESIGNED BY		
	DRAWN BY	SDL	3/89
	CHECKED BY	RLP	3/89
	APPROVED BY		
	CAD No.	SCALE	

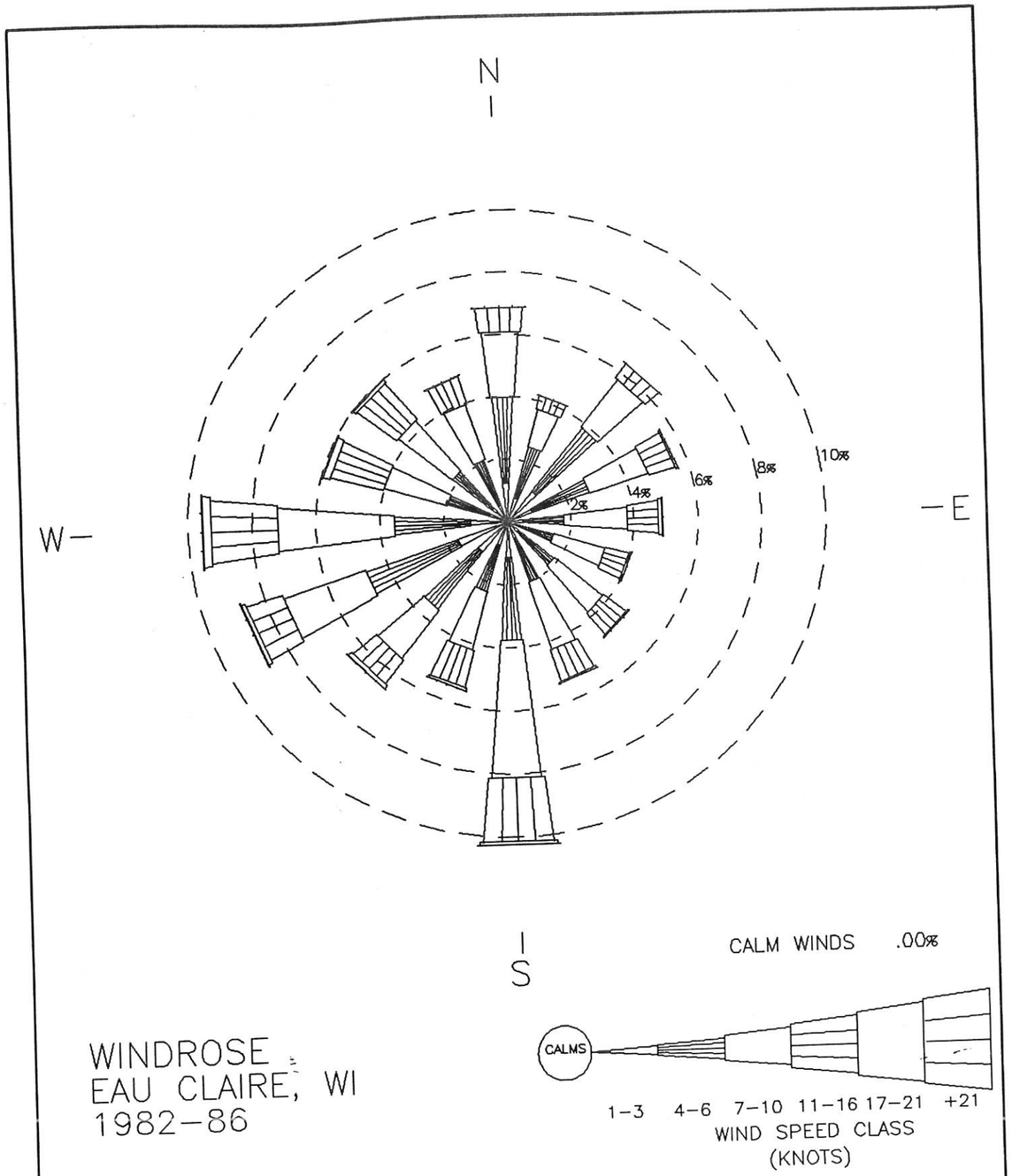
Job No	Dwg No	REV



FOTH & VAN DYKE GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION GREEN BAY, WISCONSIN			KENNECOTT MINERALS COMPANY FLAMBEAU PROJECT LADYSMITH, WISCONSIN
NOTES	APPROVAL	DATE	FIGURE NO. 3.4-4 CORRELATION OF RANGER STATION AND EAU CLAIRE WIND DIRECTION
	DESIGNED BY		
	DRAWN BY SJL	2/89	
	CHECKED BY RLP	3/89	
	APPROVED BY		
	CAD No. / SCALE		Job No / Dwg No / REV

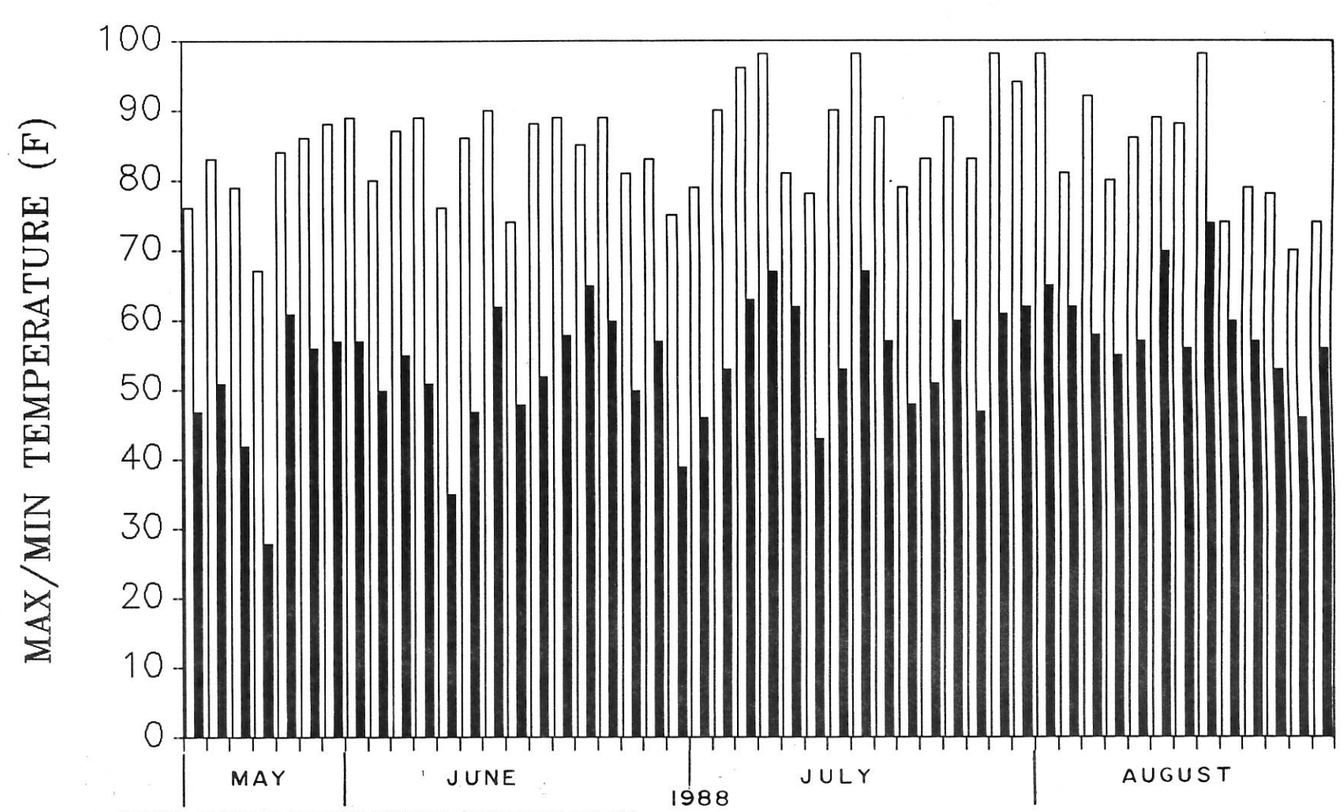


FOTH & VAN DYKE GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION GREEN BAY, WISCONSIN			KENNECOTT MINERALS COMPANY FLAMBEAU PROJECT LADYSMITH, WISCONSIN
NOTES	APPROVAL	DATE	FIGURE NO. 3.4-5 CORRELATION OF KENNECOTT MET AND EAU CLAIRE WIND DIRECTION
	DESIGNED BY		
	DRAWN BY S.D.L.	1/89	
	CHECKED BY R.L.P.	3/89	
	APPROVED BY		
	CAD No. SCALE		Job No / Dwg No / REV



WINDROSE
EAU CLAIRE, WI
1982-86

FOTH & VAN DYKE GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION GREEN BAY, WISCONSIN			KENNECOTT MINERALS COMPANY FLAMBEAU PROJECT LADYSMITH, WISCONSIN FIGURE 3.4-6 FREQUENCY OF WIND SPEED AND DIRECTION	
NOTES	APPROVAL	DATE		
	DESIGNED BY			
	DRAWN BY SJL	3/89		
	CHECKED BY RLP	3/89		
	APPROVED BY			
	CAD No. SCALE		Job No	Dwg No REV



NOTE: TEMPERATURES TAKEN APPROXIMATELY EVERY OTHER DAY BEGINNING MAY 19, 1988 AND ENDING AUGUST 25, 1988

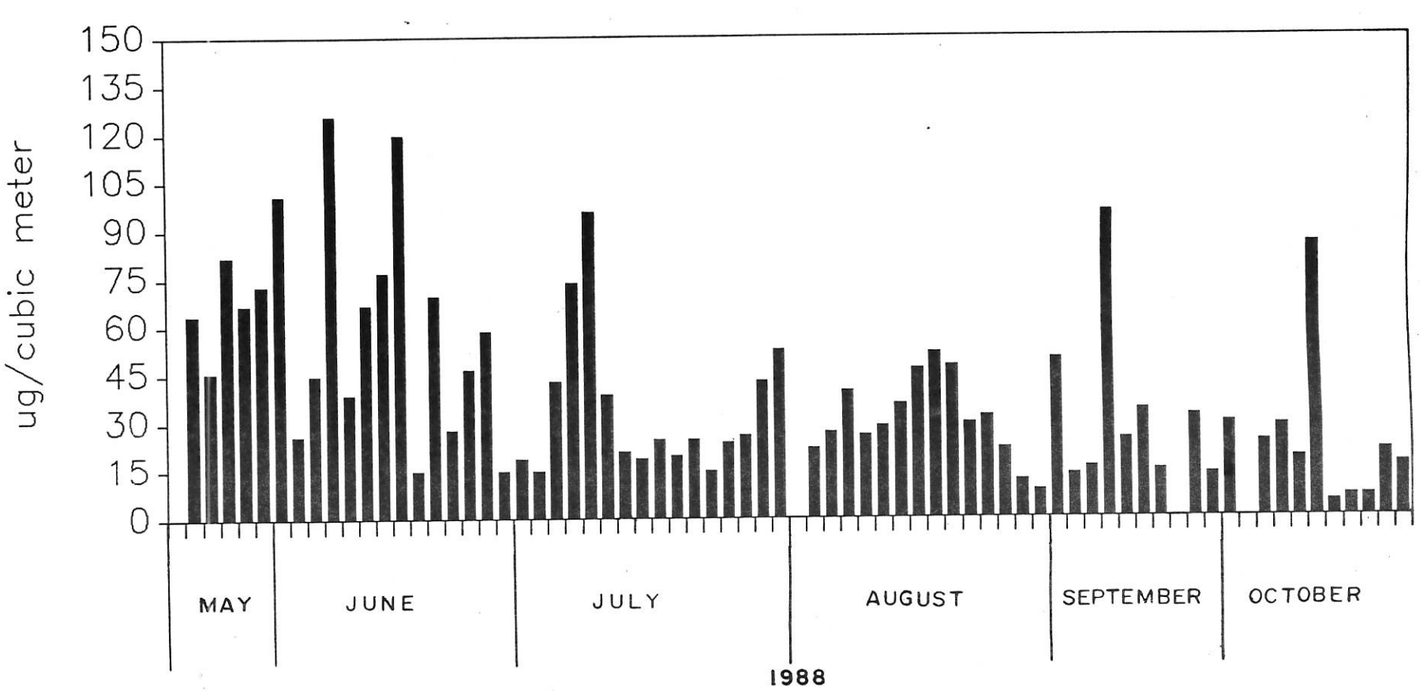
FOTH & VAN DYKE
GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION
GREEN BAY, WISCONSIN

KENNECOTT MINERALS COMPANY
FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

FIGURE NO. 3.4-7
DAILY MAX/MIN. TEMPERATURES
AT LADYSMITH RANGER STATION

No	REVISIONS	NOTES	APPROVAL	DATE
			DESIGNED BY	
			DRAWN BY RDM	2/89
			CHECKED BY RLP	3/89
			APPROVED BY	
			CAD No.	SCALE

Job No	Dwg No	REV



NOTE: SAMPLES TAKEN APPROXIMATELY EVERY OTHER DAY BEGINING MAY 19TH, 1988 AND ENDING OCTOBER 30TH, 1988

FOTH & VAN DYKE
GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION
GREEN BAY, WISCONSIN

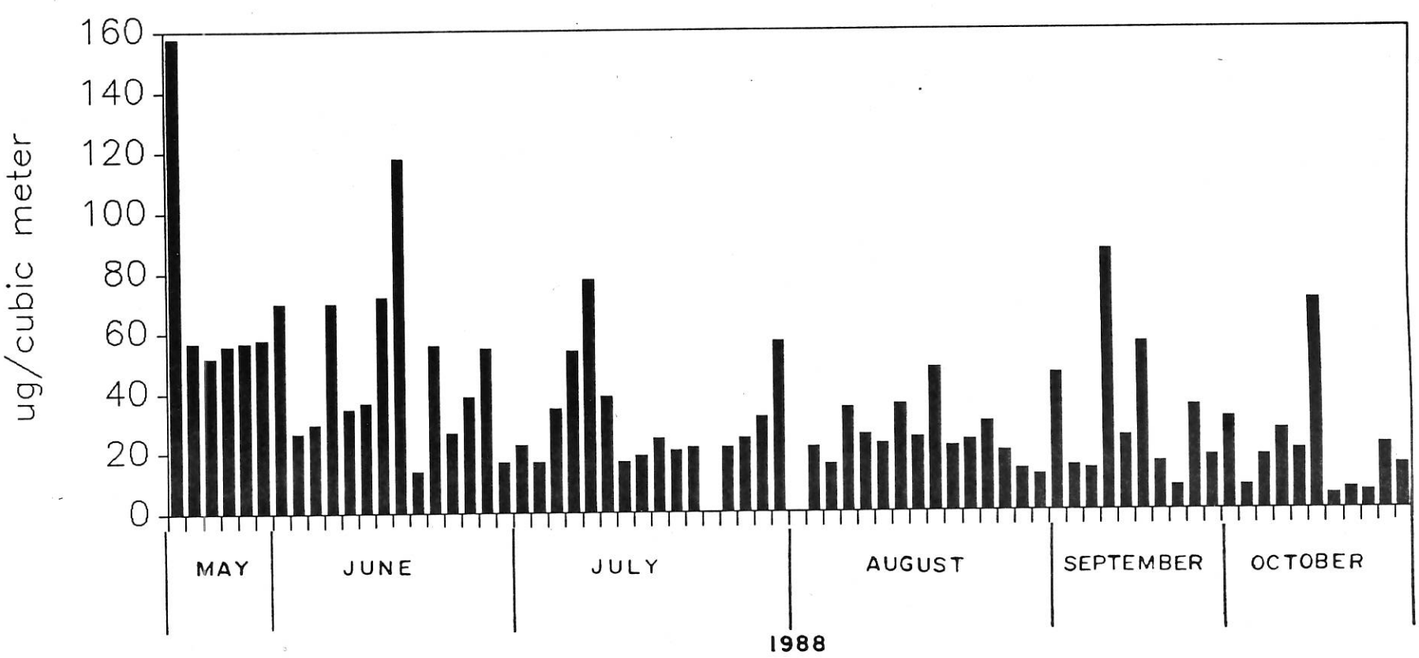
KENNECOTT MINERALS COMPANY
FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

FIGURE NO. 3.4-8
TOTAL SUSPENDED PARTICULATES
JANSEN ROAD SITE

No	REVISIONS	NOTES
1		
2		
3		
4		
5		

APPROVAL		DATE
DESIGNED BY		
DRAWN BY	RDM	2/89
CHECKED BY	RLP	3/89
APPROVED BY		
CAD No.	SCALE NONE	

Job No | Dwg No | REV



NOTE: SAMPLES TAKEN APPROXIMATELY EVERY OTHER DAY BEGINING MAY 19TH, 1988 AND ENDING OCTOBER 30TH, 1988

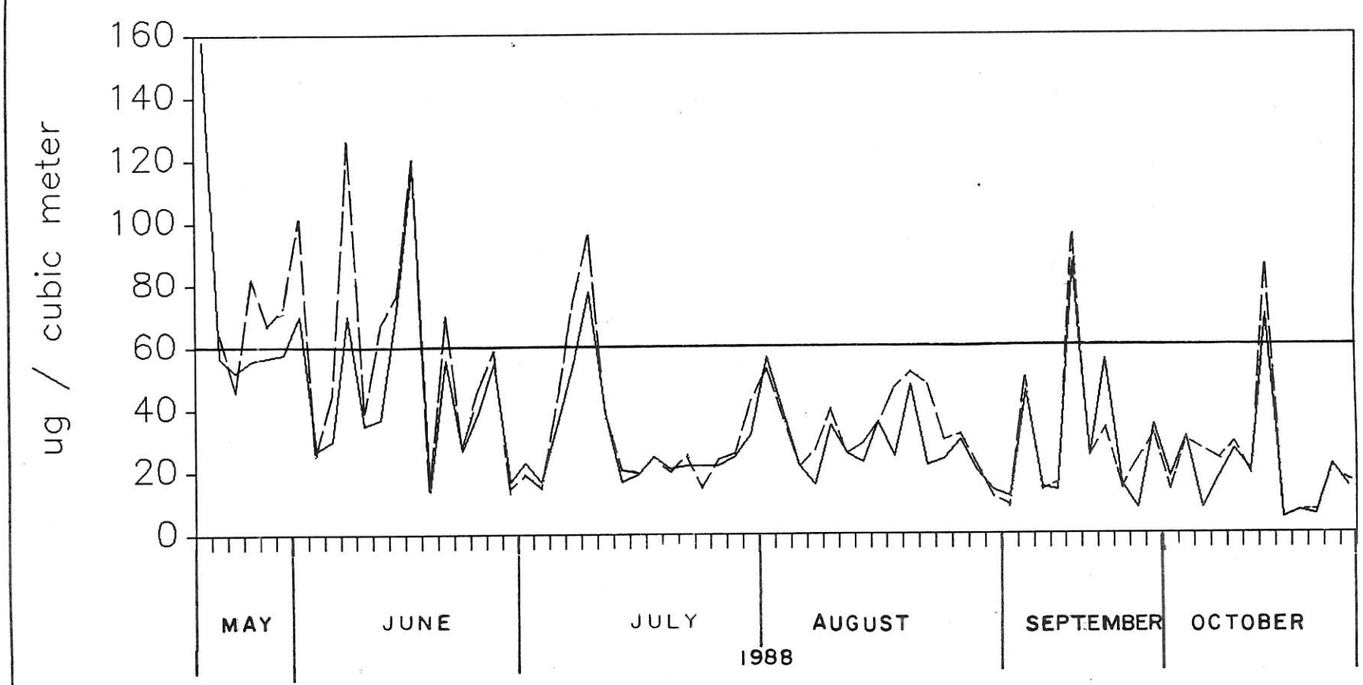
FOTH & VAN DYKE
GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION
GREEN BAY, WISCONSIN

KENNECOTT MINERALS COMPANY
FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

FIGURE NO. 3.4-9
TOTAL SUSPENDED PARTICULATES
HOSPITAL SITE

No	REVISIONS	NOTES	APPROVAL	DATE
			DESIGNED BY	
			DRAWN BY RDM	2/89
			CHECKED BY RLP	3/89
			APPROVED BY	
			CAD No.	SCALE NONE

Job No | Dwg No | REV



LEGEND

——— HOSPITAL TSP

– – – – JANSEN ROAD TSP

NOTE: SAMPLES TAKEN APPROXIMATELY EVERY OTHER DAY BEGINING MAY 19TH, 1988 AND ENDING OCTOBER 30TH, 1988

FOTH & VAN DYKE
GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION
GREEN BAY, WISCONSIN

KENNECOTT MINERALS COMPANY
FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

FIGURE NO. 3.4-10
TOTAL SUSPENDED PARTICULATES

No	REVISIONS	NOTES	APPROVAL		DATE
			DESIGNED BY		
			DRAWN BY	RDM	2/89
			CHECKED BY	RLP	3/89
			APPROVED BY		
			CAD No.	SCALE NONE	

Job No | Dwg No | REV