October 7, 1987 87K10-8

Gordon Reinke, Chief
Mine Reclamation Section
Bureau of Solid Waste Management
Department of Natural Resources
101 S. Webster Street, GEF II
P.O. Box 7921
Madison, WI 53707

Dear Mr. Reinke:

RE: Kennecott Flambeau Project
Notification of Intent to Collect Data

On behalf of Kennecott Explorations (Australia) Ltd., a Delaware Corporation, Foth & Van Dyke and Associates Inc. is enclosing 20 copies of the document titled "Scope of Study for the Kennecott Flambeau Project". An additional 17 copies have been forwarded to the Department's Northwest District Offices.

The document has been prepared in accordance with NR 132.05(7) and incorporates comments received from the Department during past meetings and those generated by the public during the September 9, 1987 NOI public hearing.

As you are aware, the project is on an accelerated schedule and therefore, we respectfully request that the Department complete its review in an expeditious manner. To assist the Department in its review of this document, Kennecott project team members will be available to answer questions or provide additional information at any time convenient to you.

Sincerely,

FOTH & VAN DYKE

Jerry W. Sevick, P.E.
Division General Manager

JWS:wjm

Enclosures

cc: William H. Clark, DNR-Spooner (w/encl.)
Lawrence E. Mercando, Kennecott (w/encl.)
Jerry Schurtz, Kennecott (w/encl.)
Edwarde R. May, Kennecott (w/encl.)
Ladysmith Office (w/encl.)
Hank Handzel, DeWitt, Porter, *et al.* (w/encl.)
James W. Wimmer, Jr. S.C. (w/encl.)
Kathleen M. Falk, Public Intervenor's Office (w/encl.)
Rolf Wegenke, Department of Development (w/encl.)
Master File (w/encl.)

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SCOPE OF STUDY FOR THE KENNECOTT FLAMBEAU PROJECT

Prepared for:

KENNECOTT

Prepared by:

FOTH & VAN DYKE and Associates Inc.
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OCTOBER 1987

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Foth & Van Dyke and Associates Inc.
1987

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APPENDIX A Quality Assurance Plan and Standard Operating Procedures

1.0 INTRODUCTION

On July 17, 1987, Foth & Van Dyke, on behalf of Kennecott, submitted to the Wisconsin Department of Natural Resources (WDNR), a document titled "Notification of Intent to Collect Data" (NOI). The document was prepared in accordance with Wisconsin Administrative Code NR 132.05 which states that "any person intending to submit an application for a mining permit shall notify the Department prior to the collection of data or information intended to be used to support the permit application". Kennecott intends to submit a mining permit application in late 1988 for the proposed Flambeau Project copper mine located near Ladysmith, Wisconsin.

The NOI contained information required under NR 132.05(2) and included a "Proposed Scope of Study". The "Proposed Scope of Study" was included in the NOI to identify issues that Kennecott felt should be addressed in the project data collection process and during environmental reviews. The "Proposed Scope of Study" did not outline all detailed technical procedures to be followed in the completion of data collection. Kennecott indicated in the NOI that it was the Company's intention to specify these upon receipt of input from the WDNR and the public during the review of the NOI.

The NOI also noted that Kennecott has, since the early 1970's, been collecting environmental data relating to the project and that it is Kennecott's intent to make use of as much of the existing database as possible to fulfill environmental review requirements. The Company stated, though, that it intends to supplement or recollect data where a need exists.

Finally, the NOI contained a listing of pertinent reports and raw data relating to the existing database in a Bibliography. All reports and data referenced in the Bibliography were provided to the WDNR as part of the NOI submittal process.

This document, which is titled "Scope of Study for the Flambeau Project", has been prepared pursuant to NR 132.05(7)(a). The "Scope of Study" (SOS) builds upon the Proposed Scope of Study included in the NOI; incorporates comments obtained from the WDNR during numerous project meetings; and addresses pertinent issues raised at the September 9, 1987 NOI public information hearing. The SOS includes:

a) A summary and an evaluation of existing data;

b) An identification of additional data requirements;

c) A description of specific methodologies that will be utilized in the data collection process, data processing, laboratory work and analysis;

d) A description of the format in which the data will be presented in the project report(s);

e) A tentative schedule for field data collection;

f) A listing of key project personnel; and

g) A description of the quality assurance program to be employed in obtaining, collecting, generating and evaluating baseline data.

All data collection, with the exception of certain portions of the geotechnical investigative work plan, will be completed under the direction of the Foth & Van Dyke Geosciences & Environmental Management Division headquartered at 2737 South Ridge Road, Green Bay, Wisconsin, 54304. The Foth & Van Dyke Project Manager is Gerald W. Sevick, P.E., General Manager of the Geosciences & Environmental Management Division. Mr. Sevick has over 17 years of experience working with environmental issues including environmental evaluations and permitting of projects under local, state and federal rules and regulations.

Those portions of the geotechnical investigations work plan not administered by Foth & Van Dyke will be completed under the direction of Mr. Lawrence E. Mercando, Director of Process Development for Kennecott. Mr. Mercando is a chemical engineer with over 30 years of experience working with engineering and environmental projects. As Kennecott's Flambeau Project Manager, Mr. Mercando has ultimate responsibility for all aspects of the project.

The SOS also contains general project information and an Appendix outlining laboratory quality control and quality assurance procedures. Since a detailed project description was included in the NOI, one is not repeated here. In reviewing the description contained in the NOI, it is important to realize that, while the proposed project description is quite specific and detailed, it is possible that modifications to the proposed plan will be made due to environmental, economic and permitting issues raised during the data collection, design, environmental and public review processes.

Throughout the SOS, references are made to the Bibliography contained in the NOI and to the project files (e.g., KEN-36) submitted to WDNR as part of the NOI. Both the NOI and project files are available at WDNR's central office in Madison and WDNR's district and area offices near the project site for reference purposes.

2.0 GENERAL PROJECT INFORMATION

2.1 Name, Address and Telephone Number of Person Submitting the Scope of Study

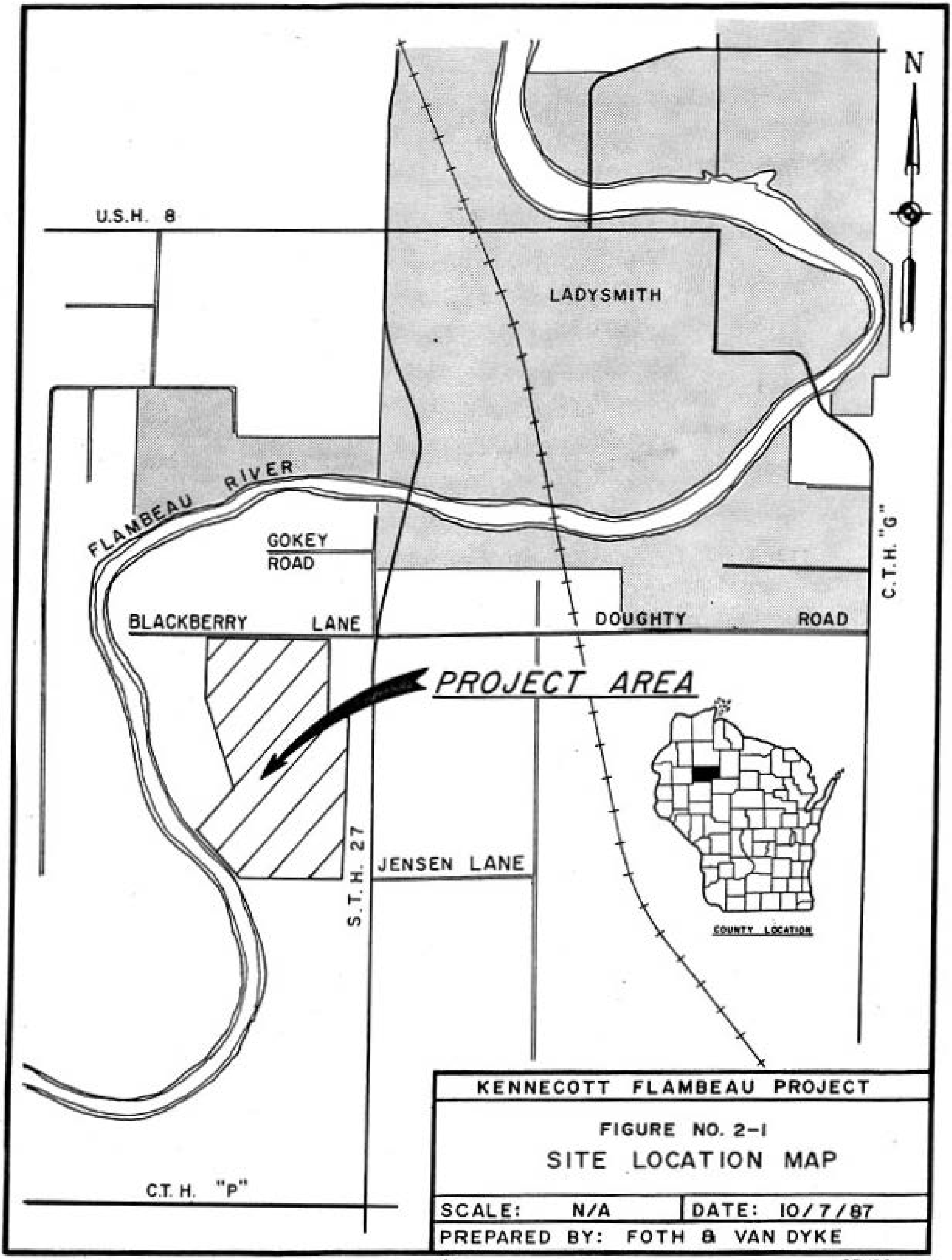
Lawrence E. Mercando, Director - Process Development
Project Development
On Behalf of Kennecott Explorations (Australia) Ltd.,
A Delaware Corporation
1515 Mineral Square
Salt Lake City, Utah 84112

(801) 322-8460

Kennecott Explorations (Australia) Ltd., a Delaware Corporation, is a sister company of Kennecott Corporation. Both companies are wholly-owned subsidiaries of Standard Oil Company. Standard Oil Company, in turn, is wholly-owned by British Petroleum.

2.2 Project Location

Figure No. 2-1 is a map showing the approximate project location. The project site is located in the Town of Grant, Rusk County, Wisconsin, about one mile southwest of the City of Ladysmith. Site topography, a preliminary project plot plan and a proposed project flow diagram were included with the NOI submitted to the WDNR on July 17, 1987.


N
U.S.H. 8
LADYSMITH
FLAMBEAU RIVER
GOKEY ROAD
BLACKBERRY LANE
DOUGHTY ROAD
C.T.H. "G"
PROJECT AREA
S.T.H. 27
JENSEN LANE
COUNTY LOCATION
C.T.H. "P"
KENNECOTT FLAMBEAU PROJECT
FIGURE NO. 2-1
SITE LOCATION MAP
SCALE: N/A
DATE: 10/7/87
PREPARED BY: FOTH & VAN DYKE

2.3 Expected Date When A Mining Permit Application May Be Submitted to WDNR Pursuant to s. NR 132.06

It is anticipated that the mining permit application for the project will be submitted in the fourth quarter of 1988.

2.4 Property Ownership

A total of 175 to 225 acres of land will be incorporated into the project. Kennecott owns the site and adjoining property. Legal descriptions for all property owned by Kennecott were submitted with the NOI.

3.0 PROJECT WORK PLANS

3.1 Aesthetics

3.1.1 Existing Data Summary and Evaluation

Scenic views and vistas and recreational factors were considered in the 1976 EIS. Relevant existing information is found in File No. KEN-28, as listed in the NOI Bibliography.

Scenic views and vistas were examined to determine aesthetic and human interest values. The impact of the mining site on the scenic views and vistas, as well as on the surrounding area, was also considered.

These available data will be reviewed and updated.

3.1.2 Data Requirements

Current regional recreational use information must be gathered from state and local agencies. Photographic documentation of preconstruction conditions from selected points of observation is also necessary. Information regarding other aspects of the proposed mine related to visual effects, odors, noise (covered elsewhere) and vibration (also covered elsewhere) should be gathered from available literature and other mining operations.

3.1.3 Methodology

The establishment of visual and other aesthetic criteria through quantitative survey approaches has been used in siting studies for a wide variety of facilities. In fact, certain setback requirements in the Wisconsin Administrative Code have aesthetic considerations in their separation distances.

Observation points will be established at Mount Senario College, the Hospital and Nursing Home Complex, multiple locations on State Highway 27, the Jensen Lane intersection, and the Flambeau River. Photographs will be taken from vantage points at each location selected on the basis of frequency of use (e.g., auto traffic, sitting areas and ease of accessibility by viewers).

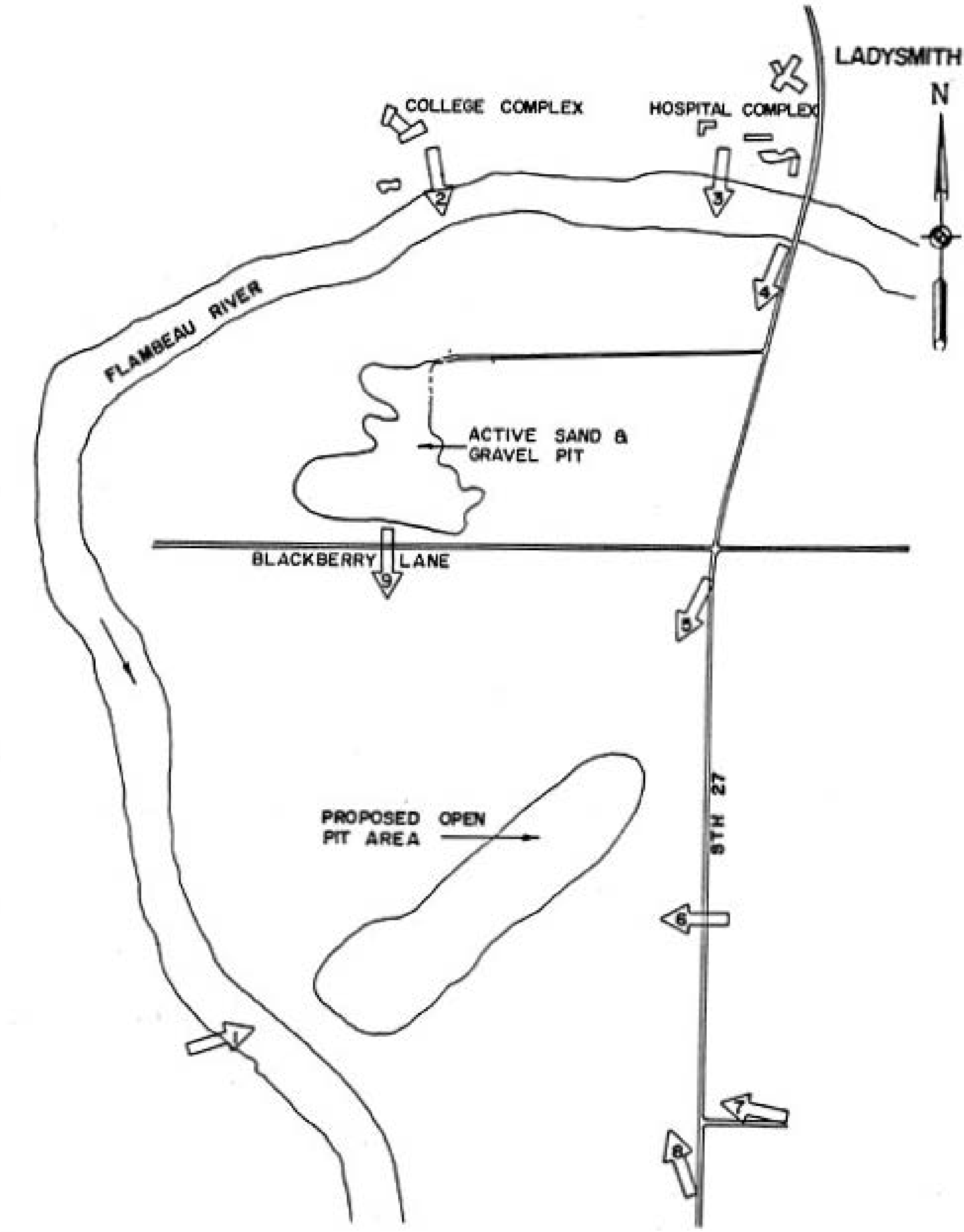
In order to establish background conditions, a series of photographs will be taken from the observation points presented on Figure No. 3-1 during spring, summer, fall and winter periods. These photographs will be used to evaluate the potential for visual intrusion and to recommend screening measures to mitigate these intrusions.

3.1.4 Data Presentation Format

Photographs from scenic viewpoints and observation locales will be used to document existing conditions and to graphically evaluate screening and reclamation measures.

3.1.5 Schedule for Field Data Collection

Photographs will be taken from the viewpoints noted on Figure No. 3-1 during early October, January, May and July.



LEGEND

LOCATION AND DIRECTION OF PHOTO

KENNECOTT FLAMBEAU PROJECT

FIGURE NO. 3-1

PROPOSED LOCATION FOR PHOTO DOCUMENTATION

SCALE: 1" ≈ 1000' | DATE: 10/7/87

PREPARED BY: FOTH & VAN DYKE

3.1.6 Key Project Personnel

The aesthetics evaluation will be accomplished by Steven Milquet, AICP, P.E., of Uniplan Associates, Green Bay, Wisconsin; Dr. V. Rajaram, Ph.D., an independent consultant in the area of rock mechanics; and Tim J. Weyenberg, M.S. of Foth & Van Dyke.

3.2 Air Quality

3.2.1 Existing Data Summary and Evaluation

The air resources database consists of both meteorological and air quality/monitoring data. Relevant existing information is found in File Nos. KEN-1 through 16, and KEN-58, as listed in the NOI Bibliography. Existing air quality data was obtained from four Hi-Vol air monitors similar to the ones the WDNR uses throughout the state. They were installed on the Ladysmith City Hall, the local hospital and two sites along on Highway 27. One of the monitoring sites was located approximately 300 yards from the proposed entrance to the mine area. The second site was located at the intersection of C.T.H. "P" and Highway 27, south of the mine site.

The Hi-Vols had internal timers. Between February 1977 and December 1982, they operated for a continuous 24 hour period every sixth day. The air monitoring program was conducted in accordance with the WDNR's quality assurance program.

The samples were analyzed for total suspended particulates (TSP's). A few samples were analyzed for sulfur. No particle size distribution measurements were taken. The TSP database is thoroughly documented and contains the following:

- Photocopies of the strip charts from the Hi-Vols;
- Calibration forms;
- Least-squares approximation calculations for fitting the calibration points into usable curves;
- The SAROAD forms showing results of the TSP levels in the ambient air;
- Transmittal letters from the Flambeau Mining Company (FMC), to the WDNR stating that the SAROAD and calibration forms were submitted monthly to the WDNR; and
- Letters from the WDNR stating that their audits demonstrated that air data were being collected in an acceptable manner.

Considerable meteorological data were recorded from 1965 through 1980. From 1965 through 1971, the meteorological data were obtained from the Ladysmith Ranger Station and the Company site. From 1972 through 1976, the data were obtained solely from the Ladysmith Ranger Station. From 1977 through 1980, data were obtained solely from the Company site. The data include:

- Average wind velocity, prevailing wind direction and relative humidity taken on a daily basis starting in April 1965 and continuing through November of 1971 (it does not include data from December, January, February or March of those years);

- Daily precipitation from 1965 through 1980 (all months); and

- Daily high and low temperatures from 1965 through 1980 (all months).

All of these data were summarized in various tables showing monthly and yearly totals and averages.

The Ranger Station remains as an active meteorological station from April through November of each year. In addition, the National Weather Station in Eau Claire, Wisconsin has collected meteorological data for a sufficient amount of time for site modeling purposes.

WDNR audits concluded that the TSP and meteorological data were collected in an acceptable manner. The WDNR's modeling programs require continuous meteorological data over a recent five year period. The existing Eau Claire database will supply these data needs.

3.2.2 Data Requirements

Based on the proposed project, the WDNR has made a determination that the mining operation is not a major TSP source and therefore, is not expected to have emissions above "de minimus" levels. Preconstruction monitoring for PSD purposes is, therefore, not required. The site will, however, require an air permit from the WDNR.

Existing data is adequate to perform the necessary modeling to assess the impacts of the proposed mine on air quality in the vicinity. It is also sufficient to develop the necessary information for an approvable application for an air permit that will be issued by the WDNR. For these reasons, no preconstruction air quality monitoring for data collection purposes is planned.

If, in the development of an application for an air quality permit, Kennecott wishes to obtain additional ambient air quality or meteorological data, they will so advise the WDNR and initiate the procedures necessary to obtain WDNR approval and acceptance of monitoring equipment, methods, sites and data management.

3.2.3 Methodology

This section does not apply. No new data are expected to be collected.

3.2.4 Data Presentation Format

Air quality monitoring information will be presented in graphic and tabular form. Graphs will be prepared using PC-spreadsheet software with plotter and laser printer output.

3.2.5 Schedule for Field Data Collection

This section does not apply. No new data is expected to be collected.

3.2.6 Key Project Personnel

Timothy P. Doran, P.E., Chemical Engineer and Air Quality Specialist with Foth & Van Dyke, will complete data analysis and data evaluations.

3.3 Baseline Groundwater Monitoring

3.3.1 Existing Data Summary and Evaluation

During the 1970's, 20 monitoring wells were installed in the vicinity of the orebody area (KEN-34). Of these, 18 were sampled at various points in time. This includes a line of four wells upgradient of the site to the southeast, a line of seven wells along the Flambeau River between the orebody and the river, and a line of seven wells downgradient of the site to the northwest. Additional wells exist further to the northwest in the vicinity of the gravel pit.

These wells have torch-cut slots instead of screens. They were constructed from black steel well casing. Numerous standing water level measurements were made in these wells (KEN-35). In addition, water samples were collected and analyzed in order to estimate baseline groundwater characteristics.

In addition to these wells, 18 soil boring test holes were drilled and small-diameter (1.25" i.d.) PVC wells were installed for the purpose of conducting in-situ permeability tests, mostly within or in the immediate vicinity of the originally proposed open pit area (KEN-38 through KEN-43). Several sets of water level measurements were made in these wells. No samples were taken from them, however. In addition to the in-situ pump tests, two long term pumping tests were also conducted (KEN-36).

Two groundwater modeling efforts were performed on the site area. The first is described in the original EIR document, and the other was completed as a Ph.D. thesis in 1983 (KEN-37).

The previous groundwater sampling program was conducted according to state-of-the-art procedures that existed in the early 1970's. However, the science of groundwater monitoring has changed since that time. In addition, quality control concerns pertain to some of these data as well. As a result, much of the data generated by that program is not acceptable by current standards. This includes all groundwater quality data, for example. It could also include water levels measured in the wells that have multiple slotted intervals, where more than one of those intervals occurs beneath the water table.

On the other hand, some of the data are still usable. This includes water levels from single slotted zone wells, along with water levels from soil boring test holes.

Pump test information is valid and will be usable. The groundwater models, with updating and enhancement, are usable as precursors to any final modeling efforts that may be necessary. These two topics are discussed in greater detail in Section 3.10 of this document.

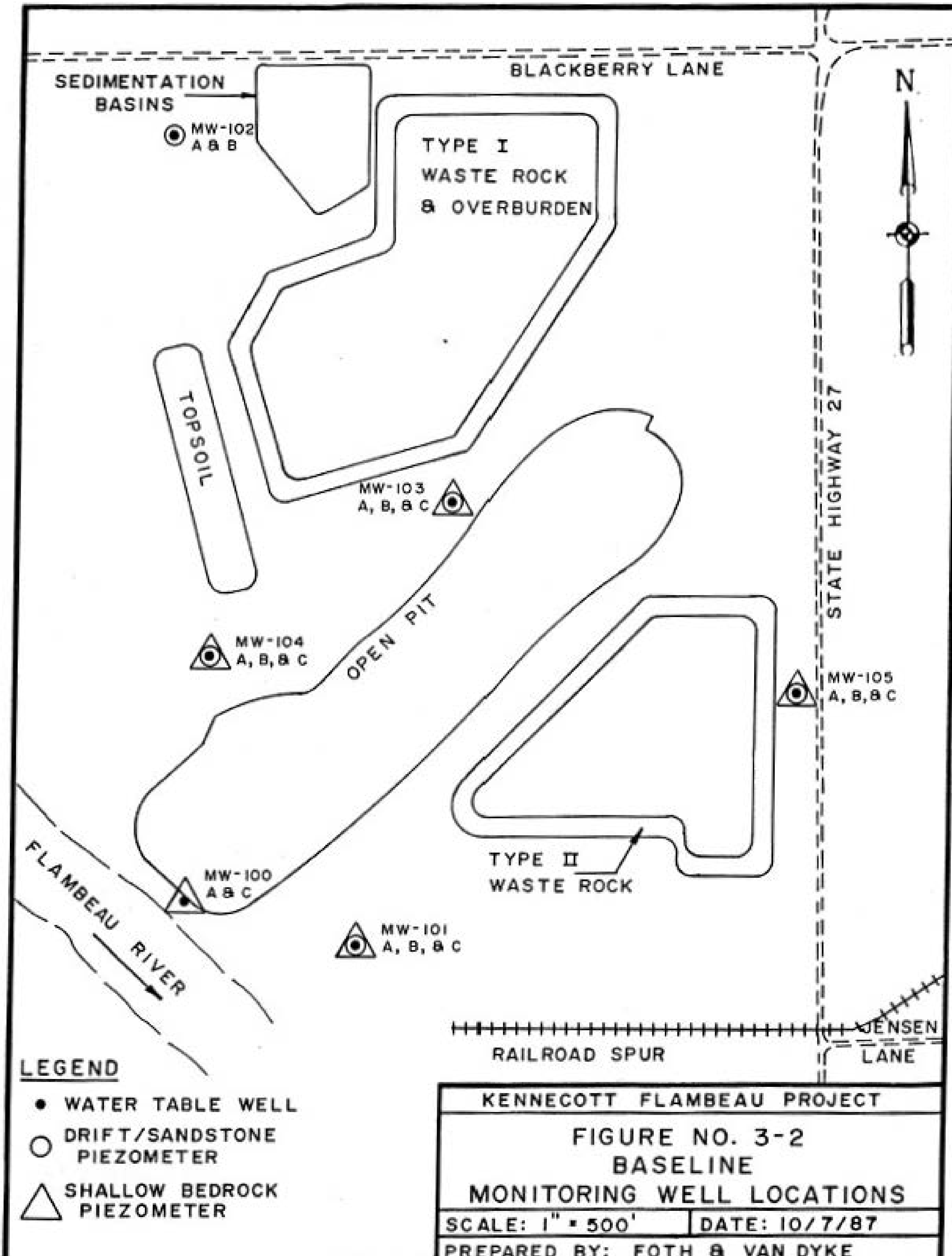
3.3.2 Data Requirements

Nested monitoring wells (into the glacial materials and bedrock) should be installed throughout the site area and sampled monthly for 12 months. These wells should be installed in areas that will be upgradient of the entire facility, downgradient of the mine pit, and downgradient of the crushing area. Water levels should be measured in these wells to provide vertical and horizontal hydraulic gradient information. In-situ permeability tests should be conducted in the wells to quantify variabilities in permeability.

3.3.3 Methodology

3.3.3.1 Well Locations

In order to define baseline groundwater quality, monitoring wells will be installed in the glacial sediments and in the bedrock. A total of 16 wells at six locations is planned. The locations of the well nests are shown on Figure No. 3-2. Six


BLACKBERRY LANE
SEDIMENTATION BASINS
MW-102 A & B
TYPE I WASTE ROCK & OVERBURDEN
N
TOPSOIL
MW-103 A, B, & C
STATE HIGHWAY 27
OPEN PIT
MW-104 A, B, & C
MW-105 A, B, & C
TYPE II WASTE ROCK
MW-100 A & C
FLAMBEAU RIVER
MW-101 A, B, & C
JENSEN LANE
RAILROAD SPUR
LEGEND
WATER TABLE WELL
DRIFT/SANDSTONE PIEZOMETER
SHALLOW BEDROCK PIEZOMETER
KENNECOTT FLAMBEAU PROJECT
FIGURE NO. 3-2
BASELINE
MONITORING WELL LOCATIONS
SCALE: 1" = 500'
DATE: 10/7/87
PREPARED BY: FOTH & VAN DYKE

water table wells in the glacial drift, five deeper piezometers in the glacial sediments and/or sandstone, and five piezometers in the shallow Precambrian rock are planned.

3.3.3.2 <u>Drilling Methods</u>

The soil borings for the drift/sandstone wells will be drilled whenever possible using hollow stem augers. Rotary wash with bentonite drilling fluid, will likely be necessary for deep borings if boulders are prevalent. The soil borings will be sampled at five foot intervals using a split spoon. Blow counts will be recorded.

A qualified geologist will supervise all drilling and sampling operations and log all soil borings. All samples will be described and classified according to the Unified Soil Classification System. Texture (grain size distribution), structure, color and geologic origin will be noted.

The holes for the shallow bedrock wells will extend into the Precambrian rock approximately 30 feet. Continuous cores of the Precambrian rock will be obtained. The cores will be logged, including geologic description, fracture frequency, rock quality designation and percent recovery. The dip of fractures, presence of weathering along joints and fractures, and the presence of secondary vein fillings will also be recorded.

3.3.3.3 <u>Well Installation</u>

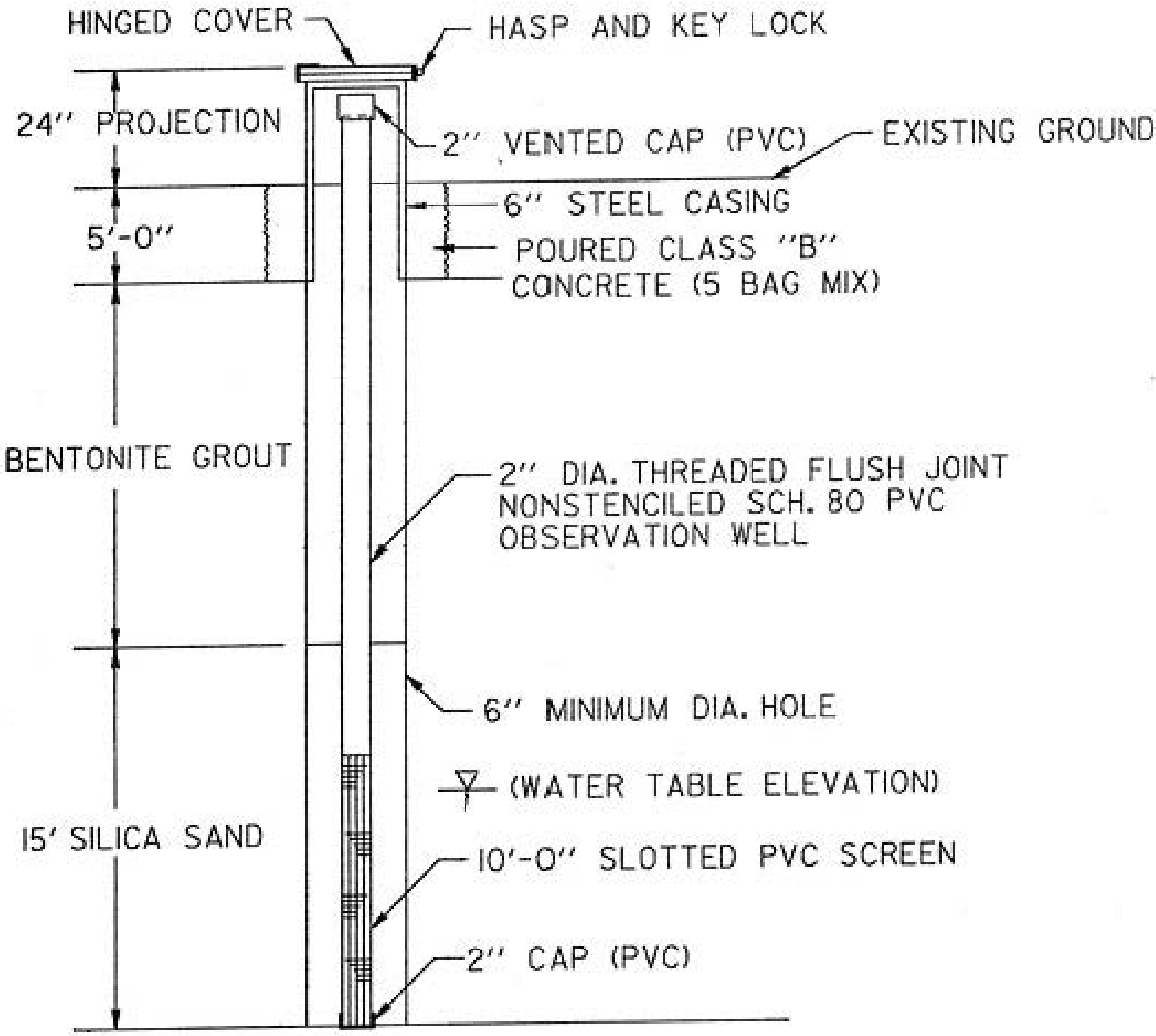
Guidelines contained within proposed NR 141 will be followed in well construction. All wells will be constructed of two-inch inside diameter flush joint threaded schedule 80 PVC casing fitted with a 5 to 10 foot length of factory slotted (0.010 slot) schedule 80 PVC screen.

The annular space of the monitoring wells will be backfilled with a suitable clean sand. Grain size analysis information on the sand backfill will be provided in the hydrogeologic report. In the piezometers, a bentonite pellet seal at least two feet thick will then be placed above the sand chamber. A bentonite grout will be emplaced by means of a tremie pipe from the top of the bentonite pellets or silica sand to about five feet below the ground surface to seal the annulus. The remainder of the hole will be grouted with neat cement and a six inch diameter protective casing with locking cap will be installed. Each PVC riser will be fitted with a vented cap to permit equilibrium with atmospheric conditions. A sloped concrete apron will be placed around the casing to prevent runoff from entering the well. Figure Nos. 3-3 and 3-4 are details showing how the monitoring wells will be constructed. Prior to emplacement, well casing and screens will be steam cleaned to remove all oils, grease and waxes.

Upon completion of monitoring well installation, the wells will be developed by surging and pumping until the fluid runs clear. The use of nonformation water during development will not be allowed.

Drilling tools and equipment will be steam cleaned before commencement of field work.

FIGURE NO. 3-3



OBSERVATION WELL DETAIL

NOT TO SCALE

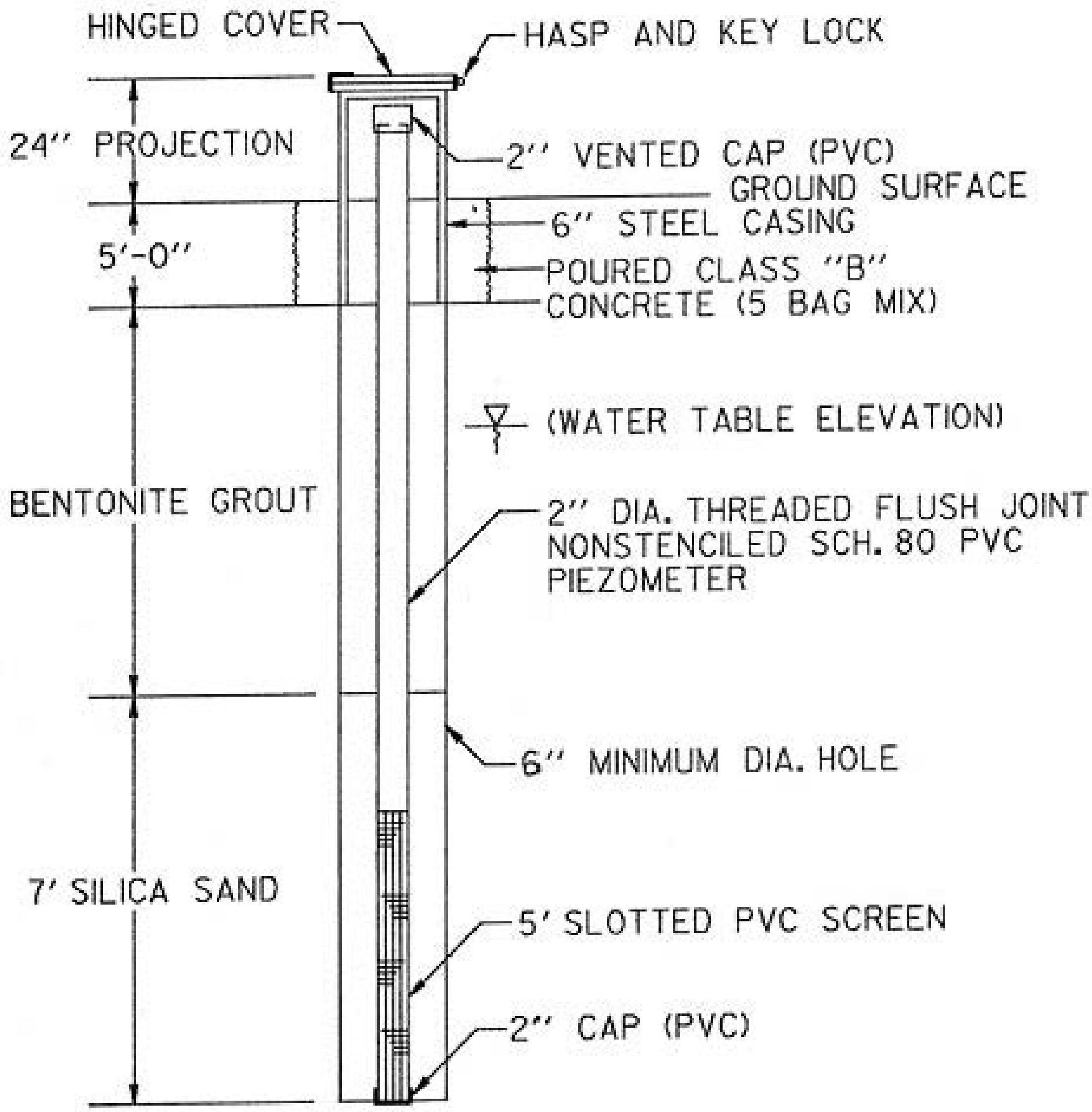
Foth & Van Dyke

Geosciences & Environmental Management Division

M.J.O. 8/28/87

87K10

FIGURE NO. 3-4



PIEZOMETER WELL DETAIL

NOT TO SCALE

Foth & Van Dyke

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3.3.3.4 Surveying

The location of each well will be surveyed to establish both vertical (ground surface and top of casing with locking cap off elevations) and horizontal (coordinates) control. Vertical control shall be established to 0.01 feet. Horizontal control shall be established to 0.1 feet. A qualified survey crew will perform the survey work.

3.3.3.5 In-Situ Permeability Testing

Field permeability tests will be performed on all monitoring wells to measure the permeability of in-place materials. Bail-down tests will be performed in the water table observation wells, and both bail-down and slug tests performed in the piezometers. Data will be analyzed according to methods presented in the text, Groundwater by Freeze and Cherry, 1979.

3.3.3.6 Groundwater Sampling

Groundwater monitoring wells/piezometers will be sampled monthly for 12 consecutive months. This will determine baseline water quality. WDNR personnel will be notified prior to each round so that they may observe procedures and/or split samples as necessary.

Sampling procedures will be consistent with those published in the WDNR PUBL WR-153-87, Groundwater Sampling Procedures Guidelines.

Prior to sample collection, each well will be purged by removing four times the volume of water in the monitoring well or until the well is dewatered, whichever comes first. The wells will be purged with a dedicated PVC bailer. In the piezometers, water will be drawn from above the screen in the uppermost part of the water column such that fresh water from the screen moves upward. Detailed field logs of evacuation procedures will be maintained.

Subsequent to purging, samples will be removed with the same dedicated PVC bailer used for purging.

Table No. 3-1 lists chemical parameters, preservatives, sample volume requirements, holding times and detection limits for the program.

For the category, "other parameters", sampling will proceed for the initial two months. If, after that time, any of the parameters in this category are either nondetectable or present only at nonsignificant levels, then those parameters will be dropped from the program.

TABLE NO. 3-1

BASELINE GROUNDWATER MONITORING ANALYTICAL PARAMETERS

PARAMETERS	SAMPLE VOLUME (ml)	PRESERVATIVES	HOLDING TIME	DETECTION LEVELS (mg/l)
(Primary Drinking Water Standards)				
Arsenic	200	HNO3	6 Months	<0.005
Barium	100	HNO3	6 Months	<1.0
Cadmium	50	HNO3	6 Months	<0.001
Chromium, Total	50	HNO3	6 Months	<0.005
Lead	50	HNO3	6 Months	<0.005
Mercury	500	HNO3	28 Days	<0.0002
Nitrogen, Nitrate/Nitrite	100	COOL 4°C+H2SO4	28 Days	<0.01
Selenium	500	HNO3	6 Months	<0.001
Silver	50	HNO3	6 Months	<0.005
Sodium	50	HNO3	6 Months	<1.0
(Secondary Drinking Water Standards)				
Chloride	100	NA	28 Days	<1.0
Copper	50	HNO3	6 Months	<0.08
Fluoride	100	NA	28 Days	<0.2
Iron	50	HNO3	6 Months	<0.1
Manganese	50	HNO3	6 Months	<0.05
pH (Field)	NA	NA	Field	NA
Sulfate	100	COOL 4°C	28 Days	<10
Soilids, Total Dissolved	100	COOL 4°C	48 Hours	<1.0
Zinc	50	HNO3	6 Months	<0.05
(Indicator Parameters)				
Alkalinity, Total	100	COOL 4°C	14 Days	<1.0
Calcium	50	HNO3	6 Months	<1.0
C.O.D.	50	H2SO4	28 Days	<5.0
Hardness, Total	100	HNO3	6 Months	<1.0
Spec. Cond. (Field)	NA	NA	Field	NA
Magnesium	50	HNO3	6 Months	<1.0
Temperature (Field)	NA	NA	Field	NA
(Other Parameters)				
Aluminum	50	HNO3	6 Months	<0.01
Beryllium	50	HNO3	6 Months	<0.001
Cobalt	50	HNO3	6 Months	<0.05
Molybdenum	50	HNO3	6 Months	<0.005
Nickel	50	HNO3	6 Months	<0.001
Thallium	50	HNO3	6 Months	<0.005
Tin	50	HNO3	6 Months	<0.01
Titanium	50	HNO3	6 Months	<0.05
Uranium	200	HNO3	6 Months	<0.02

NOTE: NA = Not Applicable

The following Primary and Secondary Drinking Water Standard parameters will not be monitored:

Primary	Secondary
Endrin	Color
Lindane	Corrosivity
Methoxychlor	Foaming Agents MBAS
Toxaphene	Odor
2,4-D	
2,4,5-TP (Silvex)	
Radium	
Gross Alpha	
Gross Beta	
Turbidity	
Coliform Bacteria	
Trihalomethanes	

These parameters are not commonly related to mining operations. Also, they are not routinely required parameters for groundwater monitoring at other types of waste sites in Wisconsin.

Water samples will be poured from the bailer into containers specifically prepared for the given parameter(s). Metal sample aliquots will be filtered in the field prior to acidification. These samples will be passed through a 0.45 micron membrane.

Conductivity, pH and temperature readings will be performed at the well head. Field observations of color, odor and turbidity will also be noted.

Field log sheets will be maintained by the field sampler. The following will be documented on these sheets:

1. Well number and location;
2. Well depth;
3. Depth to static water level and measurement technique;
4. Well evacuation procedure and equipment;
5. Sample collection date and time;
6. Well sampling sequence;
7. Types of sample containers used and sample identification numbers;
8. Preservatives used;
9. Parameters requested for analysis;
10. Field analysis data and methods;
11. Sample distribution and transport(s); and
12. Name of sample collector.

Additional information on these, and other quality control and quality assurance procedures, can be found in Section 4.0 of this document.

3.3.4 Data Presentation Formats

Well locations will be indicated on a map and in tabular form. Well construction details and boring logs will be presented in tabular format and in drawings. Chemical analyses will be presented in tabular and graphical formats.

3.3.5 Schedule for Field Data Collection

Installation of groundwater monitoring wells will commence in September of 1987 with sampling to commence in October 1987. In-situ permeability tests will be performed in October 1987.

3.3.6 Key Project Personnel

Boyd N. Possin, Senior Hydrogeologist with Foth & Van Dyke, will be responsible for the collection, interpretation and presentation of data relating to the groundwater database.

3.4 Baseline Surface Water and Sediment Monitoring

3.4.1 Existing Data Summary and Evaluation

The existing surface water quality data may be separated into two parts, that which was collected monthly from 1970-1973 for the initial mine application and EIR, and that which was collected semi-annually from 1977-1984 for Kennecott's own use.

The water quality data are of questionable value due to possible quality control problems. Samples may not always have been properly preserved in the field in accordance with present day standards and certain laboratory procedures were used that may also not have been in accordance with present day standards. Therefore, the existing surface water quality data will not be used for the current proposed project.

Continuous flow data on the Flambeau River have been recorded by the U.S. Geological Survey (U.S.G.S.) since the 1950's at the Thornapple gaging station approximately six miles downstream of the site. These are the discharge data that the previous investigations have relied upon.

A comparison of the Flambeau River watershed areas as measured at the Thornapple U.S.G.S. site and the proposed mine site is 1,761 and 1,736 square miles, respectively, a 1.4% difference. Clearly then, flows in the river do not change significantly between the site and the Thornapple U.S.G.S. monitoring location. Thus, the past surface water flow data will be usable, and any future data from this station also ought to be sufficient, to reasonably represent surface water flows past the site. Over time, a stage/discharge relationship will be developed between the site's staff gage (to be installed), and the Thornapple discharge readings, thus providing more convenient flow data to the on-site samplers.

Flow data were also collected on two intermittent tributary streams that will be impacted by the proposed project. These are referred to as streams A and B in the previous EIS. In those investigations, the weir-measured maximum flows during the year 1973 were 1.0 and 1.4 cfs, respectively.

No sediment characterization data were collected in the previous investigations.

3.4.2 Data Requirements

The surface water and sediment evaluation should include the sampling and analysis of both surface waters and river sediments, and measurements of surface water flow.

Upstream and downstream locations should be sampled on a monthly basis for a year to define baseline chemistries in the Flambeau

River. The sediments should also be sampled in the Thornapple Dam pool and, if possible, upstream of the site for the purpose of defining baseline chemistry.

All water sampling episodes should be accompanied by a corresponding flow measurement in the river. In this way, any relationships between baseline surface water quality and the hydrologic characteristics of the Flambeau River watershed will be noted.

The flow work on the tributary streams that was conducted in 1973 seems to be adequate for the purposes of the proposed project. Therefore, no additional data need be collected on these streams.

3.4.3 Methodology

3.4.3.1 Surface Water Sample Collection

3.4.3.1.1 Location

The location of each sampling point has been chosen to determine the present conditions surrounding the mining site and to provide background information.

The first point will be located at the end of Blackberry Lane. This site is immediately upstream from the mining activity and will be used to determine the background chemistry in the Flambeau River.

The second point will be at Port Arthur. This site is approximately 2.5 miles downstream from the proposed mine. This is far enough to include a well-mixed sample from all possible point and nonpoint discharges from the mine site, and yet close enough to prevent influences from other sources further downstream.

3.4.3.1.2 Parameters

Table No. 3-2 lists chemical parameters, preservatives, sample volume requirements, holding times, and detection limits for the program.

3.4.3.1.3 Frequency

Two sampling points will be monitored on a routine basis for one year. Each point will be sampled once each month at approximately the same time of the month.

3.4.3.1.4 Method of Sample Collection

Samples to be analyzed from each sampling location will be a composite of three grab samples taken at three locations along a cross section of the stream. The grab samples taken from each site will be collected from the following locations:

- One third of the distance from the east shore to the center of the stream;

- Midway in the stream channel; and

TABLE NO. 3-2

ANALYTICAL PARAMETERS FOR SURFACE WATER SAMPLES

PARAMETERS	SAMPLE VOLUME (ml)	PRESERVATIVES	HOLDING TIME	DETECTION LEVELS (mg/l)
Alkalinity, Total	100	COOL 4°C	14 Days	<1.0
Aluminum	50	HNO_3	6 Months	<0.01
Arsenic	200	HNO_3	6 Months	<0.005
Barium	100	HNO_3	6 Months	<1.0
Beryllium	50	HNO_3	6 Months	<0.001
B.O.D	1,000	COOL 4°C	48 Hours	<6.0
Cadmium	50	HNO_3	6 Months	<0.001
Calcium	50	HNO_3	6 Months	<1.0
Carbon, Total Organic	50	H_2SO_4	28 Days	<1.0
Chloride	100	NA	28 Days	<1.0
Chlorophyll-a	1,000	FIELD FILTER	NA	NA
Chromium, Hexavalent	100	COOL 4°C	24 Hours	<0.05
Chromium, Total	50	HNO_3	6 Months	<0.005
Cobalt	50	HNO_3	6 Months	<0.05
Copper	50	HNO_3	6 Months	<0.08
C.O.D.	50	H_2SO_4	28 Days	<5.0
Fluoride	100	NA	28 Days	<0.2
Hardness, Total	100	HNO_3	6 Months	<1.0
Iron	50	HNO_3	6 Months	<0.1
Lead	50	HNO_3	6 Months	<0.005
Magnesium	50	HNO_3	6 Months	<1.0
Manganese	50	HNO_3	6 Months	<0.05
Mercury	500	HNO_3	28 Days	<0.0002
Molybdenum	50	HNO_3	6 Months	<0.005
Nickel	50	HNO_3	6 Months	<0.001
Nitrogen, Ammonia	500	H_2SO_4	28 Days	<0.03
Nitrogen, Nitrate/Nitrite	100	COOL 4°C+H_2SO_4	28 Days	<0.01
Nitrogen, Total Kjeldahl	1,000	H_2SO_4	28 Days	<1.0
Oxygen, Dissolved	NA	NA	Field	NA
pH (Field)	NA	NA	Field	NA
Selenium	500	HNO_3	6 Months	<0.001
Silver	50	HNO_3	6 Months	<0.005
Sodium	50	HNO_3	6 Months	<1.0
Solids, Total Dissolved	100	COOL 4°C	48 Hours	<1.0
Solids, Total Suspended	500	COOL 4°C	7 Days	<8.0
Spec. Cond. (Field)	NA	NA	Field	NA
Sulfate	100	COOL 4°C	28 Days	<10
Temperature (Field)	NA	NA	Field	NA
Thallium	50	HNO_3	6 Months	<0.005
Tin	50	HNO_3	6 Months	<0.01
Titanium	50	HNO_3	6 Months	<0.05
Uranium	200	HNO_3	6 Months	<0.02
Zinc	50	HNO_3	6 Months	<0.05

NOTE: NA = Not Applicable

- One third of the distance from the west shore to the center of the stream.

Each sampling site will be marked on shore so that the same site will be used each time. Samples will be collected, at approximately one half the distance to the bottom of the stream, in a nonmetallic sampler that is designed to maintain the integrity of the sample, including the preservation of gases. Specifically, the type of sampler to be used is a Kemmerer bottle.

Adequate sample volume will be collected, as necessary, to allow for duplicate analyses and for splitting the sample with the WDNR.

The WDNR will be notified two weeks prior to each sampling period so that they have the option to be present to witness the sampling. This will be particularly important for the first sampling period to confirm the validity of the sampling locations. It is anticipated that samples will be routinely split with WDNR on a quarterly basis.

The samples will be split into sample containers immediately after collection and preservatives, per Table No. 3-2, will be added at that time.

At the time of collection, a Chain-of-Custody form will be initiated. Appendix A details the Chain-of-Custody procedures that will be followed.

A field blank will also be included with each set of samples. This blank will accompany the sample collection team in the field. It will be run through the sampling device and preserved in the field in the same manner as the samples are handled. The blank will consist of lab grade deionized water.

Sample containers and preservatives will be prepared by Foth & Van Dyke. For purposes of splitting samples with the WDNR, a sufficient volume will be collected in one container, mixed, and then poured into separate sample containers for the respective laboratories. Those samples which must be kept cool will be put on ice immediately after sample collection. The ice will be maintained in transit to the laboratory. More detailed information on project quality control procedures is contained in Section 4.0 of this document.

3.4.3.2 Sediment Sample Collection

3.4.3.2.1 Locations

The purpose of the sediment evaluation will be to determine background levels of any metals in the sediment. This rationale will drive the choice of sampling locations. The physical structure of the stream bed may not allow for upstream sampling of sediments as there are few, if any, alluvial deposits between the mine site and the dam located in Ladysmith, Wisconsin. Downstream sites will be chosen based on the location of alluvial deposits. These will most likely be in the backwater pool created by the Thornapple Dam.

The first part of the overall study will be to define the stream characteristics and map the stream habitats. During this phase of the data collection process, decisions will be made, in consultation with WDNR personnel, as to the exact locations for sediment sampling.

3.4.3.2.2 Parameters

The analyses that will be completed on the samples are listed in Table No. 3-3.

TABLE NO. 3-3

Analytical Parameters for Sediment Samples

Arsenic	Manganese
Cadmium	Mercury
Chromium, Total	Particle Size
Copper	Solids, Total
Iron	Sulfur, Total
Lead	Zinc

3.4.3.2.3 Frequency

At this time it is expected that approximately five to ten samples will be collected on a one time basis.

3.4.3.2.4 Method of Sample Collection

The sampling methods and equipment which will be used in the collection of sediment samples will be determined by the sediments' physical characteristics and thickness of the alluvial deposits. Sampling will be done in a manner that will isolate the layers of deposit for analysis.

The top layer, approximately the top two inches, will be analyzed to characterize that part of the sediment blanket that could contain concentrations of metals. This sample will be collected by drawing off the top layer of sediment with a small pump. Although this method will not lend itself to true values in the analysis of percent solids, it is the only practical way to collect light surface sediments.

Core samplers and dredges will be used to collect the deeper layers of sediment to a maximum depth of five feet. Again the exact type of sampling procedures will be dictated by the sediment characteristics. These samples will be divided into sections based on any distinct layers that may be present in the natural stratification.

The sampling equipment, made of a nonmetallic material, will be rinsed and cleaned with laboratory grade water prior to sampling at each site. As with the surface water samples, a Chain-of-Custody document will be used. It is not anticipated that the sediment samples will be split with WDNR.

3.4.3.3 Flow Measurements

Flow is currently monitored downstream of the site, at the Thornapple Dam, by the U.S. Geological Survey. Since the flow at this location is similar to flow at the site, a stage versus discharge relationship will be established between a site staff gage and the Thornapple station. The site gage will be read during all surface and groundwater sampling episodes.

3.4.4 Data Presentation Format

Water quality and flow information will be presented in graphic and tabular form. Graphs will be prepared using PC-spreadsheet software with plotter and laser printer output.

3.4.5 Schedule for Field Data Collection

Surface water sampling and flow monitoring will begin in October of 1987 and continue on a monthly basis for one year. Sediment sampling will be conducted during October 1987.

3.4.6 Key Project Personnel

Mr. Gerald J. Berg, of Foth & Van Dyke, will manage the surface water program. He will be assisted by Mr. Boyd N. Possin, also of Foth & Van Dyke, who will manage the flow aspects of the data collection program.

3.5 Biological Environment

3.5.1 Existing Data Summary and Evaluation

Biological data utilized in the preparation of the EIR and the EIS for the original 1970's project is available for use in the current study, to the extent they are relevant and valid. Such data can be found in file numbers KEN-20 through 29, as listed in the NOI Bibliography.

The terrestrial communities in the vicinity of the open pit were characterized in the early 1970's by an extensive floral study titled "The Flora and Plant Communities of an Area in Rusk County Designated for a Copper Mine Operation", R. Matson, 1974 (KEN-25). This study provides quantitative and compositional data on the eight major plant communities in the proposed mining area. Species lists for all communities are provided. These data are adequate, with the addition of verification efforts and new mapping, for use in the EIS.

Terrestrial vertebrates were studied both quantitatively and qualitatively in the 1970's. Observation reports and other studies by Gorla, 1972, 1973, Piotrowski, 1972a, 1972b and Rongstad, 1979 are available for mammals, birds and herps. These data should be augmented to address changes in habitats since the 1970's.

The aquatic communities were characterized for the Flambeau River upstream and downstream of the open pit area by Dames & Moore in their 1973 report titled "An Aquatic Ecological Study of the Flambeau River and Its Tributaries Near the Proposed Copper Mine Site, Rusk County, Wisconsin." This report was the basis for the EIS on the original project and characterized the river biota (fish, benthos, aufwuchs, plankton and water quality) based on a one week sampling effort (two month exposure for the artificial substrates) in the spring of 1973 (KEN-33). These data should be supplemented with information from summer and fall seasons.

The existing soil/geological environment has levels of heavy metals that are associated with the presence of the orebody. Biological communities in close proximity to these sources of heavy metals have the potential for accumulating and concentrating unusually high levels of these elements. There has been considerable attention previously given to this phenomenon on the proposed mine site and the issue was addressed in the original EIR and EIS.

Tissues from selected plant species were collected and analyzed in 1975 as reported in the "Initial Heavy Metal Monitoring for the Flambeau Mining Corporation" by R. Matson (1975, KEN-25). These samples were taken near the previously proposed waste containment area located approximately one mile to the south and presumably out of the influence of the orebody. Tree tissues over the orebody were also sampled for Cu, Pb and Zn.

In 1979 small mammal tissues were analyzed for heavy metals by Rongstad, 1979 as part of a University of Wisconsin research project.

In 1975, crustacean tissue samples from the Flambeau River were analyzed for heavy metals (Cu, Zn, Mn, Pb, Mn, Ni, Co, Cd) by the University of Minnesota (Hopwood, 1975, KEN-32). Tissue samples from seven fish collected from the river at the site were analyzed by Dames & Moore for As, Cu, Cr, Hg, Mn, Pb and Zn.

The existing database related to biological communities provides a relatively comprehensive characterization of the proposed mine area. Terrestrial communities are defined and described.

Extensive species are available for comparison and determination of the probability of the occurrence of endangered species. The data were collected in a scientifically appropriate manner and most were accepted for use in the original project's EIS. For the most part, the existing biological database is acceptable for descriptive and impact assessment purposes. However, the early successional communities of the 1970's have matured and currently present new associations.

Likewise, verification of the existing data is desirable in some cases because the lowering of the river level, due to the removal of the old Port Arthur dam, which was addressed in the EIS as having an effect on the plant communities and habitats in the western portion of the site, has continued to influence community composition.

Aquatic communities were characterized based on data from the spring season. Certain indicator groups that are present in the river have trends in population levels and variable life forms that are important from a seasonal standpoint.

Metal accumulation in the biota was considered during the 1970's and was addressed in the original project's EIR and EIS. Verification of these data and expansion of the database to include other groups important in the food chain and a control site is desirable.

3.5.2 Data Requirements

The existing biological database established in the 1970's represents a comprehensive background for the project area. However, additional field data is required to further characterize the existing biological environment in order to identify changes since the mid 1970's and to verify the existing database. The additional work should include:

- Resurvey/survey of floral communities in the project area to verify and further characterize the major plant associations and determine the status of endangered and threatened plant species known from the region.

- Because there are no known occurrences of endangered or threatened terrestrial vertebrates on the site, the trapping/observation program should concentrate on the habitats that have changed since the 1970's and the wetland areas identified in the wetlands inventory. Small mammal trapping and bird transects should be conducted in spring and autumn seasons. A spring observational survey of amphibians should also be conducted.

- Plant and animal tissues from terrestrial communities overlying and north of the west end of the orebody, and at a representative "control" site, should be sampled and analyzed for heavy metals. Two ecotypes, mesic deciduous forest and disturbed/early successional communities, should be studied in the vicinity of the west end of the proposed open pit area. Soil invertebrates and small mammals should be collected from these locations for chemical analysis. The west end of the orebody and areas immediately north of the proposed pit should be the preferred on-site sampling locations for several reasons:

- Overburden is thinnest at this point;

- The selected areas are over the orebody or hydrologically downgradient of it; and

- Biological communities available represent both the most mature areas on the site and relatively recently disturbed areas, both of which are relevant from a scientific and reclamation standpoint.

- In conjunction with the physical and chemical characterization of river sediments, benthic fauna and fish should be sampled upstream and downstream of the site to determine community composition and the possibility of any heavy metal concentrations.

3.5.3 Methodology

3.5.3.1 Terrestrial Biology

Terrestrial floral studies performed in the 1970's and summarized in the EIR defined eight habitats based on floral composition and land use in the original, larger project area. Of these, the following occur in the reduced study area:

- Mixed, Lowland, Deciduous - Coniferous Forest;
- Shrub Swamp (along alternate Rail Right-of-Way);
- Mixed Upland Deciduous - Coniferous Forest;
- Old Field;
- Meadow (along Flambeau River); and
- Disturbed Areas - Residential, Field.

Each of these ecotypes will be qualitatively sampled and observed to update the existing database. Special attention will be given to those areas inventoried as wetlands. In addition, a number of selected sites will be studied in depth to determine existing metal levels in the soils and terrestrial food chain as discussed later in this Section. Color aerial photography taken in 1987 will be used to map all major ecotypes and field surveys will verify and refine these descriptions.

3.5.3.1.1 Floral Communities

All plant communities on the site will be qualitatively observed and sampled to verify the work done previously (Matson, 1973). Qualitative surveys will be accomplished in autumn 1987, and spring and summer of 1988 to document changes in the extent of floral associations identified and mapped in the 1970's. In addition, the surveys will verify and augment the existing species list, and determine the status of protected species on the project site.

3.5.3.1.2 Terrestrial Vertebrates

The available habitats on-site will be evaluated for potential use by large and small mammals. Field surveys to detect and describe sign for large mammals will be accomplished in all seasons.

Small mammals will be trapped using baited Sherman live traps and museum special snap traps. If shrews are not readily captured by these methods, pit traps in dense litter areas will be set. Transects of 50 traps across all ecotypes will be set in the spring/summer period for a total of 500 trap nights for the site. All pertinent data for each individual (total length, tail length, ear length, hind foot length, total weight, age, sex, species, trap location) will be recorded. See Figure No. 3-5 for sampling locations.

Birds will be studied using visual and audial observation methods along transects crossing all ecotypes, including the Flambeau River corridor. Each transect will be observed during a morning and evening survey in late September-early October, in late April-early May, and in late June-early July. Transects will last for one hour each. All audial and visual verifications will be recorded in field logs.

The active eagle nest located approximately one mile southwest of the site presents a need to document use of the site and the river bordering the site by the nesting pair and their young. Although the available habitats appear to present no special or unique opportunity for feeding or roosting by eagles, up to four

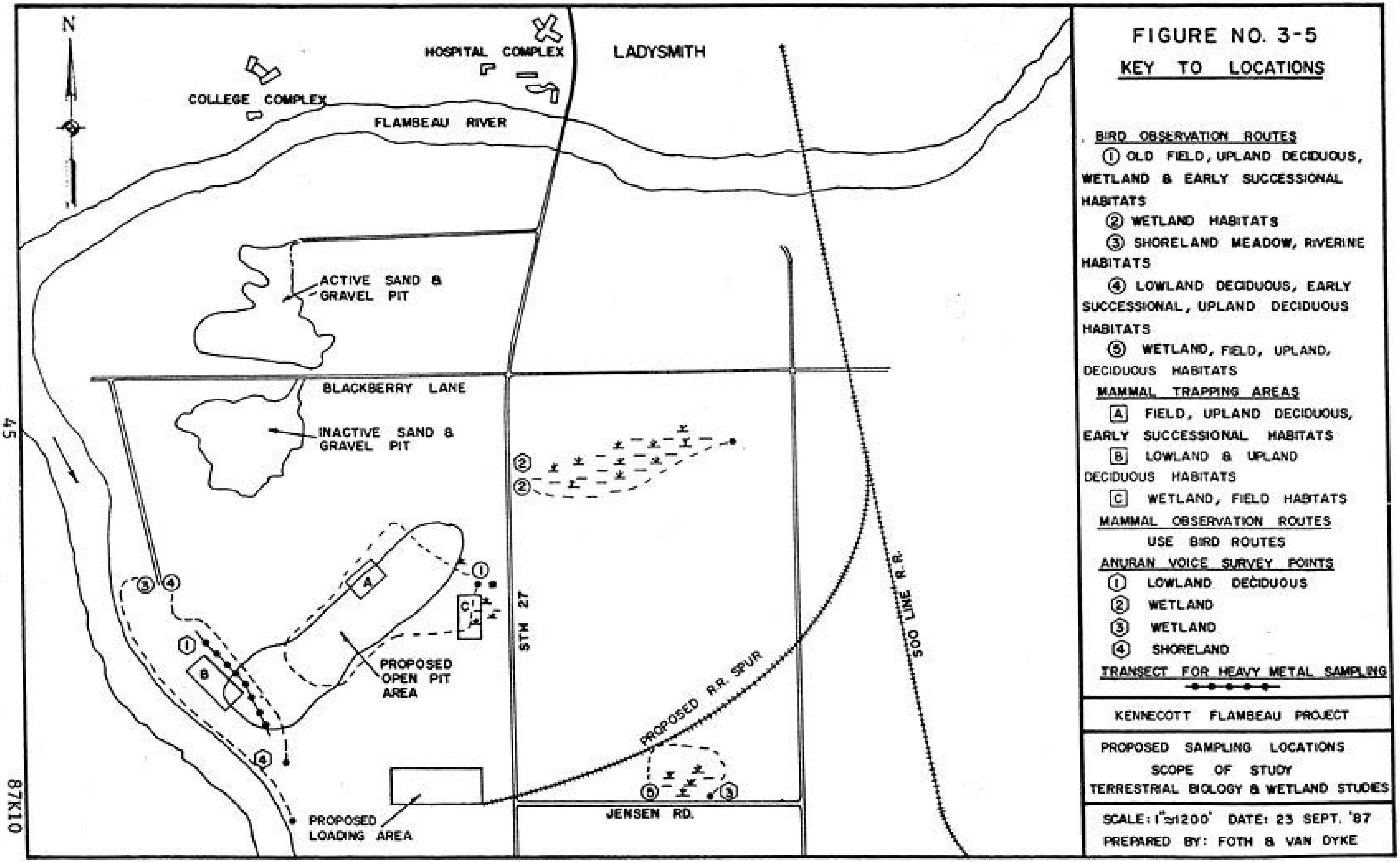
FIGURE NO. 3-5
KEY TO LOCATIONS
BIRD OBSERVATION ROUTES
① OLD FIELD, UPLAND DECIDUOUS, WETLAND & EARLY SUCCESSIONAL HABITATS
② WETLAND HABITATS
③ SHORELAND MEADOW, RIVERINE HABITATS
④ LOWLAND DECIDUOUS, EARLY SUCCESSIONAL, UPLAND DECIDUOUS HABITATS
⑤ WETLAND, FIELD, UPLAND, DECIDUOUS HABITATS
MAMMAL TRAPPING AREAS
A FIELD, UPLAND DECIDUOUS, EARLY SUCCESSIONAL HABITATS
B LOWLAND & UPLAND DECIDUOUS HABITATS
C WETLAND, FIELD HABITATS
MAMMAL OBSERVATION ROUTES
USE BIRD ROUTES
ANURAN VOICE SURVEY POINTS
① LOWLAND DECIDUOUS
② WETLAND
③ WETLAND
④ SHORELAND
TRANSECT FOR HEAVY METAL SAMPLING
KENNECOTT FLAMBEAU PROJECT
PROPOSED SAMPLING LOCATIONS
SCOPE OF STUDY
TERRESTRIAL BIOLOGY & WETLAND STUDIES
SCALE: 1"≅1200' DATE: 23 SEPT. '87
PREPARED BY: FOTH & VAN DYKE
N
HOSPITAL COMPLEX
LADYSMITH
COLLEGE COMPLEX
FLAMBEAU RIVER
ACTIVE SAND & GRAVEL PIT
BLACKBERRY LANE
INACTIVE SAND & GRAVEL PIT
PROPOSED OPEN PIT AREA
STH 27
SOO LINE R.R.
PROPOSED R.R. SPUR
JENSEN RD.
PROPOSED LOADING AREA

man-hours of time will be spent observing the use of the site and river during each bird survey period (autumn, spring and summer). Number of birds, time of day, behavior and observation time on the site will be recorded. Any other observations of eagles during other field efforts will also be recorded.

Amphibians and reptiles observed during other field efforts will be recorded. A spring anuran voice survey will be conducted in late evenings during the spring and summer bird surveys at each wetland in the project area.

3.5.3.1.3 <u>Background Heavy Metal Concentrations in Terrestrial Ecosystem</u>

Establishment of background heavy metal concentrations in the terrestrial ecosystem is important for long term monitoring and reclamation purposes. The existing database on metals concentrations (Cu, Pb, Zn) in terrestrial communities includes data from soils, plant tissues and small mammals. The purpose of the sampling and analysis program described here will be to evaluate, verify, and supplement the existing data by sampling tissues from the areas studied previously. Additional sampling and analysis will depend on these findings.

During the data collection process, two tissue-sampling collection sites will be established over the west end and immediately north of the orebody. Sites will be selected from these habitats:

- Mixed Lowland Forest (Area of Groundwater Surcharge - Seep);
- Mixed Upland Forest; and
- Disturbed Area - Old Field.

From each site, the following samples will be collected in the June-July period:

- 3 tree species - second year twigs (possibly hemlock, aspen, black ash);
- 3 deep root or wildlife forage species (to be selected based on initial survey results);
- 2 soil samples for invertebrate extraction in the laboratory;
- 2 substrate samples from topsoil - duff horizon; and
- 3 small mammals (mice, shrews) if collected during trapping effort.

Plant tissues selected in the field will be collected by hand. Each individual discrete or composite sample will be sealed in a clean plastic bag in the field. Each sample will have a separate identification label. Following every collection period, each sample will be washed with distilled water to remove dust and other surface contaminants and then sealed into another clean plastic bag. Samples will be frozen until just prior to laboratory preparation.

Immediately prior to laboratory analysis, each sample will be oven-dried, weighed and acid-digested. The sample will be brought to a standard volume with distilled water prior to analysis. Refer to Section 4.0 for laboratory test methods and quality assurance related to laboratory handling, testing and reporting.

All samples will be preserved by freezing in plastic containers. Metals to be analyzed are Hg, Ni, Cu, Pb, Ag and Zn. One sample from each species will be tested for Uranium. We anticipate one sampling period. In all cases, except mammals, total biomass will make up the sample. Where sufficient biomass is available, sample size will be selected to assure minimum detection limits. Pooling of some samples may be required to obtain adequate biomass. Mammals will have the contents of their GI tract removed prior to whole body tests. The following schedule representing the minimum number of samples is proposed:

- Second year twigs from trees	12 samples
- Herbs (whole plant, roots washed)	8 samples
- Soils (composite of topsoil)	6 samples from 6 sites
- Soil invertebrates (possibly pooled)	2 samples

- Small mammals (pooled by species)

Whole body	3 samples
Liver	3 samples
Hair	3 samples
Kidneys	3 samples
Total Samples	40

A control site approximately one half mile south of the mine site, and currently owned by Kennecott, will be used. The area to the south of the pit is out of the hydrogeological influence of the orebody. Prior to specific site selection, soil and vegetation maps will be used to identify areas as similar as possible to the pit area. Sampling will essentially replicate the program above.

3.5.3.2 Aquatic Biology

The aquatic ecosystem of the Flambeau River will be investigated as described below. The investigation will be coordinated with the surface water and river sediment characterization studies addressed in Section 3.4 of this document.

The aquatic ecosystem study is designed to supplement existing background information that will be used for environmental impact assessment purposes. It will also establish certain background conditions that will be used to actually monitor the proposed mining operation.

3.5.3.2.1 Habitat Characterization - Sampling Site Selection

A habitat characterization program will be accomplished prior to any biological sampling. The habitat characterization program will be conducted in the field by an aquatic biologist and observed by WDNR fisheries personnel. The area to be evaluated includes the Flambeau River on the downstream side of the dam in Ladysmith to the Thornapple Dam - a stretch of about ten river miles. The aquatic habitat characterization procedure will be to float the river in early October and map habitats using aerial photographs which will be obtained in early September. Physical characteristics of the river that will be considered in sample station selection are:

- Type of sediment/substrate;
- Flow characteristics;
- Bank conditions;
- Adjacent land use (use, cover type, erosion evidence);
- Physical diversity;
- Extent of snags or other physical features; and
- Tributaries (flow, land use, etc.).

During the habitat characterization program, sampling stations will be selected. A station will be represented by a 20 feet wide cross section of the river, bank to bank. Transects as opposed to discrete sampling sites will be used because the Flambeau River at this location does not lend itself to discrete quantitative sampling methods. Stations will be selected using the following criteria:

- Location relative to site (estimate one upstream - three downstream);

- Comparability of upstream/downstream conditions;

- Available habitats in the cross section (maximize diversity at a station);

- Accessibility - ease of sampling; and

- Appropriateness depending on group (fish, invertebrates, etc.).

Stations for sampling invertebrates, the attached community, and fish will be selected. These stations may be different for each group depending on habitat characteristics. All habitats at each station will be mapped and a depth profile taken in cross section.

3.5.3.2.2 Invertebrates

Each invertebrate station selected during the habitat characterization described above will be sampled in late October-early November (pre-winter), in early spring (as soon after ice-out as practical), and in July-August (low flow). Methods will be "best available" depending on habitats. Dredges, surber samplers, drift nets and hand-picking will be used as appropriate. Available substrates in the Flambeau River are limited to pebble, cobble and boulder types for the most part. For this reason, quantitative methods will be difficult to employ. Standing biomass is expected to be minimal. Hand-picking will occur at each station until no new species are encountered for 15 minutes. Field logs will record Time-of-Day (TOD), air and water temperature, dissolved oxygen, specific conductivity, river discharge, depth profile in cross section, locations of discrete sampling (surber, dredges), methods, time spent at station and number and names of collectors.

If significant attached communities are present, they will be swept with drift nets and scraped into sample containers. Samples will be preserved and stored for laboratory identification. Any dredge samples will be washed through a U.S. Standard 30 sieve and the retained material preserved for future identification.

3.5.3.2.3 Fish

The Flambeau River in this area is not conducive to some traditional collecting methods due to stream velocity, habitat types and population densities suspected for the area based on previous work on the Chippewa River and the Flambeau near the site. Therefore, we propose to characterize the fishery on the basis of sampling in the fall and summer seasons by gill or fyke netting, electroshocking, and hook and line methods. Where hand seining is feasible, it will be employed. All habitats will be sampled. Anticipated per station sampling time will be:

- Gill or fyke netting — 2 nights each in fall and summer, and above and below the site;

- Hook and line — 36 person hours in early summer;
- Seining — As required to cover available area; and
- Electroshocking — 1 day/night each in fall and summer above and below the site.

Gill nets will be experimental type with mesh sizes ranging from 3/4" to 4" in five panels per net. Up to 300 feet of gill net will be used at each station. It is recognized that muskellunge and sturgeon occur in these waters. If gill netting efforts produce unacceptable mortality of these species, the continuation of this effort will be reconsidered. Nets will be set in deeper pool areas and checked at least twice each night. Fyke nets, if used, will have mesh size small enough to capture larger bait fish.

Hook and line sampling will be in the late spring/early summer of 1988 when water temperatures exceed 60°F so that small mouth bass will be active.

Electroshocking will be accomplished with a variable volt, boat mounted boomshocker during fall and summer periods if conditions permit. One day/night period each above and below the site will be dedicated to electroshocking. Fish will be measured and released. Specimens dedicated to the metals analysis will be retained.

3.5.3.2.4 Background Heavy Metal Concentrations in Aquatic Ecosystem

In order to verify previous background values in the Flambeau River for the heavy metals of potential concern (Hg, Ni, Cu, Pb, Ag, Zn, U), the attached algae - invertebrate - small forage fish (minnows) - predator fish - food chain will be sampled. Also, large forage species (Catastomids) will be sampled.

Invertebrates and attached algae will be collected using artificial substrates that will be located at two stations along the east shore of the river to be selected during the habitat characterization effort.

The substrates will be barbecue basket type and will be filled with native stones collected from the river bottom. The stones will be between one and four inches in diameter and will be scrubbed and washed with river water prior to setting.

Each basket will be anchored under water to the river bottom so as to maximize the surface area exposed to the river flow. Three baskets will be set at each location to increase the probability of recovery of one at each station. Exposure time will be initially two months during May and June. If, at the end of two months, insufficient colonization has taken place, a second basket will be allowed to remain for a third month.

Baskets will be surrounded by a drift net prior to removal in order to collect mobile or loosely attached organisms that may be lost during extraction from the river. A subsample of the stones from each basket will be cleaned by picking and scraping. All biomass will be preserved for taxonomic identification. Another subsample will be cleaned and sorted from one upstream and one downstream location for metals analysis according to the following categories where they are in sufficient quantity:

- Attached algae/macrophytes;
- Foraging invertebrates; and
- Predator invertebrates.

Fish for heavy metal analysis will be selected during the fall sampling. Specimens from one upstream and one downstream station will be frozen for laboratory sample preparation. Samples to be analyzed for metals will be:

- Large forage fish (catostomids)

    Fillets (2)
    Liver (2)

- Large omnivores (catfish)

    Fillets (2)
    Liver (2)

- Small forage fish (darters, minnows)

    Whole body (2)

- Predators (walleye, northern pike, bass)

  Fillets (2)
  Liver (2)

Washing, storage and preservation techniques for invertebrate, periphyton, and fish will be the same as described for plant tissues. Animal tissues will be frozen prior to laboratory analysis. Decisions on compositing samples will depend on collection location, sample size (preferred weight prior to digestion is 100 grams), and species relationships. For instance, whole body samples of small forage fish may be multiple species samples, but all will occupy the same functional niche in the ecosystem. Fish fillets will be prepared similar to preparation by a person who would eat them (i.e., the skin will be removed and only the muscle tissue will be used).

Metals to be analyzed under this program are Hg, Ni, Cu, Pb, Ag and Zn. One sample from each group will be tested for Uranium.

3.5.4 Data Presentation Format

All biological information will be presented in descriptive, tabular and graphic formats in keeping with generally accepted presentation styles for biological descriptions.

Typical data presentation formats where appropriate will be:

- Maps showing sampling site locations, habitat distribution and special features as they relate to the project site;

- Tables of species and relevant data such as frequency of occurrence, density, importance, standing biomass, status, seasonal use of area and habitat preferences;

- Graphs showing community structure and composition, seasonal trends and relationships to other environmental factors; and

- Narrative describing the sampling program methods, sites, communities, relationship to mining site and special or unique features.

3.5.5 Schedule for Field Data Collection

The biological data collection will occur in the autumn of 1987 and spring and summer of 1988.

3.5.6 Key Project Personnel

Biological studies will be performed by or under the direction of Tim J. Weyenberg, M.S., of Foth & Van Dyke. Consultants in specialty areas (e.g., taxonomy, ecology, raptors) will be used as required.

3.6 Blasting and Vibration

3.6.1 Existing Data Summary and Evaluation

Blasting is expected to occur during excavation of rock in the lower portions of the pit. Similar mining operations have been studied and the U.S. Bureau of Mines has extensive data on the effects of blasting. These data will be valuable in the assessment of blasting and vibration as they relate to the Flambeau Project.

3.6.2 Data Requirements

Data on expected blasting frequency and methods should be developed. Information on vibration effects, noise, and air pollution should be gathered from existing sites.

3.6.3 Methodology

The survey of background vibration levels will be accomplished at the most proximate receptor locations, including the STH 27 bridge, the Hospital Complex, and Mount Senario College. These measurements will be taken in October 1987 for the purpose of completing the blasting and vibration assessment. The survey will be completed using a portable seismograph.

Appropriate models will be selected to predict the effects of blasting on vibration and noise in the vicinity of the mine.

A general reconnaissance survey of structures in the project area will be made to determine distance from the pit and their general characteristics and construction. This information will be used to prepare a Pre-Blast Survey Plan.

3.6.4 Data Presentation Format

The data will be presented using tables, geologic cross sections, maps, graphs, computer print-outs, and narrative text sufficient to present and describe the methods, results, and conclusions of the studies.

3.6.5 Schedule for Field Data Collection

Field data for the background vibration survey and reconnaissance of structures will occur in October and November of 1987.

3.6.6 Key Personnel

Data gathering, evaluation and impact assessment of the effects of blasting and vibration will be directed by Dr. V. Rajaram. Dr. Rajaram has a Ph.D. in rock mechanics. His experience includes impact analysis of blasting for rock tunnel construction and mining projects.

3.7 Floodplain Evaluation

3.7.1 Existing Data Summary and Evaluation

As part of the 1970's site work, estimates of flood stage were made using flow data collected at the Big Falls gaging station, which is located upstream of Ladysmith at the Dairyland Dam. The 100-year recurrence flow was calculated to be 22,500 cfs, at 4.5 ft/sec. It was further calculated, using the Conger method, that the resultant flood crest would occur at elevation 1,098 feet above mean sea level.

The techniques used to derive these numbers likely have produced elevations that are moderately accurate. However, more recent investigations, completed to satisfy the requirements of the federal Flood Insurance Program, require calculation of elevations to the nearest 0.1 feet. This necessitated that the simulation of flooding be accomplished through the use of computer models, such as the U.S. Army Corps of Engineers' HEC-2 hydraulics model.

3.7.2 Data Requirements

The 100-year floodplain has not been identified in the area of the proposed mine site. It is possible that a portion of the western end of the site would encroach on a part of the floodplain that is essentially an embayment of an intermittent stream. It is not likely that encroaching upon this embayment would have any substantive effects on upstream flood levels. Nevertheless, a formal hydraulic modeling effort should more conclusively make this demonstration.

The data needed to undertake such an effort are, with one exception, already available. Hydrologic information on flows will be available from the Ladysmith Flood Insurance Study conducted just upstream of the site. Topographic information adjacent to the stream is available from detailed two-foot topographic mapping undertaken by Kennecott in the 1970's. The only piece of information that will have to be developed is stream channel depths along the modeling cross-sections.

3.7.3 Methodology

At least three cross-sections will be used in modeling river hydraulics with a HEC-2 computer program. The sections will be constructed using existing topographic maps and channel bottom information obtained from soundings taken by boat.

The techniques and procedures used in this program will be essentially the same as those used in conducting Federal Flood Insurance studies.

3.7.4 Data Presentation Format

A map will be prepared showing the floodplain configuration, and a profile prepared showing the 100-year flood elevation along the Flambeau River.

3.7.5 Schedule for Field Data Collection

The channel bottom information will be obtained during the first surface water sampling episode in October. The modeling will then be undertaken and finished before the end of 1987.

3.7.6 Key Project Personnel

The project manager of the modeling effort will be Mr. Mike Liebman, P.E. of Foth & Van Dyke. Mr. Liebman is a civil engineer who specializes in hydrology/hydraulics investigations.

3.8 Geotechnical Investigations

3.8.1 Existing Data Summary and Evaluation

Extensive coring of the orebody, as well as soil testing of the overburden over the orebody, has been accomplished in the area of the formerly proposed pit (KEN-46, 49, 50, 51, 52). However, the wall of the currently proposed pit is not at the same location as was proposed for the old pit. Therefore, the old information is of limited usefulness in evaluating the structural integrity of the currently proposed wall.

No geotechnical information exists regarding the engineering properties of the soils underlying the proposed railroad right of way, or the proposed waste rock storage areas.

3.8.2 Data Requirements

In the vicinity of the proposed pit wall, data must be collected in the overburden characterizing such slope stability engineering parameters as shear strength, Modified Proctor density, moisture content, grain size distribution, permeability and, if appropriate, Atterberg Limits. In the bedrock, information must be derived regarding fracture distribution, shear strength orientation, and continuity. Rock substance physical parameters need to be defined, including uniaxial and triaxial compressive strength, tensile strength, and density.

Along the railroad right of way and beneath the Type II waste rock storage pile, soil samples should be collected to characterize such parameters as shear strength, consolidation, density, moisture content, grain size distribution permeability and, if appropriate, Atterberg Limits.

The locations at which sampling is proposed to accomplish this testing are shown on Figure No. 3-6.

3.8.3 Methodology

Oriented continuous cores will be obtained from angled coreholes. Detailed geotechnical core logging will be performed including geologic descriptions, fracture attitude and frequency, rock quality designation, percent core recovery, core photography and point load strength. Rock samples will be preserved for laboratory strength determination. Drill stem packer testing will be conducted at selected depths to determine rock permeability. Head measurements will be made in adjacent coreholes during these tests to monitor the interconnection of the fracture network.

Soil samples will be obtained both by split-spoon and shelby tube techniques. Shelby tube samples will be used for testing shear strength, permeability and consolidation. Split-spoon samples will be used for the other laboratory soil tests.

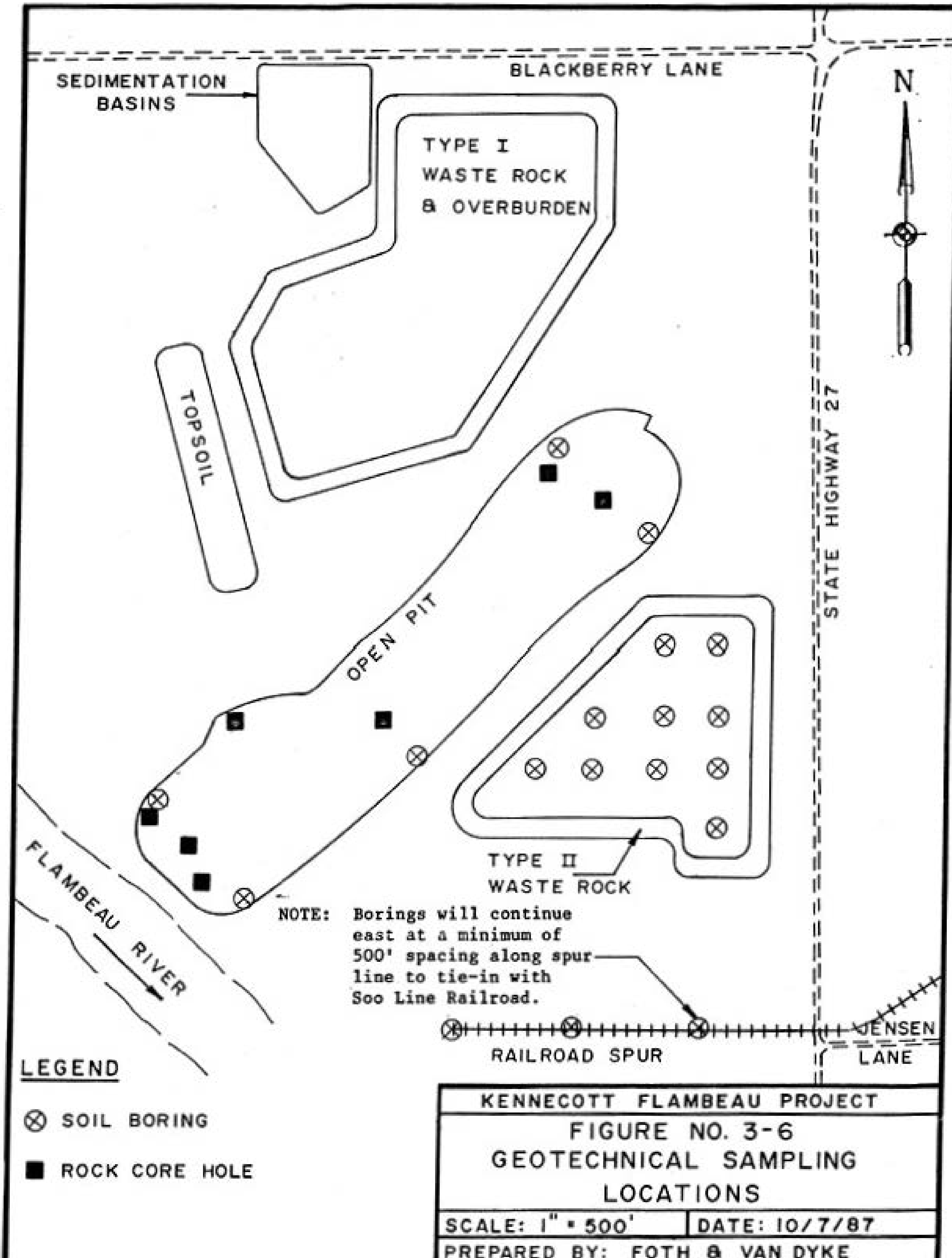

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FIGURE NO. 3-6
GEOTECHNICAL SAMPLING LOCATIONS

SCALE: 1" = 500' DATE: 10/7/87

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All field and lab testing will be accomplished per appropriate ASTM standards.

3.8.4 Data Presentation Format

All pertinent raw field and laboratory data will be presented and summarized on tables, maps, cross-sections, and graphs, as appropriate.

3.8.5 Schedule for Field Data Collection

Data collection will commence in October 1987 and be completed in early 1988.

3.8.6 Key Project Personnel

Zavis M. Zavodni, Ph.D., P.E., manager - geotechnical engineering with Kennecott, will coordinate the collection, interpretation, and presentation of the geotechnical data. He will be assisted by Edwarde R. May, a mining geologist and consultant to Kennecott, and Boyd N. Possin, a senior hydrogeologist with Foth & Van Dyke.

3.9 Historical, Archaeological and Architectural Resources

3.9.1 Existing Data Summary and Evaluation

There are two existing archaeological surveys for the site (KEN-19). The final report is titled "Archaeological Survey of the Flambeau Mining Corporation's Proposed Copper Mining

Project, Rusk County, Wisconsin" by J. Tiffany, 1976. Tiffany concluded that no further archaeological work was required based on the lack of potential for finding such resources in the areas to be disturbed.

The State Historical Society concluded in 1976 that on-site buildings were of no historic or archaeological value. Since there are no known resources of any significance and the existing data appears to be adequate, no additional data collection needs exist.

3.10 Other Hydrogeological Work

3.10.1 Existing Data Summary and Evaluation

Several types of hydrogeological information were collected during studies conducted in the 1970's which will be useful for the purposes of the present project. More than ten years of water level measurement were made in several of the existing monitoring wells and soil test holes (KEN-35). Single well *in-situ* permeability tests were made at many of the soil test holes and monitoring wells (KEN-36). Two major pumping tests, complete with extensive monitoring well arrays, were conducted (KEN-36). A finite difference flow model was developed to simulate the drawdown conditions which would have occurred under the old mining plan (KEN-37). All of these data have value and will be incorporated in the overall hydrogeological evaluation, as appropriate.

Lacking in the old data are sufficient quantifications of vertical hydraulic gradients and sufficient permeability information in the bedrock formations, and in the drift formations away from the mine pit area.

3.10.2 Data Requirements

The hydrogeological work which should be completed, other than the baseline groundwater quality monitoring, may be divided into three major information collection efforts. Information should be collected both on private well distribution and on background water quality in private wells near the proposed mine. Information should be collected regarding the nature and orientation of the groundwater flow systems occurring in the site area, and information should be collected which will enable the effects of the proposed operation on groundwater quality to be evaluated, both during mining and after reclamation.

As part of the process of receiving a groundwater removal permit per 144.855(3) of the Wisconsin Statutes, a survey should be made of the private wells in the vicinity of the mine. In addition, consistent with the requirements of NR 182.75(1)(d)6, background groundwater quality (i.e., "quality of groundwater that is not affected by the site but which is in the aquifers near the site") should be monitored in private wells.

The groundwater flow systems should be evaluated and monitored for several purposes. The most important relate to the potential effects of water table drawdowns during mining operations. The open pit will be as deep as 200 feet below existing grades. This will put the bottom of the pit as deep as 180-190 feet below the water table in some locations, creating, in effect, a large dug well. The existing hydraulic gradient distribution, and the distributions of permeabilities in the underlying aquifers, must each be understood in order to evaluate the degree to which water table drawdown effects will extend from the mine pit. The effects of such drawdowns on nearby private wells and wetland areas should be evaluated. Such information is also necessary in order to accurately estimate the rate at which groundwater will flow into the pit during mining, and to establish design parameters for handling this water.

NR 132 requires that a demonstration be made that proposed mining operations will not cause groundwater contamination problems. By understanding the existing groundwater quality distribution (as will be determined by the baseline groundwater monitoring program), and by understanding the existing groundwater flow systems (as will be determined by this program), it will be possible to predict, through the use of models, what the groundwater quality impacts will be, if any, from the proposed mining project.

3.10.3 Methodology

The survey of private wells will be accomplished within the area indicated on Figure No. 3-7. The outline of the area shown on Figure No. 3-7 was drawn, using the natural hydrologic boundaries surrounding the site. All the private and public well construction logs on file at either the WDNR or the

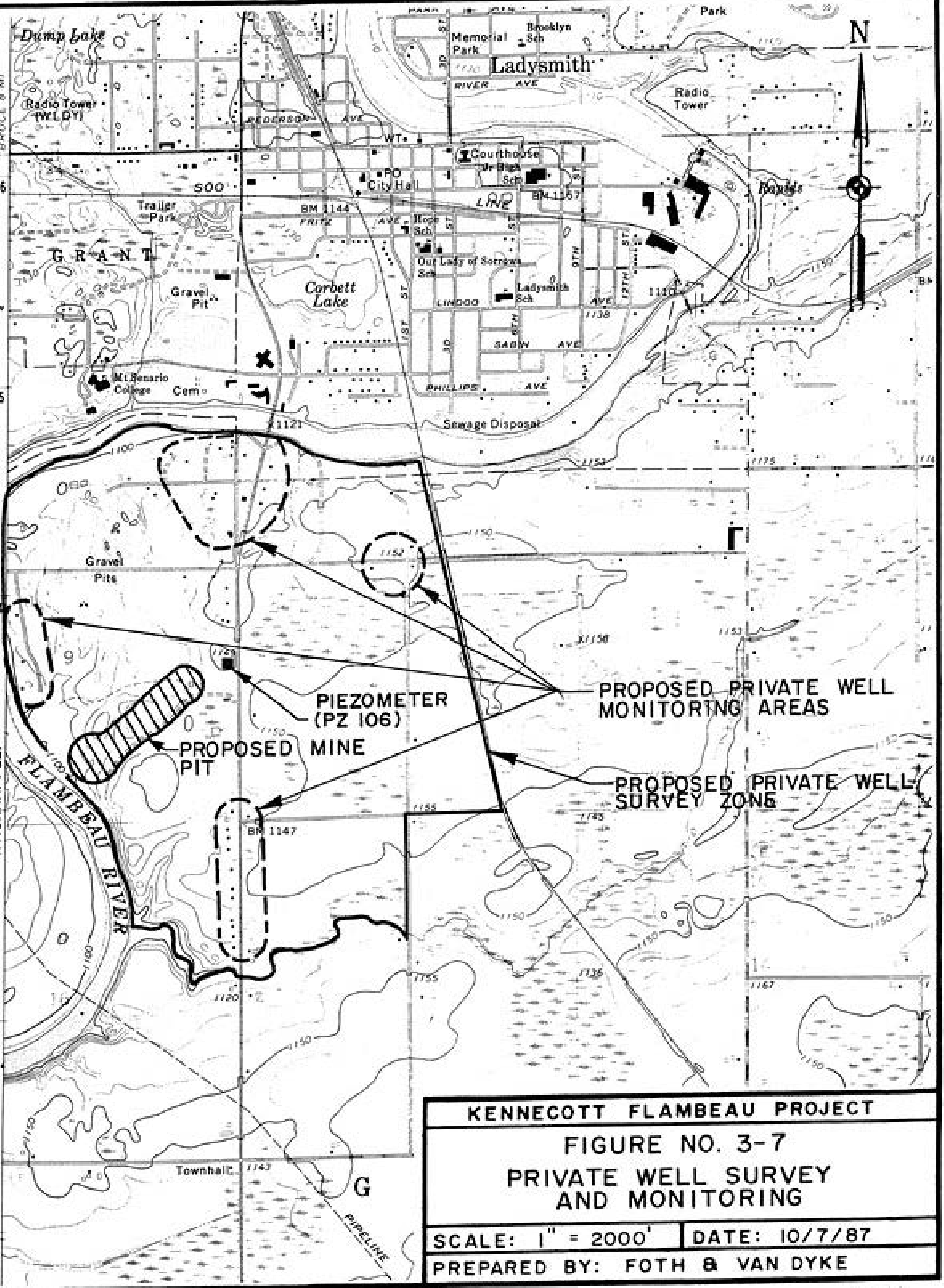

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FIGURE NO. 3-7

PRIVATE WELL SURVEY AND MONITORING

SCALE: 1" = 2000'	DATE: 10/7/87

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Wisconsin Geological and Natural History Survey (WGNHS) will be acquired for wells located within the area outlined on the figure. The house locations for which no such records exist will also be noted, on the assumption that such structures do nevertheless have wells.

In order to accomplish private well background monitoring, a candidate private well in each of the four areas indicated on Figure No. 3-7 will be sought for monitoring. Wells will be selected only if construction logs for them are on file at the WGNHS. Monitoring will be conducted on two occasions, in December 1987 and in March 1988, at the same time the baseline groundwater monitoring wells are sampled in those months. The samples will be analyzed for the parameters listed on Table No. 3-4.

The distribution of hydraulic heads will be determined by measuring static water levels in the baseline monitoring wells, and in some of the old monitoring wells and soil test holes remaining from the 1970's project. Water levels in the wells will be measured on a monthly basis for one year, at the same time the baseline water samples are collected. Old monitoring wells with multiple slotted intervals below the water table will not be included in this monitoring network.

A piezometer nest, PZ-106, will be constructed to determine the groundwater flow system configuration between the proposed open pit and the wetland area to the east and northeast of the pit and to the east of Highway 27 (Figure No. 3-7). The wells in this nest, to be installed, developed, and tested for

TABLE NO. 3-4

PRIVATE WELL ANALYTICAL PARAMETERS

PARAMETERS	SAMPLE VOLUME (ml)	PRESERVATIVES	HOLDING TIME	DETECTION LEVELS (mg/l)
(Primary Drinking Water Standards)				
Arsenic	200	HNO_3	6 Months	<0.005
Barium	100	HNO_3	6 Months	<1.0
Cadmium	50	HNO_3	6 Months	<0.001
Chromium, Total	50	HNO_3	6 Months	<0.005
Lead	50	HNO_3	6 Months	<0.005
Mercury	500	HNO_3	28 Days	<0.0002
Nitrogen, Nitrate/Nitrite	100	COOL 4°C+H_2SO_4	28 Days	<0.01
Selenium	500	HNO_3	6 Months	<0.001
Silver	50	HNO_3	6 Months	<0.005
Sodium	50	HNO_3	6 Months	<1.0
(Secondary Drinking Water Standards)				
Chloride	100	NA	28 Days	<1.0
Copper	50	HNO_3	6 Months	<0.08
Fluoride	100	NA	28 Days	<0.2
Iron	50	HNO_3	6 Months	<0.1
Manganese	50	HNO_3	6 Months	<0.05
pH (Field)	NA	NA	Field	NA
Sulfate	100	COOL 4°C	28 Days	<10
Soilids, Total Dissolved	100	COOL 4°C	48 Hours	<1.0
Zinc	50	HNO_3	6 Months	<0.05
(Indicator Parameters)				
Alkalinity, Total	100	COOL 4°C	14 Days	<1.0
Calcium	50	HNO_3	6 Months	<1.0
C.O.D.	50	H_2SO_4	28 Days	<5.0
Hardness, Total	100	HNO_3	6 Months	<1.0
Spec. Cond. (Field)	NA	NA	Field	NA
Magnesium	50	HNO_3	6 Months	<1.0
Temperature (Field)	NA	NA	Field	NA

NOTE: NA = Not Applicable

permeability according to the same procedures as described in Section 3.3 of this document, will be installed at depths of approximately ten feet from the land surface, at the crystalline bedrock surface, and in the drift halfway between the other two well screens. Such a placement will allow a determination to be made regarding the degree to which, if any, the wetland is perched, permanently or seasonally.

Permeability determinations will be made at several types of locations. In-situ slug and bail-down tests, per methods described in Freeze and Cherry's well known text, Groundwater, will be conducted at all newly installed wells and piezometers. Packer yield tests will be conducted at selected intervals in the coreholes to be drilled at the locations indicated on Figure No. 3-8. Grain size analyses done on representative soil samples collected during the baseline monitoring well installation, piezometer nest installation, geotechnical investigations, and waste characterization sampling program, will provide additional information relative to permeability. Finally, the permeability determinations made as a part of the 1970's project will be used, as appropriate.

The modeling of groundwater flow and of chemical transport will be accomplished through the use of U.S.G.S.'s MODFLOW 3-D finite difference model, and the Prickett-Lonquist-Naymik Random Walk model, respectively. One specialized type of data required by the transport model relates to the necessary input parameter, dispersivity. This parameter will be quantified through the conducting of single-well withdrawal-injection tests, per Freeze and Cherry's Groundwater. These tests will be conducted at all

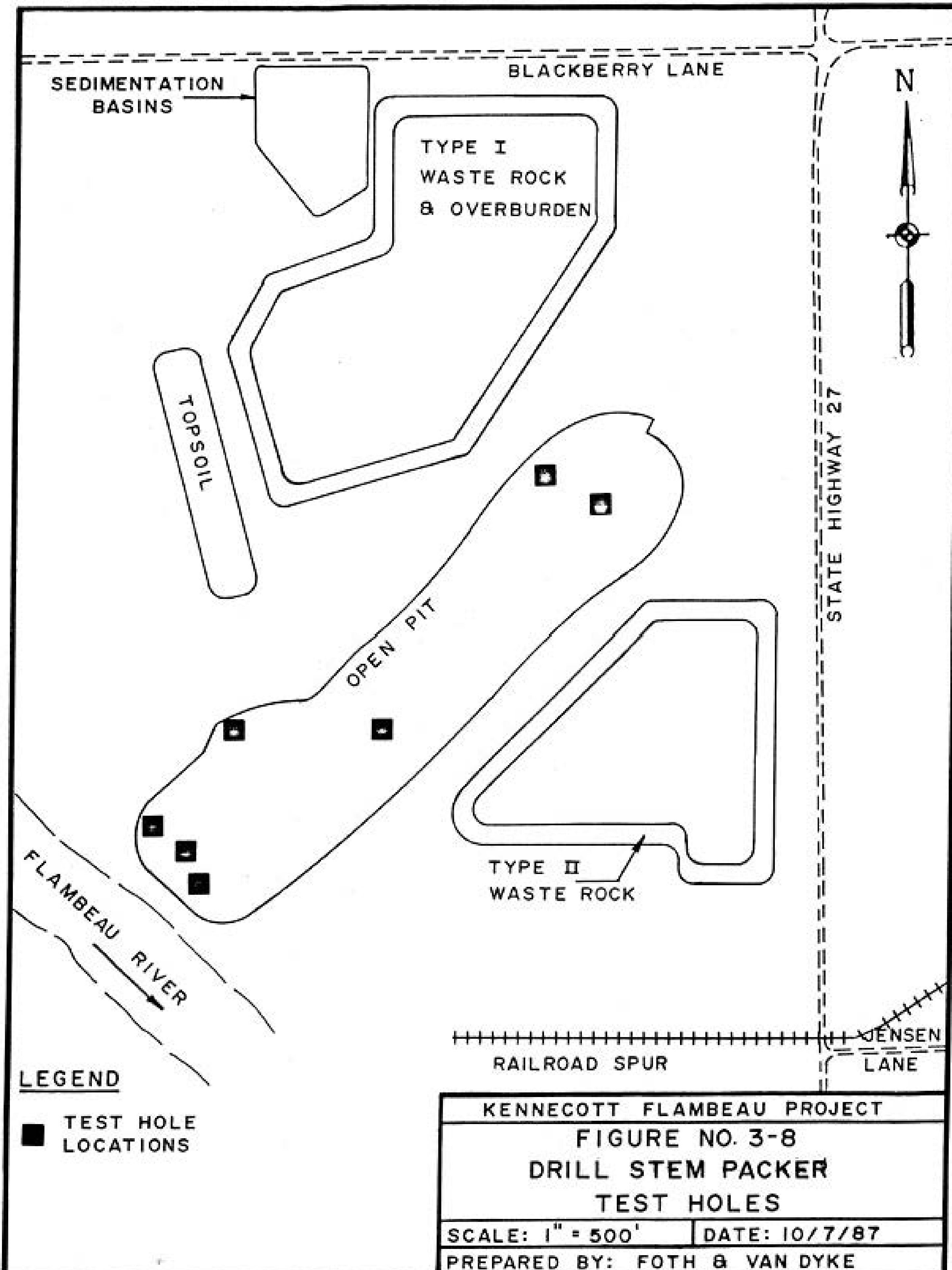

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FIGURE NO. 3-8
DRILL STEM PACKER
TEST HOLES

SCALE: 1" = 500' DATE: 10/7/87

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the baseline monitoring wells and the new piezometer nest. The tracer used will be sodium chloride, measured in the field as specific conductivity.

Three scenarios will be modeled. The first will be existing conditions. The second will be the conditions existing during the maximum extent of mining. The third will be the conditions existing after reclamation is accomplished. Predictions regarding watertable drawdowns and water quality changes relative to baseline conditions will be made.

3.10.4 Data Presentation Format

In the various project reports, appropriate raw field and laboratory data will be presented in appendices and summarized on tables, maps, cross-sections, and graphs, as appropriate. Included will be well location maps; water table maps; potentiometric maps of deeper formations, if appropriate; flow net cross-sections; water quality contour maps, cross-sections, and graphs, as appropriate; model input and output; and accompanying narrative discussion.

3.10.5 Schedule for Field Data Collection

Data collection will be underway in October of 1987 and completed by September of 1988.

3.10.6 Key Project Personnel

Boyd N. Possin, Senior Hydrogeologist with Foth & Van Dyke, will be responsible for the collection, interpretation and presentation of data relating to the groundwater database. He will be assisted in the modeling efforts by Fred J. Doran, Foth & Van Dyke's groundwater modeling expert.

3.11 Mining Related Noise

3.11.1 Existing Data Summary and Evaluation

Sound levels were measured at a total of 37 locations in the vicinity of the site three times during April, May and June of 1973 (KEN-17 and 18). Readings were taken using dBA and dBC scales without a wind screen. Methods were very similar to those accepted today. Projections of anticipated noise were made based on data recorded at open pit mining operations at the Bingham Canyon Mine in Utah.

Changes in the project scope and methodologies since 1976 and in site surroundings (planting of vegetation screens) require the re-evaluation of noise generation using site-specific background data.

3.11.2 Data Requirements

A field noise survey should be conducted to establish ambient levels in the community as it exists today. These data should be used as a baseline to predict noise impacts, if any.

3.11.3 Methodology

Ambient sound levels will be measured at 19 sites in the project vicinity as shown on Figure No. 3-9, and as listed in Table No. 3-5. Survey work will consist of at least six discrete

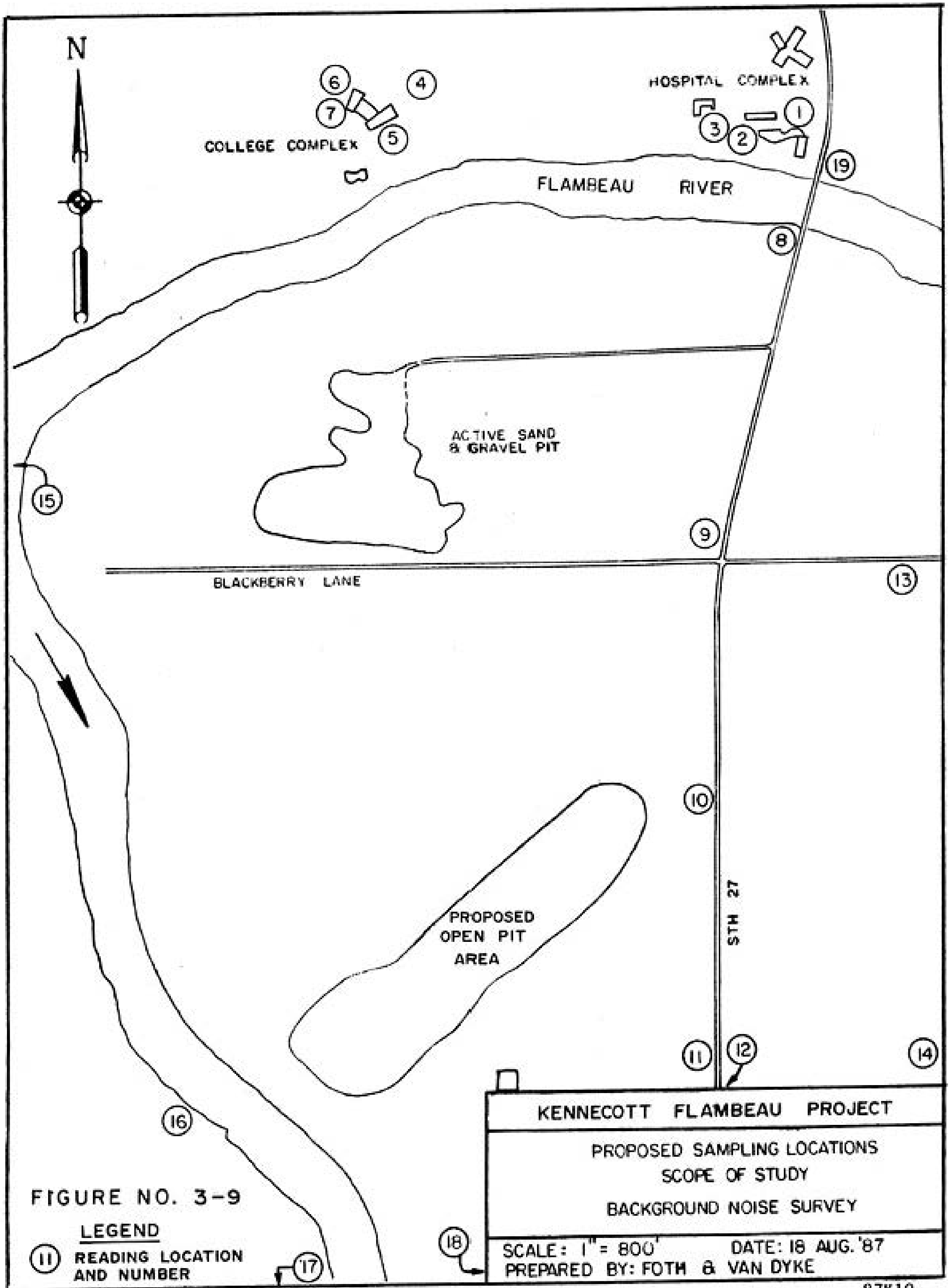


FIGURE NO. 3-9

87K10

TABLE NO. 3-5

Proposed Sound Monitoring Locations for Mining and Transportation Related Noise Survey

Proposed Site No.	Description
1	Rest Home Parking Lot
2	W Corner Hospital
3	S of Convent
4	NE of College
5	S of College
6	N of College
7	W of College
8	STH 27 at Bridge (South)
9	STH 27, Blackberry Lane
10	STH 27, E of Pit
11	STH 27/Entrance Road
12	STH 27, S of Site
13	RR at Town Road
14	RR at Meadowbrook Road
15	W of River, NW of Pit
16	W of River, W of Pit
17	S of River, SW of Pit
18	STH 27 at CTH P
19	STH 27 at Hospital Entrance

observation periods, representing average day conditions at each location. Measurements at each site will be made on both the A-weighted and C-weighted scales. In addition, supplemental A-weighted observations will be made at seven representative locations adjacent to State Trunk Highway 27 for use in modeling transportation-related noise. In total, 121 A-scale survey periods and 114 C-scale periods will be included in the field work.

It is anticipated that data collection will take place in September/October 1987 with full vegetation cover, and in December 1987 with sparse vegetation cover.

Data collection will be conducted in accordance with the standards of ASTM E1014 (Standard Method for Measurement of Outdoor A-Weighted Sound Levels) and ANSI S1.4 (Specification for Sound Level Meters).

Sixteen of the sites chosen for the 1987 field work correspond to previous monitoring sites. Earlier data will be useful for comparison, but some changes are anticipated.

3.11.4 Data Presentation Format

Data on ambient noise levels will be presented in tabular form with high, low and average decibel levels shown for the A and C scales at each survey location, and for both normal and sparse vegetation conditions. The 1973 observations will also be noted. A supporting map will show locations of the sampling points.

Information collected at each monitoring location will be compared to projections of mining-related noise that will be generated by the proposed facility. Projections will be based upon monitoring (of A-weighted and C-weighted noise) previously performed at the Kennecott open pit mine at Bingham Canyon, Utah. An evaluation of the impacts, if any, of the project upon surrounding land uses will be conducted in both absolute (total decibels) and relative (change in noise levels) terms, in accordance with U.S. Department of Housing and Urban Development (HUD) guidelines for compatible and noncompatible noise levels. HUD standards will also be presented in tabular form for reference.

3.11.5 Schedule for Field Data Collection

Field data will be collected in September/October and December 1987.

3.11.6 Key Project Personnel

The field work and analysis will be performed by or under the direct supervision of Steven R. Milquet, P.E., A.I.C.P., of Uniplan Associates of Green Bay.

3.12 Site Topography

3.12.1 Existing Data Summary and Evaluation

The topographic database consists of maps contained in the original project files. Relevant topographic maps include a

1"=200' scale drawing with a five foot contour interval. The area covered is both the site and the areas to the east, west and south of the site. Also available is a 1"=500' topographic map of the site and surrounding area at a five foot contour interval and a 1"=100' topographic map of a major portion of the site at a two foot contour interval.

This topography was flown in the early 1970's. The vertical control is tied to the U.S.G.S. quadrant map of the area. The horizontal control is a site-generated grid system. Recently, in September of 1987, a resurvey of the existing control monuments and station points was completed. At the same time horizontal control was established on the State Plane Coordinate System. This may allow Kennecott to convert the site generated grid system to the State Plane Coordinate System if it is deemed necessary at a later date.

It is intended that the 1"=200' scale, five foot contour map be utilized as a base map for presentation of all data as listed in this document. In addition, it is also intended that this base map be utilized in the application for the mining permit. The 1"=100' scale, two foot contour map will supplement the information on site, especially along the western boundary of the pit near the Flambeau River.

The existing site topographic data is adequate. No further data collection appears to be necessary.

3.13 Socioeconomics

3.13.1 Existing Data Summary and Evaluation

Most of the previous environmental reports for the 1970's are outdated and not applicable to an impact assessment of the current project. New information from existing sources will need to be obtained as described in the following sections. However, a report titled "Summary Discussion of the Effect of the Flambeau Project on the Population, Employment, Economy and Taxes of the State of Wisconsin", prepared by the Colorado School of Mines Research Institute (1976), offers a framework for socioeconomic aspects of the project. With updating of data, the methods and assessments will be useful.

3.13.2 Data Requirements

3.13.2.1 Population

Although the proposed mine project is considerably smaller in size than the one proposed during the mid-1970's, a modest increase in local population can be expected. To estimate what this increase will be, as well as assess the impact of the population gain on the affected governmental units, population data will be required for the following four levels: 1) the residents of the project site/impact area; 2) the residents of the adjacent Grant Township; 3) the residents of the City of Ladysmith; and 4) the residents of Rusk County.

In addition to population, information on potentially affected civil divisions will be needed in order to obtain demographic parameters necessary to analyze the proposed project's impact on such factors.

3.13.2.2 <u>Zoning</u>

Data pertaining to zoning and land management in the planning area will be required. The planning area falls under the jurisdiction of the Rusk County Zoning Ordinance.

The planning area is located in the Township of Grant just outside the City of Ladysmith in Rusk County. According to the Grant Town Chairman, Robert Plantz, the Town has no zoning ordinance or other land management tool in place governing land use in the proposed planning area.

The City of Ladysmith, however, does have a zoning ordinance and a Comprehensive Plan which, while dealing primarily with land use in the County's corporate limits, does touch on the issue of extraterritorial zoning and mining as an industrial use. These documents should be obtained and reviewed.

Finally, information regarding zoning and land use constraints and opportunities as identified in similar mining projects in northern Wisconsin should be collected.

3.13.2.3 <u>Land Use</u>

The most recent land-use inventories, aerial photos, and topographic maps of Grant Township and Rusk County should be acquired. The most recent land-use inventories of Rusk County and Grant Township were completed in 1972 according to the Northwest Regional Planning Commission (NWRPC). The most recent aerial photos for the region were flown in 1979 and the most recent Topographic Maps date from 1971. A listing of the Kennecott holdings should be acquired to update the existing inventory.

Northwest Regional Planning Commission data on recent land-use statistics and maps of Rusk County and the areas surrounding the project site will be needed to identify changes that have occurred in order to update the aged data. An on-site inspection will be required to completely update land-use information.

3.13.2.4 <u>Employment and Income</u>

Employment data by activity will be required and must be compiled for the City of Ladysmith, Rusk County and the State of Wisconsin. This information should be used to analyze the distribution and composition of the labor force as well as to identify major employers in both Ladysmith and Rusk County.

Employment and payroll data for the proposed project during both the construction phase and the actual operation of the mine will be necessary.

Unemployment rates and other work force data will be required for Rusk County, other similar Wisconsin Counties and the State of Wisconsin for comparison purposes. This data should include a breakdown of the labor force by sex, occupation and wage levels.

Income data including Medium Household Income (MHI), Adjusted Gross Income Per Capita (AGIPC), and percent of population with income at or below the poverty level, will be needed for Ladysmith, Rusk County and comparable Wisconsin Counties, as well as the State of Wisconsin.

Estimates of the value of various supplies and services expected to be purchased locally for the operation over the course of the project will be required. Updated information compiled by the Wisconsin Department of Revenue (WDOR) in a report titled "Taxes, Aids, and Shared Taxes" should be gathered.

3.13.2.5 Taxes and Revenue

Property tax data for the City of Ladysmith, Rusk County and the State of Wisconsin will be required. This will include all local, state, county and school taxes.

Tax rates for the affected taxing jurisdictions over the past seven years should be reviewed and projections for future collections should be estimated.

The U.S. Internal Revenue Service can provide Federal Income Tax figures and Federal Excise Tax information and data.

Information and data on State payments to localities will be needed from the WDOR as well as other State agencies such as the Department of Transportation, Department of Administration and Department of Natural Resources.

Two other sources of information for taxes and revenue are the Wisconsin League of Municipalities and the Wisconsin Taxpayers Alliance. Both organizations should be requested to provide updated information.

3.13.3 Methodology

3.13.3.1 Population

Population change in both absolute and relative terms will be determined for the State of Wisconsin, Rusk County, Ladysmith, Grant Township and the proposed mine site/impact area over the past several decades. As per NWRPC data, anticipated populations for the four levels over the next five, ten and twenty years will be considered.

Based on expected mine employment figures, the impact on the affected municipalities during both the construction and mine operation periods, as well as following the scheduled shut down of the operation, will be assessed. This information, coupled with population projections, will be used to determine whether or not existing public facilities and services, housing, etc., will be sufficient to handle the expected increase.

Basic demographic data such as median age and age distribution will be studied for the affected governmental units and compared to state norms. The impact of the proposed mine project on such information will then be considered. For example, northern communities such as Ladysmith often have a higher percentage of senior citizens than state norms. The population increase resulting from the proposed mine project may lower the median age in the community somewhat. This slight change in age distribution would alter slightly the economic conditions in the area and to some degree change public facilities and services that are needed by residents.

3.13.3.2 Zoning

The existing zoning ordinance will be systematically examined and evaluated in terms of the existing and proposed land use in the planning area.

3.13.3.3 Land Use

The existing land use will be broken down into three areas: Kennecott holdings, Grant Township and Rusk County. These categories, in turn, will be broken down into general land use classifications based on acreages and the percent totals of each classification. An example of some of the classifications would be wetland, agriculture, residential, commercial, transportation and industrial. This information will be critical when analyzing the impacts of the mining operation on surrounding land uses as well as on projecting future land use after mining is complete.

3.13.3.4 Employment and Income

Existing economic conditions for Ladysmith, Rusk County and the State of Wisconsin will be established. Analysis of employment by industry for each economy will characterize the State, County and Ladysmith, identifying what the critical and dominating economic activities presently are at each level. A comparison of Ladysmith and Rusk County to similar state entities, as well as Wisconsin figures, will help to identify unique aspects of the local economy.

Labor force data, including unemployment figures, will be compiled for Rusk County and compared to other Wisconsin Counties and State figures to further characterize the local economy. This portion of the analysis will include a breakdown of the work force by such categories as sex, occupation and income.

Income characteristics for Ladysmith and Rusk County will also be explored, including MHI, AGIPC and percent of persons at or below poverty level.

Impact of the proposed Flambeau Mine project on local and state economies during construction, mine operation, and shutdown phases will be assessed.

An employment multiplier will be calculated for Ladysmith and Rusk County to determine how many new jobs will result from mine employment in other sectors of the local economy. The effect of this new employment (mine employment and other) on unemployment and other labor factors will then be analyzed.

The probability that mine permitting and operation will cause some supplies and services to be purchased locally also will be analyzed for its impact on the local economy.

3.13.3.5 Taxes and Revenue

Personal property tax has undergone considerable change in Wisconsin over the past several years with manufacturing machinery and equipment, as well as materials and finished products, having some exemptions. Whether the proposed mine project is 100% exempt from these taxes will be investigated and any impact reported.

Sales, use, and excise taxes for Rusk County and the State of Wisconsin will be obtained. Impact of the Flambeau Mine project on local and state economies during the construction and operation periods will be assessed based on County and State-wide averages.

In Wisconsin, a net proceeds occupation tax exists for mined copper-bearing ores and concentrates. The amount assessed on the Flambeau Project during its operating life, and the distribution of this tax among local entities and the state and its benefit to these taxing jurisdictions, will be analyzed.

Finally, the impact of the project on shared revenue and State and Federal grant and aid programs to local entities will be evaluated and impacts reported. This will include all shared taxes, payments to school districts and counties and other various aids and grants.

Based on past and current tax rates for the affected taxing jurisdictions, an estimate for future property tax collections from the Flambeau Mine project will be made. The distribution of this revenue to each taxing jurisdiction plus the resulting impact will then be assessed. The affected taxing jurisdictions are the local school district and vocational school, Rusk County, Ladysmith, and the State.

The impact of the project in terms of personal income tax during both the construction period and the operating life will be established. This will involve the estimated average yearly salary of direct employees on the project plus the estimated average of each salary for jobs created by the project in other sectors of the local economy.

Utilizing current state tax rates, the impact of the project in terms of corporate tax to the state will be estimated on a per annum and total basis.

Sales, use, and excise tax impact can be estimated as a percentage of personal income tax collected. Percentages are available for both Rusk County and the State; this percentage is applied to the personal income tax amount collected in order to calculate a dollar impact.

Production tax will be estimated by applying current production tax rates to the projected production of the proposed mine.

3.13.4 Data Presentation Format

Data and analysis results will be presented in tabular and graphic formats that will best describe the conclusions. This applies to population, land use, zoning, employment and income, and taxes and revenue.

3.13.5 Schedule for Field Data Collection

No field data collection is required. Gathering of the existing data will occur during late 1987 and early 1988.

3.13.6 Key Project Personnel

Key project personnel include James M. Schlies, Kenneth A. Jaworski, Carol J. Bacon and William S. Bosiacki of Foth & Van Dyke Consulting Group, Inc.

Mr. Schlies will oversee the data collection, evaluation and analysis of the socioeconomic aspects of the project. His experience includes a study of the Jackson County Economy and how it is related to the impact of mining and development alternatives.

Mr. Jaworski will conduct the zoning studies and evaluation. His responsibilities as a planning consultant focus on land use issues and zoning ordinance evaluation, writing and review. He is also involved in outdoor recreation and resource planning.

Ms. Bacon will be responsible for the economic aspects of the project. She has experience in public policy analysis, local government planning and community economic development. Her specialties include population analysis, housing and demographic forecasting.

Mr. Bosiacki will collect and analyze the data related to land use for the project. He specializes in land use research and analysis, with particular emphasis on natural resources and mapping, impact assessment, and planning.

3.14 Transportation

3.14.1 Existing Data Summary and Evaluation

Hourly counts of vehicles traveling on S.T.H. 27 and C.T.H. P were developed for two 48-hour periods in April and June, 1973. These traffic counts are outdated and need to be redeveloped.

3.14.2 Data Requirements

Information on ambient highway operating and geometric conditions (e.g., width, gradient and surface conditions) and the site itself (e.g., sight limitations at entrances and crossings) should be obtained by field inspection. Wisconsin Department of Transportation data on vehicular traffic on S.T.H. 27 is available in published form and should be obtained. Because no adequate modeling of railroad spur noise exists, comparable sites should be monitored to determine noise levels to be expected at the site. Field noise calibration tests (dBA) should be conducted in accordance with ASTM E 1014.

Data on projected traffic increases due to the mining operation, tourists, and secondary services that will arise should be developed.

3.14.3 Methodology

No on-site data collection, other than inspection, will be required. The available DOT data and projected increases will be used to determine the adequacy of existing facilities and improvement needs, if any.

3.14.4 Data Presentation Format

Transportation impacts will be evaluated on the following basis:

A. Highway

1) Traffic Counts - The impacts of site-generated traffic will be evaluated using the standards of the Wisconsin Department of Transportation and American Association of State Highway and Transportation Officials. Issues addressed will include capacity, operating speeds and sight distances.

2) Noise - The impact of site-generated traffic will be modeled and evaluated using the guidelines of National Cooperative Highway Research Program Reports 117, 140 and 174 on Highway Noise.

B. Railroad Spur

1) Noise - Noise generation will be modeled and its impact evaluated using the above cited guidelines

and those of the U.S. Department of Housing and Urban Development. Vibration impacts, if any, upon surrounding land uses will also be addressed.

2) Safety - The proposed highway crossing will be evaluated according to Wisconsin DOT Standards for degree of hazard. The need for protection and enhanced sight distances will also be reviewed.

3.14.5 Schedule for Field Data Collection

No site specific transportation noise investigation work is required. Data collection for railroad spur noise modeling can be obtained at any time.

3.14.6 Key Project Personnel

The work will be performed by or under the direct supervision of Steven R. Milquet, AICP, P.E., of Uniplan Associates of Green Bay, Wisconsin.

3.15 Utilities

3.15.1 Existing Data Summary and Evaluation

There is no useful existing file information.

3.15.2 Data Requirements

No field work is required. Data will be gathered by correspondence with appropriate agencies, firms, persons and from published sources.

Utility service requirements of the proposed mine will be obtained from Kennecott.

3.15.3 Methodology

The adequacy of existing utilities will be determined based on the review of data gathered by contacting appropriate agencies, firms, persons and from published sources.

3.15.4 Data Presentation Format

The following utilities will be described and, where appropriate, mapped:

A. Sanitary Sewer;
B. Water;
C. Electricity;
D. Telephone;
E. Solid Waste; and
F. Other.

In each case, demand levels established for the project and the impact upon the various public utilities involved will be assessed. The possible impacts of on-site utility provision (e.g., private water supply) will be addressed elsewhere as appropriate. In addition, the possible impact upon utilities not directly involved in the project (e.g., pipelines) will be assessed.

3.15.5 Schedule for Field Data Collection

No site work is required.

3.15.6 Key Project Personnel

The analysis will be performed by Steven R. Milquet, AICP, P.E. of Uniplan Associates of Green Bay, Wisconsin.

3.16 Waste Characterization

3.16.1 Existing Data Summary and Evaluation

During investigations completed in the 1970's, many soil and overburden samples were collected and analyzed over portions of the orebody (KEN-46, 47, 53, 54, 55, 56, 57). In addition, many diamond drill holes were cored into the Precambrian bedrock and orebody.

Extensive geochemical analyses have been performed on the soils covering the southwestern half of the orebody. Analyses were performed for mercury, copper, zinc and lead on samples collected at six-inch depths. The results indicate that concentrations of these metals in the soils above and adjacent to the orebody are higher than at other areas on the site. Samples were also collected at 24 inch depths along two long transects which were constructed at right angles to the orebody in order to investigate geochemical and biochemical transport of copper and zinc. No sampling was conducted by soil horizon, nor were samples collected from the soils overlying the northeastern third of the orebody.

Waste rock leaching tests were conducted using 1973 state-of-the-art technology. Due to changes in waste characterization methodologies since 1973 and the need to assess more parameters, additional waste characterization is necessary. The existing data, however, will be very useful in predicting waste rock - groundwater reactivity.

In 1978, Kennecott staff conducted a study of ore and rock core samples in order to determine if there are any radioactivity concerns. Fourteen mill bench test ore samples were composited to make up five samples. These composite samples were analyzed for Gross Alpha, Gross Beta and Radium-226. The results of these analyses indicate the radioactivity in the material from the Flambeau deposit is within normal background ranges. Therefore, no additional analyses for radioactivity are planned for the project.

3.16.2 Data Requirements

Three types of non-ore material will be excavated as part of the proposed open pit mining operation. They include: topsoil, overburden, and waste rock. Representative composited samples of each material should be characterized as part of the project.

Previously collected soil boring and diamond drill cores and assays should be combined with the information derived from the proposed geotechnical investigations work plan in order to estimate the volumes and classifications of waste rock and overburden. The distribution and types of topsoil should be estimated from data collected from dug soil pits. The proportions of materials gathered in the composites for characterization work should be based upon these classifications and volume estimates. The rate at which these materials will be generated should be estimated from the mining plan.

Bulk chemical analyses should be performed on the samples composited for characterization. In addition, the mineralogical compositions of the samples should be determined. One unit in the overburden is distinctively different, mineralogically, from the other units. That unit is a clay rich saprolite. The saprolite should be examined and characterized separately from the rest of the overburden.

Particle size analyses should be performed directly upon the topsoil composite, the overburden composite and the saprolite.

Extraction procedure toxicity, per NR 181, should be performed on the waste rock composite samples.

The chemical and physical characteristics of the waste rock regarding its acid-producing potential, leaching potential and leachate composition should be determined. This information can then be utilized in the design of any storage areas and treatment facilities. It is not anticipated that the topsoil, the overburden, and the saprolite composite samples will be acid producing. Therefore, these materials should be analyzed only for their leaching potential and composition of leachate.

3.16.3 Methodology

3.16.3.1 Sampling Locations

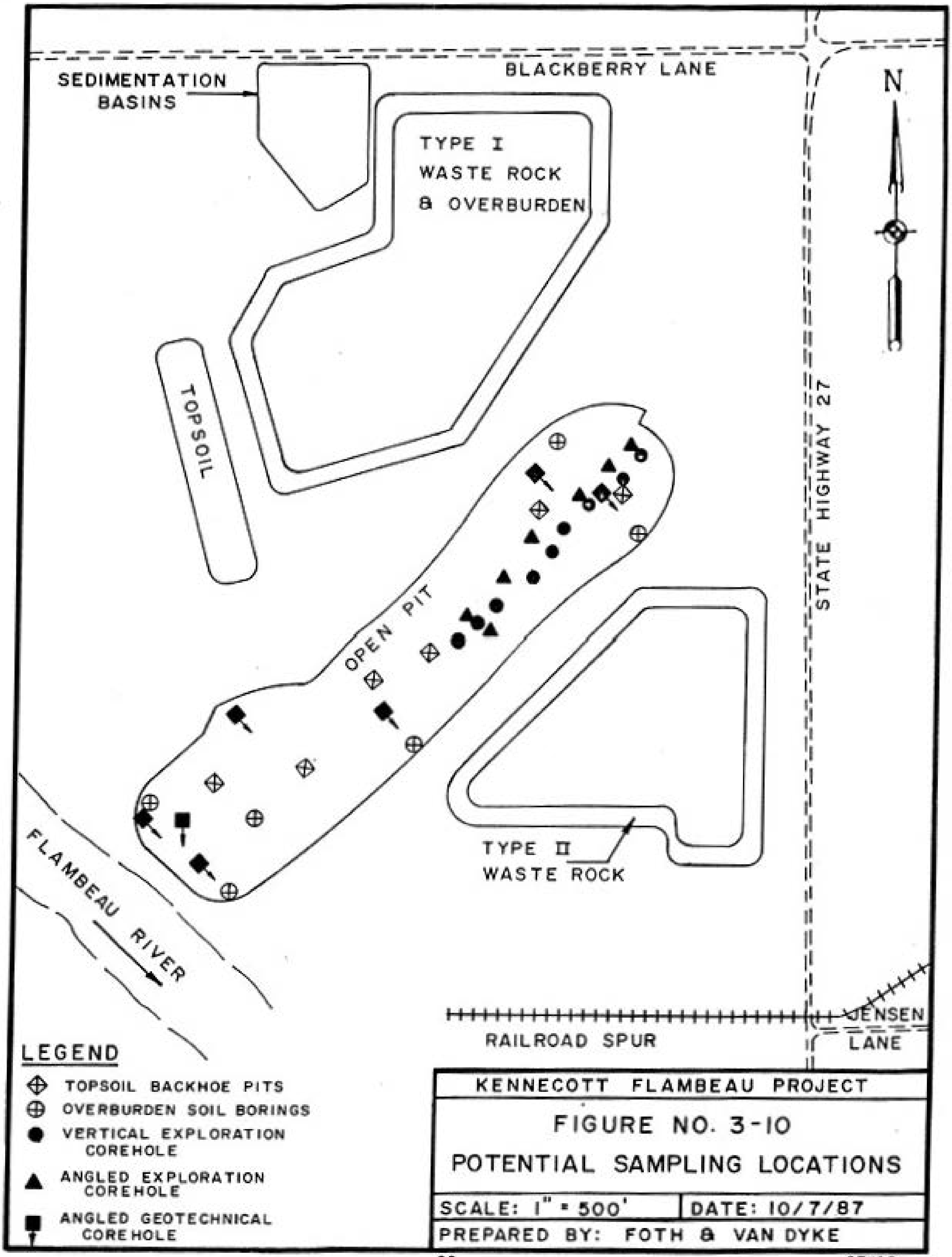
Figure No. 3-10 is a plot of all proposed sampling locations. Topsoil samples will be taken from six backhoe pits. Overburden samples will be taken from three soil borings located along the centerline of the open pit and from five additional borings located around the perimeter of the open pit.

Saprolite and waste rock for waste characterization purposes will be obtained from the samples and cores removed from the geotechnical engineering and exploration coring program previously described.

3.16.3.2 Field Descriptions and Sampling Techniques

Soil pits will be described and classified both according to the U.S.C.S. and SCS format. Soil borings will be described and classified following the Unified Soil Classification System.

Selected samples will be collected and preserved to minimize chemical and physical degradation. Preservation will be accomplished by placing the samples in double lined bags and shipping them under iced conditions to the laboratory where they will be stored under refrigerated conditions until analytical work is performed. Care will be exercised in order to minimize the loss of constituents through volatization and to prevent contamination of samples.



KENNECOTT FLAMBEAU PROJECT

FIGURE NO. 3-10
POTENTIAL SAMPLING LOCATIONS

SCALE: 1" = 500' | DATE: 10/7/87
PREPARED BY: FOTH & VAN DYKE

87K10

3.16.3.3 Compositing Scheme

Three topsoil composites will be created for analysis. The composites will represent the middle of the open pit and each end of the open pit. Similarly, three composites will be created for the overburden, representing the middle and each end of the open pit. One saprolite composite will be prepared.

Five composites will be prepared for analysis of the waste rock. The composites will be prepared based upon the amount of observed sulfide mineralization. The five samples will represent the range of mineralization, from least to most, that will be expected in the waste rock. Verification of this range will be accomplished through a total sulfur analysis of each core sample used to make the composites.

3.16.3.4 Laboratory Analysis

Particle size analyses will be performed on the topsoil, saprolite and overburden composite samples by sieving and hydrometer following ASTM procedures.

Bulk chemical analyses conforming with U.S.G.S. techniques will be performed on waste rock materials. Mineralogical characteristics of the waste rock samples will be determined by standard petrographic thin section techniques, and, where appropriate, by X-ray diffraction techniques.

The topsoil samples will be analyzed for total organic matter. The topsoil, overburden and saprolite samples will be analyzed for pH. In addition, these samples, along with the waste rock samples, will be analyzed for total sulfur.

Acid-production potential will be performed on waste rock samples. If, contrary to current projections, the sulfur concentration of the topsoil, overburden, and saprolite samples exceeds one percent, then those samples would also be analyzed for their acid-producing potential. Any sample which demonstrates an acid production potential, as defined in the B.C. Research Method, would have a confirmation analysis performed utilizing active cultures of _Thiobacillus ferroxidans_.

Extraction procedure toxicity will be determined for the waste rock composite samples for the metals listed in Table No. 3-6 utilizing standard USEPA procedures.

TABLE NO. 3-6

EP Toxicity Analytical Parameters

Arsenic	Chromium	Selenium
Barium	Lead	Silver
Cadmium	Mercury	

Two different column leaching tests will be performed on the samples. One will simulate the reactions of the material stored above grade to alternating wet and dry cycles caused by rainwater infiltration. The other will simulate the reactions between those materials that will be returned to the pit and which will ultimately be in continuous contact with groundwater. The column leaching tests will be performed under the following conditions:

1. All materials will be leached with a synthetic solution approximating the pH and composition of rainwater. The columns will be saturated for one day and allowed to drain for five days. This cycle will be repeated sixteen times. Leachate samples will be collected during the first, second and sixteenth cycles, and analyzed for all of the parameters listed in Table No. 3-7. Samples will also be collected during the fourth and eighth cycles and will be analyzed for key parameters. These key parameters, subject to WDNR staff approval, will be determined from the first two sets of analyses. For each cycle for which analytical work will be performed, leachate samples will be collected on the first day of drainage.

2. Those materials that exhibit an acid-producing potential will also be analyzed in columns, under conditions similar to those in the above section, but under acidic conditions. The pH of the acid solution will be determined from the acid production potential analyses and in consultation with WDNR staff.

3. Those materials to be returned to the pit which ultimately will be in continuous contact with groundwater will be leached in columns that are saturated with synthetic groundwater, agitated periodically, and maintained under reducing conditions by sparging the columns with argon gas. The composition of the synthetic groundwater will be based

upon the analysis of bedrock groundwater samples selected during the first round of baseline groundwater monitoring. Samples of leachate will be collected on the same periodicity as specified in Item 1 above, and analyzed for the same parameters. Following sample collection, removed leachate will be replaced by synthetic groundwater.

At this time it is envisioned that only the three overburden composites and the saprolite will be analyzed under these conditions. If, however, the initial results of the groundwater study indicate that the groundwater within the crystalline bedrock reacts with the groundwater in the overburden, then the waste rock sample would also be leached under these conditions. Any materials that would undergo this saturated column leaching will be those that have previously been leached with rainwater solutions.

4. Two particle sizes will be utilized for the waste rock composite samples. Each sample will have a column for material less than 100 mesh size particle and a column for one to two inch diameter particle sizes.

TABLE NO. 3-7

Leach Column Analytical Parameters

Aluminum	Iron	Silver
Arsenic	Lead	Sodium
Barium	Manganese	Thallium
Beryllium	Mercury	Tin
Cadmium	Molybdenum	Titanium
Chromium	Nickel	Uranium
Cobalt	Selenium	Zinc
Copper		

3.16.4 Data Presentation Formats

All data and interpretations will be presented in map, tabular and graphic formats as warranted. The accompanying text will detail the locations and methods utilized in the study and will provide an interpretation of the results.

3.16.5 Schedule for Field Data Collection

The collection of the field data and samples will commence in the fall of 1987. Analyses and interpretations will be completed within nine months of the completion of sampling.

3.16.6 Key Project Personnel

John E. Thresher, Jr., a soil chemist, will be in charge of the field work, sampling and the interpretation of the results of the analyses. David E. Turriff, Ph.D., manager of Foth & Van Dyke's Laboratory Services section, will be in charge of the analyses and will assist with the interpretation of the data generated.

3.17 Wetlands

3.17.1 Existing Data Summary and Evaluation

The Rusk County wetlands inventory provides a basis from which to begin the inventory necessary for the site and affected areas. Biological information on plant and animal species from the 1970's work is also available and will be useful in the assessment phases of the wetlands evaluation.

3.17.2 Data Requirements

A detailed inventory of wetlands in the project area should be developed using new aerial photography (1987) and ground survey information. The definition of "wetlands" in NR 132 should be used as the criteria for including a given area in the inventory. The area to be inventoried should be as shown on Figure No. 3-5 (Section 3.5.3). This area is east of the Flambeau River and west of the Soo Line RR. This area includes all lands that may be affected by the proposed project.

That environmental information necessary to evaluate the biological, watershed, hydrologic support, groundwater, storm and flood storage, shoreline protection and other potentially unique functions that are not currently available should be collected to prepare an assessment of the importance and functions of each wetland. Criteria contained in NR 132.06(4)(g) should be used to assess each wetland that will potentially be affected by the project.

3.17.3 Methodology

Full spectrum color and color infrared aerial photography has been obtained during early September 1987 under "leaf-on" conditions. The flight area includes the Flambeau River on the north, the existing railroad on the east, County Highway "P" on the south, and the Flambeau River on the west. Nine by nine inch stereo sets (scale 1"=500') will be the format for the working photos.

Field reconnaissance by a soil scientist-hydrologist and biologist will verify the extent and quality of each wetland area in the flight area. Functions and values itemized in NR 132.06(4)(g) will be used to evaluate the significance of each wetland.

A procedure to evaluate the importance, value and function of each wetland will be developed, described and submitted to WDNR prior to the evaluation phase. The procedure will address each function in NR 132.06(4)(g) and will systematically compare and evaluate each wetland relative to its local and regional importance.

3.17.4 Data Presentation Format

The "wetlands" in the project area will be mapped at the 1"=500' and 1"=200' scales on existing topographic maps.

Any wetland to be affected by the project will be described and evaluated. A narrative explaining the evaluation procedure and results will be provided.

The potential effects of the project on each wetland will be described, and the criteria contained in NR 132.06(4)(h) used to demonstrate, if required, that an exemption from NR 132.06 is necessary for the project to proceed.

3.17.5 Schedule for Field Data Collection

Aerial photography will be obtained in early autumn of 1987 so that vegetation will be identifiable. Field analysis will occur in autumn 1987 and spring 1988.

3.17.6 Key Project Personnel

Wetland work will be performed by or under the direct supervision of the following Foth & Van Dyke scientists:

John E. Thresher, Ph.C. - Soil Scientist
Boyd N. Possin, M.S. - Water Resources
Tim J. Weyenberg, M.S. - Ecologist

4.0 QUALITY ASSURANCE PROGRAM

4.1 General Information

The objectives of quality assurance for the Kennecott Flambeau project are two-fold: 1) to ensure that the procedures used will produce representative baseline monitoring results; and 2) to ensure that all activities, findings and results follow an approved plan and are documented.

All sampling for individual work plans will be conducted in accordance with methods described within each plan. All laboratory standard operating procedures and quality control programs will be in compliance with NR 149 and NR 219.

4.2 Sampling Personnel

All field sampling for the Kennecott Flambeau project will be performed by trained and experienced personnel. Where field determination of parameters is critical, sampling will be performed only by qualified specialists in the various disciplines represented within this project.

4.3 Sample Collection and Handling Procedures

All sample storage containers will be provided by Foth & Van Dyke Laboratory Services. These will consist of clean, newly manufactured bottles or other containers made of materials suitable for constituents to be analyzed.

As samples are collected, they will be preserved in a manner consistent with the constituent to be analyzed. Samples to be preserved under "cool" conditions will be placed in a cooler containing ice immediately following collection.

Following sample collection, and prior to shipment to laboratories, samples will be stored in a secure location at Kennecott's Ladysmith office. Samples will be stored under conditions appropriate to the preservation requirements of the constituents to be analyzed.

Full chain-of-custody procedures will be followed for all sampling as outlined in Appendix A, Foth & Van Dyke Laboratory Services Quality Assurance Plan. All groundwater samples will be taken in accordance with PUBL-WR-186 (Groundwater Sampling Procedures, Wisconsin Department of Natural Resources, September 1987).

4.4 Reports

A formal internal review procedure for all documents generated in support of the Kennecott Flambeau project will involve cooperation between project segment managers and technical personnel. Reports of analyses from Foth & Van Dyke Laboratory Services will be reviewed and checked for accuracy by Mr. David Turriff, Ph.D., Laboratory Manager. Reports from all laboratories involved in the Kennecott Flambeau project will be monitored and reviewed by Mr. Bruce Burton, Senior Project Geologist, for procedural consistency and relevance to the project.

All written reports, memorandums and drawings resulting from the work plans outlined in this document will be reviewed by Mr. Lawrence E. Mercando, the Kennecott Project Manager and by Mr. Jerry W. Sevick, P.E., the Foth & Van Dyke Project Manager, in order to insure technical accuracy and consistency.

4.5 Project Safety and Health

Each Division of Foth & Van Dyke has a Safety Officer whose function is to maintain an ongoing safety program for each Division of the Company. Each employee is required to be aware of safety rules and practices of his/her Division.

Foth & Van Dyke maintains a Safety & Health Manual which covers such areas as:

- Personal Safety;
- Work-place Safety;
- Travel Safety;
- Lists of Available Safety Equipment;
- Hazardous Waste Sites;
- Medical Monitoring;
- Safety Training; and
- First Aid.

All field, laboratory and office safety rules and practices outlined in this manual will be carried out during the course of the operations outlined in this document.

4.6 Laboratory Quality Assurance

Appendix A to this Scope of Study consists of the Foth & Van Dyke Laboratory Quality Assurance Plan (LQAC). The LQAC covers many topics important to the Kennecott Flambeau project, including the following:

1. Laboratory Organization and Responsibility;
2. Safety Manual;
3. Services Available;
4. Sample Handling;
5. Shipping of Samples;
6. Chain-of-Custody Procedures;
7. Quality Control;
8. Duplicate and Blank Sampling Procedures;
9. Training Procedures;
10. Detection Limits;
11. Equipment Available;
12. Equipment Maintenance and Standards; and
13. Current Wisconsin Department of Natural Resources Certification (No. 405051240).

Foth & Van Dyke Laboratory Services will additionally be responsible for monitoring quality control procedures at subcontracting laboratories for the Kennecott Flambeau project.

4.7 Parameter Lists

Table No. 4-1 is a list of parameters to be sampled and analyzed, together with identifications of the laboratories which will perform the analyses.

TABLE NO. 4-1

Analytical Parameters for Groundwater, Surface Water, Stream Sediment, Waste Rock, Soil, and Biological Samples

Foth & Van Dyke Laboratory Services, Green Bay, Wisconsin:

Alkalinity, Total	Magnesium
Aluminum	Manganese
Arsenic	Mercury
Barium	Nickel
Beryllium	Nitrogen, Ammonia
B.O.D.	Nitrogen, Nitrate/Nitrite
Cadmium	Nitrogen, Total Kjeldahl
Calcium	Oxygen, Dissolved
Chloride	pH (Field)
Chromium, Hexavalent	Selenium
Chromium, Total	Silver
Cobalt	Sodium
Copper	Solids, Total Dissolved
C.O.D.	Solids, Total Suspended
Fluoride	Spec. Cond. (Field)
Hardness, Total	Sulfate
Iron	Temperature (Field)
Lead	Thallium
	Zinc
Acid Producing Potential	Modified Proctor
Leaching Potential	Moisture Density
Leachate Composition	Grain Size
EP Toxicity	Atterbergs
	Permeability

Enviroscan, Inc. (formerly Zimpro/Passavant, Inc.) Rothschild, Wisconsin:

Carbon, Total Organic
Molybdenum
Sulfer, Total
Tin
Titanium

Northern Lake Services, Crandon, Wisconsin:

Chlorophyll-a

TABLE NO. 4-1 (Continued)

McCoy and McCoy, Inc., Madisonville, Kentucky:

Uranium

Twin City Testing, St. Paul, Minnesota:

Triaxial Compressive Strength
Uniaxial Compressive Strength
Tensile Strength
Consolidation
Direct Shear Strength

To be Selected:

Bulk Chemical Analysis
Petrographic Analysis
X-Ray Diffraction

APPENDIX A

Foth & Van Dyke Laboratory Services
Quality Assurance Plan
and
Standard Operating Procedures
Revised: September 1987

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APPENDIX - LABORATORY CERTIFICATION

1.0 ORGANIZATION AND RESPONSIBILITY

In order for a laboratory to operate professionally and efficiently, an organizational structure with defined responsibilities is necessary. The job responsibilities of key staff are outlined below.

1.1 Laboratory Manager

- Long-range planning of the laboratory;
- Hiring and assignment of personnel;
- Justification, purchase and successful implementation of new equipment;
- Management of laboratory resources to accomplish designated goals; and
- Keeping laboratory staff focused on a quality control program that will meet legally defensible data quality objectives.

1.2 Technical Operations Supervisor

- Monitoring data for completeness, accuracy and data quality;
- Certification of personnel on new procedures;
- Maintaining up-to-date procedures and enforcing compliance with the written laboratory methods;
- Identifying corrective actions when quality control limits are not within acceptable limits; and
- Coordination of service work on instruments.

1.3 Chemists

- Performance of required tests according to a defined protocol;
- Calculation and calculation verification of lab results;
- Informing supervisor when out-of-control situations exist;
- Maintaining instrument log books for each instrument;

- Performing all quality control requirements for a project; and
- Preventive maintenance on instruments that they use.

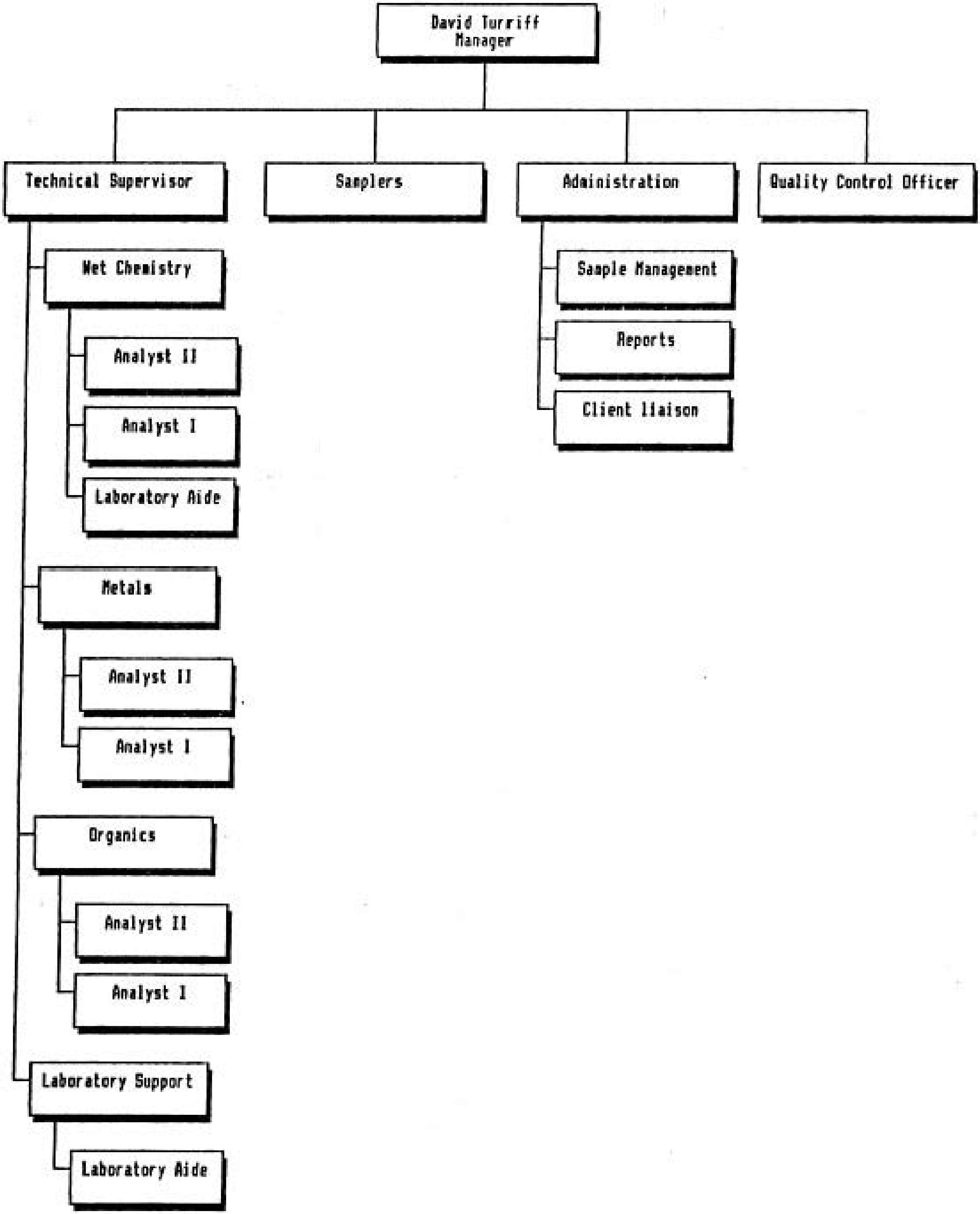
1.4 Quality Control Officer

- Ensuring chain-of-custody procedures and quality control protocols are being enforced as per client or agency requirements;
- Determination of enforcement limits for quality data;
- Ensuring that proper training protocol is being followed; and
- Supervising standards preparation and replacement.

Figure I is an organizational chart for Foth & Van Dyke Laboratory Services as of August 1987.

Figure I

Environmental Laboratory-Foth&Van Dyke
Organizational Chart
August 1987



2.0 LABORATORY SAFETY MANUAL

To maintain a safe working environment, a uniform set of standards, policies and procedures is required. Safety depends upon safety-mindedness and good judgment at all times. Our laboratory has an outstanding safety record.

The types of accidents that can be encountered in a laboratory setting are burns, cuts, punctures, explosions and exposure to corrosive materials.

In this manual are recommended procedures to maintain a safe working environment.

2.1 Safe Dress

No open toed shoes in main laboratory working areas.

No midriff tops.

Laboratory coats must be worn.

Safety glasses are worn at all times in the laboratory (except at designated desk areas).

2.2 Smoking

No smoking is allowed in the laboratory. Many chemicals are flammable.

2.3 Food

Laboratory glassware or equipment is not to be used for food preparation or beverages. Food is not permitted in the laboratory except at designated desk areas. Remember the type of samples we work with - wash those hands.

2.4 Laboratory Cleanliness

A safe work area is a clean place with everything in its place. A work area with clean aisles and neatly arranged equipment is a major factor in accident prevention.

2.5 Sample and Waste Disposal

Broken glasssware is disposed of in the plastic garbage can labeled "glassware." This is located in the main chemistry laboratory.

Groundwater samples may be rinsed down the drain and the sample bottles rinsed with tap water and thrown away.

Acids and alkalies can be discarded by rinsing them down a drain that is being flushed with tap water.

If in doubt about other materials, contact the Laboratory Supervisor.

2.6 Acids

All opened acid must be in shatter-proof, leak-proof containers. Acids are to be stored in acid safety cabinet.

2.7 Flammable Liquids

Flammable liquids and solvents are stored in the flammable safety cabinet.

2.8 Pipetting

Always pipet using a suction bulb. <u>Never pipet by mouth</u>.

3.0 LABORATORY SERVICES

3.1 Goals and Objectives

The purpose of the laboratory is to:

Provide analytical support for engineering projects as well as for industrial, governmental and private clientele.

Our primary goal is to provide laboratory services of the highest quality at a competitive price. To meet these goals, we maintain an efficient and technically superior staff equipped with state-of-the-art instrumentation. Recognizing that our personnel are our number one resource we provide:

- A safe working place;
- An organization which recognizes achievements and efforts;
- A structure allowing for advancement; and
- An opportunity for continuing education.

This in turn will provide a comfortable working environment allowing us to maintain top efficiency and high morale.

3.2 Range of Services

The following is a listing of areas in which our laboratory is involved:

3.2.1 Wastewater Analysis

- Routine monitoring for discharge permits.
- Treatability studies.
- Performance testing.
- Testing for billing purposes.
- Pilot plants.

3.2.2 Drinking Water

- Primary drinking water standards.
- Secondary drinking water standards.
- Corrosion potential.
- Process suitability.
- Private water supplies.

3.2.3 Groundwater

- Landfill monitoring.
- Environmental investigations.
- Wastewater seepage cell monitoring.
- Chemical spill monitoring.

3.2.4 Solid Waste

- Hazardous waste determination.
- Leaching evaluations.

3.2.5 Surface Waters

- Lake and stream studies.
- Sediment analysis.

3.2.6 Air Monitoring

- Ambient particulates.
- Landfill gas.

3.2.7 Product Analysis (Dairy, Paper, etc.)

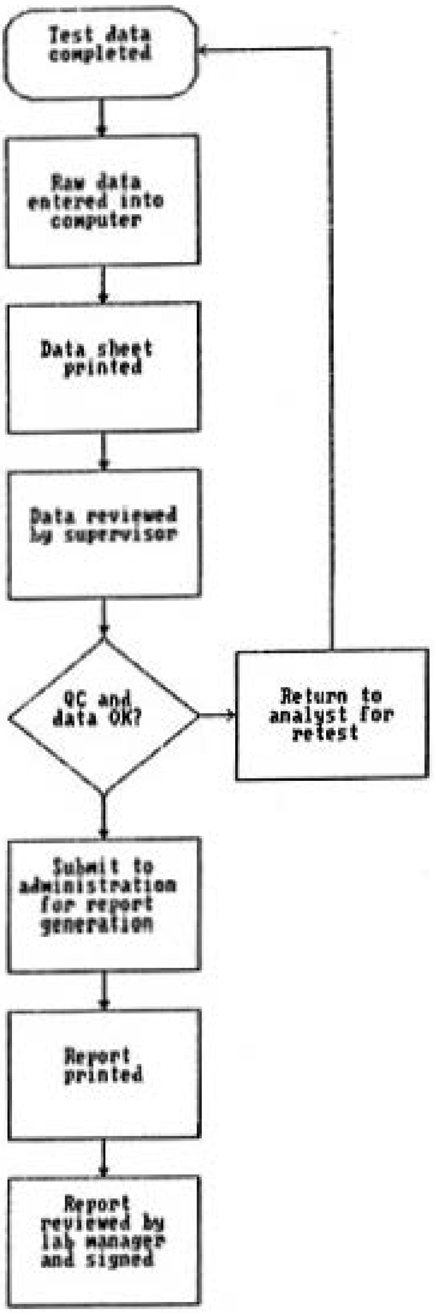
- Production trouble shooting (i.e., source of contamination).
- Performance testing.
- Nonroutine research.

We also provide sampling services and equipment. This includes:

- Groundwater monitoring equipment;
- Automatic wastewater samples;
- Flowmeters;
- Sediment sampling equipment;
- Velocity meters; and
- Lake and stream samplers.

Figure II

LABORATORY REPORT GENERATION



4.0 LABORATORY QUALITY CONTROL

4.1 Purpose

The purpose of a laboratory quality control program is to provide proof that the data generated from a laboratory is accurate and reliable. A detailed description of precision and accuracy can be found in Section 104 of "Standard Methods for the Examination of Wastewater, 15th Edition, 1980".

4.2 Responsibility

"A good analyst tempers confidence with doubt. Frequent self-appraisals should embrace every step--from collecting samples to reporting results."

4.3 Standard Methods

This philosophy defines the foundation for any quality control program. It must be adhered to by all levels of laboratory personnel, from the technician to the management staff. However, the analysts are the main factor controlling the program. They must prepare standards, spiked samples and run duplicate analyses. They also must monitor their results to determine whether the data are within the acceptable limits established by the quality control officer.

4.4 Quality Control Program Details

Foth & Van Dyke's Quality Control Program meets or exceeds requirements set forth by the U.S. EPA in Handbook for Analytical Quality Control in Water and Wastewater Laboratories, EPA-600/4-79-019 and is certified by the State of Wisconsin under the Wisconsin Administrative Code NR 149 for commercial laboratories.

4.4.1 Sample Collection

In collecting a sample, it is necessary to view the purpose for which the data generated from the laboratory will be used. The analyses that are required will dictate which sampling device, container and kind of preservative be used. Furthermore, a representative sampling point should be selected. As an example, if a representative sample of wastewater from a single industrial process is desired, a point must be selected that isolates that process. The flow from that process must be evaluated to determine when and how to take the sample. A completely mixed or homogeneous sample must be taken.

Figure III lists the recommended containers, preservatives and holding times for commonly desired analyses. It is strongly recommended that sampling personnel consult with the laboratory personnel prior to sample collection. The lab will supply all necessary bottles, preservatives and instructions. Holding times, which are the maximum times allowed between sampling and analysis, are very sensitive for some analyses and almost nonexistent for others. This is because some elements are unstable and may change valence states, precipitate out of solution or change to a vapor and leave the sample as a gas. Compounds can break down or also change to a vapor state. The laboratory must comply with the holding time restrictions. Prior notification that samples are going to be sent can avoid missed hold times.

4.4.2 Standard Solutions

A standard solution is a sample or series of samples of known concentrations. These solutions are made up in the laboratory by the analyst or bench chemist performing the analysis.

Standards are prepared with great caution, often using standardized material from a commercial supplier. Their purpose is two-fold:

Figure III

FOTH & VAN DYKE
LABORATORY QUALITY CONTROL
SAMPLE HANDLING

PARAMETER	EPA TEST METHOD NO.	SAMPLE VOLUME	PRESERVATIVE	SAMPLE CONTAINER	HOLDING TIME	INSTRUMENT
Acidity	305.1	100 mls	Cool 4 C	P-G	14 Days	N/A
Alkalinity	310.1	100 mls	Cool 4 C	P-G	14 Days	N/A
Aluminum	202.1 202.2	100 mls	HNO_3	P-G	6 Months	(3) (4)
Ammonia	350.3	500 mls	H_2SO_4 Cool 4 C	P-G	28 Days	(6)
Arsenic	206	100 mls	HNO_3	P-G	6 Months	(3) (4)
Barium	208.1 208.2	100 mls	HNO_3	P-G	6 Months	(3) (4)
B.O.D.	507**	1000 mls	Cool 4 C	P-G	48 Hours	(1)
Boron	212.3	100 mls	HNO_3	P	6 Months	(5)
Cadmium	213.1 213.2	100 mls	HNO_3	P-G	6 Months	(3) (4)
Calcium	215.1	100 mls	HNO_3	P-G	6 Months	(3) (4)
C.O.D.	410.4	100 mls	H_2SO_4	P-G	28 Days	(2,5)
Chlorides	325.3	100 mls	Cool 4 C	P-G	28 Days	N/A
Chromium, Hex.	218.5	100 mls	Cool 4 C	P-G	24 Hours	(3)
Chromium, Total	218.1 218.2	100 mls	HNO_3	P-G	6 Months	(3) (4)
Copper	220.1	100 mls	HNO_3	P-G	6 Months	(3) (4)
Cyanide	335.1 335.2	1000 mls	NaOH, Cool 4 C	P-G	14 Days	(5)
Fluoride	340.1	100 mls	None	P	28 Days	(5)
Hardness	130.2	100 mls	HNO_3	P-G	6 Months	N/A
Iron	236.1 236.2	100 mls	HNO_3	P-G	6 Months	(3) (4)

NOTE: All methods from "Methods for Chemical Analysis of Water and Wastes," US-EPA 1983.
* Federal Register, 49, NO 209, pp 1-210, 1984
** Standard Methods for the Examination of Water and Wastewater, 16th Edition.

Sample Handling (cont.)

PARAMETER	EPA TEST METHOD NO.	SAMPLE VOLUME	PRESERVATIVE	SAMPLE CONTAINER	HOLDING TIME	INSTRUMENT
Kjeldahl Nitrogen	351.3	500 mls	H_2SO_4, Cool 4 C	P-G	28 Days	N/A
Lead	239.1 239.2	100 mls	HNO_3	P-G	6 Months	(3) (4)
Magnesium	242.1	100 mls	HNO_3	P-G	6 Months	(3) (4)
Manganese	243.1	100 mls	HNO_3	P-G	6 Months	(3) (4)
Mercury	245.2	500 mls	HNO_3	P-G	28 Days	(3)
Nickel	249.1	100 mls	HNO_3	P-G	6 Months	(3) (4)
Nitrate & Nitrite	353.3	100 mls	H_2SO_4 Cool 4 C	P-G	28 Days	(5)
Nitrate	353.3	100 mls	Cool 4 C	P-G	48 Hours	(5)
Nitrite	353.3	100 mls	Cool 4 C	P-G	48 Hours	(5)
Oil & Grease	413.1	1000 mls	H_2SO_4 Cool 4 C	G	28 Days	N/A
Organic nitrogen	See Kjeldahl					
Orthophosphate	365.2	100 mls	Filter Cool 4 C	P-G	48 Hours	(5)
Oxygen, Dissolved	360.1	500 mls	On Site		Immediately	(1)
pH	150.1	100 mls	On Site	P-G	Immediately	(7)
Phenols	420.1	1000 mls	H_2SO_4 Cool 4 C	G	28 Days	(5)
Phenols- (Acid Extractables by gas Chromatography)	604*	1000 mls	Cool 4 C	G	7 Days Ext. 40 Days Analysis	(9)
PCB/Pesticides	608*	1000 mls	Cool 4 C	G	7 Days Ext. 40 Days Analysis	(9)
Phosphorus	365.2	100 mls	H_2SO_4 Cool 4 C	P-G	28 Days	(5)
Potassium	258.1	100 mls	HNO_3	P-G	6 Months	(3) (4)

NOTE: All methods from "Methods for Chemical Analysis of Water and Wastes," US-EPA 1983.
* Federal Register, 49, NO 209, pp 1-210, 1984
** Standard Methods for the Examination of Water and Wastewater, 16th Edition.

Sample Handling (cont.)

PARAMETER	EPA TEST METHOD NO.	SAMPLE VOLUME	PRESERVATIVE	SAMPLE CONTAINER	HOLDING TIME	INSTRUMENT
Solids, Total	160.3	100 mls	Cool 4 C	P-G	7 Days	N/A
Solids, Dissolved	160.1	100 mls	Cool 4 C	P-G	48 Hours	N/A
Solids, Suspended	160.2	100 mls	Cool 4 C	P-G	7 Days	N/A
Solids, Volatile	160.4	100 mls	Cool 4 C	P-G	7 Days	N/A
Selenium	270.2 270.3	100 mls	HNO_3	P-G	6 Months	(3) (4)
Silver	272.1 272.2	100 mls	HNO_3	P-G	6 Months	(3) (4)
Sodium	273.1 273.2	100 mls	HNO_3	P-G	6 Months	(3) (4)
Specific Conductivity	120.1	200 mls	Cool 4 C	P-G	28 Days	(8)
Sulfate	275.4	200 mls	Cool 4 C	P-G	28 Days	(5)
Sulfide	376.1	200 mls	Zn Acetate NaOH, Cool 4 C	P-G	7 Days	N/A
Sulfite	377.1	200 mls	On Site		Immediately	N/A
TOC	415.1	100 mls	H_2SO_4, Cool 4 C	G	28 Days	(11)
Volatile Organics	601,602*	40 mls	Cool 4 C	G	14 Days	(10)
Zinc	289.1 289.2	100 mls	HNO_3	P-G	6 Months	(3) (4)
BACTERIA						
Fecal Coliform	909C**	100 mls	$Na_2S_2O_3$ Sterile	P-G	24 Hours	N/A
Total Coliform	908A**	100 mls	$Na_2S_2O_3$ Sterile	P-G	24 Hours	N/A
Flash Point	ASTM D-93-79 Pensky-Martens Closed Cup Tester	100 mls		Glass		

NOTE: All methods from "Methods for Chemical Analysis of Water and Wastes," US-EPA 1983.

* Federal Register, 49, NO 209, pp 1-210, 1984

** Standard Methods for the Examination of Water and Wastewater, 16th Edition.

Figure III (continued)

Required containers, preservation techniques, and holding times are from the Wisconsin Administrative Code, Chapter NR 219.

INSTRUMENT CODE

1. Weston & Stack Dissolved Oxygen Analyzer, Model 330
2. Hach COD Reactor & Digestion Solution
3. Perkin-Elmer 3030B Atomic Absorption Spectrophotometer
4. Perkin-Elmer HGA 300 (furnace)
5. Bausch & Lomb Spectronic 70
6. Orion Model 701A/Digital Ionalyzer
7. Orion Model 201/Digital pH Meter
8. YSI Model 33-S-C-T Meter
9. Perkin-Elmer Sigma 1
10. Hewlett-Packard 5890 with Tracor ALS 2 for Purge and Trap
11. Dohrmann DC80 TOC Analyzer
12. Dohrmann DX20 TOH Analyzer

CAPABILITY EXISTS FOR OTHER ANALYSES. PLEASE CONTACT THE LABORATORY FOR MORE INFORMATION.

- Preparation of a standard curve for instrumentation calibration; and

- Testing of the performance of the analyst and method.

4.4.3 Procedural Blanks

Procedural blanks will be performed for each batch of samples or for each set of 20 samples when more than 20 samples are submitted with a batch. A blank solution of Mili-Q water is prepared and treated as a sample to be run with the batch of samples being analyzed. The blank is subjected to all pretreatment, digestion and dilution or concentration procedures and analyzed on the instrument or instruments that the associated samples were analyzed by. Any contamination that may be introduced into the sample during the sample preparation or analytical procedures would be identified in the procedural blank.

If the concentration of the blank is above the instrument detection level (IDL): For any groups of samples associated with a particular blank, the concentration of the sample with the least concentrated analyte must be 10X the blank concentration, or all samples associated with the blank and less than 10 times the blank concentration must be redigested and reanalyzed. The sample value will not be corrected for the blank value.

4.4.4 Field Blanks

Field blanks will be periodically submitted with the set of samples to be analyzed. The field blank is an empty sample container with preservatives and a blank solution that is sent to the sampling site with the other sample containers. The bottle is exposed during the sampling process and returned to the laboratory along with the other sample containers. The field blank is analyzed by the same methods as the samples are analyzed. A clean field blank would indicate that sample bottles are not being contaminated during the bottle preparation of the sampling process.

4.4.5 Duplicates and Spikes

Duplicates and spikes will be run on every 10 or fewer samples as indicated below:

1-10 Samples: 1 spike and 1 duplicate
11-20 Samples: 2 spikes and 2 duplicates

The samples will be divided into three matrices for tracking quality control data:

- water
- leachates
- solids/sludges

If different samples in an analysis set require different preparation methods, each set must have its own spikes and duplicates.

At least one standard check sample shall be run with each set of analyses and after every set of 20 samples. The instrument response for the standard shall be within the following limits:

- For the following analyses, the deviation of the check standard must be within +/- 10%.

Nitrate	Orthophosphate
Nitrite	Phosphorus
Ammonia	C.O.D.
Total Kjeldahl Nitrogen	Cyanide
Fluoride	Phenols

Aluminum	Cadmium
Chromium	Calcium
Nickel	Potassium
Silver	Sodium
Zinc	Arsenic
Barium	Copper
Boron	Mercury
Selenium	Silicon
Hardness	Chloride
Sulfate	

- B.O.D. limits shall be established in an authoritative source such as "Standard Methods."

- Other parameters will establish limits as a result of laboratory performance records utilizing +/- 3x standard deviation. Each standard solution shall be labeled in the following manner:

Standard Solution: (Parameter)
Concentration: (mg/l, mg/ml, g/l, etc.)
Date Prepared:
Expiration Date:
Prepared by:

A standard solution shall not be used beyond its expiration date unless no other standards or reagents to prepare standards are available. If circumstances prohibit the use of fresh standard solutions, the results shall note this fact.

The standard solutions shall be handled and stored in such fashion as to prevent degradation of the analyte.

4.4.6 Duplicate Analyses - Precision

A duplicate sample is prepared within the laboratory by taking two portions from one sample and analyzing them as individual samples. After completion of the analyses, the following formula shall be used to calculate % error of the check or duplicate analyses:

$$\% \text{ Error} = \frac{(A - X) \times 100}{X}$$

Where:
A = The large value of the two duplicate analyses,
X = Average of the two duplicate analyses.

A duplicate analysis shall be run after every tenth sample. The laboratory shall establish limits for each analyte based on laboratory performance records.

4.4.7 Spiked Samples-Accuracy

A spike sample is created by preparing a duplicate sample to which a known amount of analyte has been added to determine percent recovery. The spiking of the sample shall be done before any extraction or digestion. A spike sample shall be analyzed for every 10 samples except for those analytes listed below:

Alkalinity/Acidity	pH
Color	Oil and Grease
Specific Conductance	Sulfide
Sulfite	Surfactants
Turbidity	Corrosivity
Ignitability (Flash Point)	Reactivity
Titrametric Tests	Gravimetric test
B.O.D.	

After completion of the analyses, the following formula shall be used to calculate % recovery:

$$\% \text{ Recovery} = \frac{(A - B)}{C} \times 100$$

Where:

A = Results of the spiked duplicate analysis.

B = Results of the unspiked duplicate analysis.

C = Known value of the spike concentrations.

The laboratory shall establish limits for each analyte based on laboratory performance records utilizing +/- 3x standard deviation of a 99.7% confidence limit.

If the results of standards, duplicates or spikes exceed quality control limits, corrective action shall be taken by the laboratory. Results generated back to the last acceptable quality check shall be questioned and reanalyzed. If any data are out-of-control, the analyst must first check the calculations. If the calculations are valid, the analyst should rerun the spike or duplicate immediately along with one other spike or duplicate on another sample from the same set. The plan of action after these results are known must be discussed with the technical supervisor or lab manager.

Spike sample failures may be due to a special sample matrix. The laboratory shall be cognizant of this and attempt to determine if that special sample is subject to error not characteristic of the other analyses.

4.4.8 Unknown Samples

Unknown samples can be divided into two categories:

Figure IV

Foth and Van Dyke Laboratory
Quality Control Limits
Accuracy
Year:1987

Parameter	Matrix	Mean Recovery,%	Warning Limits	Control Limits

Blind Standards
Certification Standards

A blind standard means a sample with a known amount of analyte in which the concentration of the analyte is unknown to the analyst. The concentration is known to the section manager and quality control officer. A certification standard is the same as a blind standard. However, results from the analysis are to be submitted to the certifying authority for review and approval. A blind standard must be successfully analyzed on two separate occasions prior to an analyst being approved for that particular analyte procedure. A blind standard shall be run at least four times per year for each analyte. Failure to complete the analysis within the limits established for standard solutions or those provided with the sample will result in corrective action by the laboratory. Again, the analyst failing to correctly analyze a blind standard must repeat the procedure until proficiency is gained and successful completion of a blind standard is accomplished. The certification standards will be regulated by the certifying authority. At the present time, Foth & Van Dyke is certified under Chapter 149 of the Wisconsin Administrative Code for all parameters listed in Appendix A.

Blind standards are available through the U.S. - E.P.A.'s office of Quality Control. Blind quality control samples, obtained from commercial sources, are also submitted quarterly and records are maintained of performance.

4.4.9 Establishment of Method Detection Limits

The method detection limit (MDL) shall be established by obtaining the standard deviation of the analysis of spiked reagent water at a concentration of analyte 3-5 times the estimated MDL on three nonconsecutive days with seven measurements per day. Three times the standard deviation shall be the MDL. Five times the standard deviation shall be the limit of quantitation or LOQ.

Figure V

LAB DETECTION LIMITS MG/L

Parameter	Detection Limit	Parameter	Detection Limit
Acid/Alkalinity	10	Nickel	0.04/0.001
Ammonia-N	0.03	Nitrate/Nitrite-N	0.01
Arsenic	0.001	Oil & Grease	5
$B.O.D._5$	6	Oxygen, Dissolved	0.05
Barium	0.1	pH	0.01 S.U.
Bromide	2		
Cadmium	0.001	Phenols	0.005
Calcium	0.05	Phosphorus, Ortho	0.10
Chloride	1.0	Phosphorus, Total	0.01
Chromium, Hex	0.05	Potassium	0.01
Chromium, Total	0.05	Selenium	0.001/0.0002
C.O.D. (Std.)	20	Silver	0.02/0.0002
Conductivity	1 Micro mhos/cm		
Copper	0.02/0.001	Sodium	0.05/0.0002
Cyanide	0.02	TDS	20
Fluoride	0.1	TSS 50 ml.	4
Hardness	2.0	TS	10
Iron	0.03	TVS	20
Kjeldahl-N	1	T.O.C.	1
Lead	0.1/0.001	Sulfate Sulfite	1 2
Magnesium	0.01	Thallium	0.1/0.001
Manganese	0.01	Zinc	0.01/0.00005
Mercury	0.0002	Total Coliform Fecal Coliform	1 organism/100 mls 1 organism/100 mls
Aluminum	0.1/0.003	Flash Point	1° F/C
Antimony	0.2/0.003	PCB	0.0001
Boron	0.02	Volatile Organics Base Neutrals	* *
Sulfide	Depends on Sample	Acid Extractables Pesticides	* *
Molybdenum	0.1/0.001		

NOTE: Metal limits given as Flame/Graphite Furnace.
*Dependent upon compound requested.

4.5 Training

Before an analyst can be certified on any procedure, he/she must complete the following steps:

- Must be shown the procedure by an experienced analyst;
- Must perform the test under the supervision of an analyst; and
- Must successfully analyze an unknown sample on two separate occasions

4.6 Preventative Maintenance

The frequency of maintained procedures varies from daily to annual. All maintenance performed will be documented in the instrument's preventative maintenance log book along with routine readings that are taken on a daily basis.

4.6.1 Mercury Analysis System

The hydride system requires a minimum of daily care. At the end of the day, the reductant reservoir is removed and stoppered. A bottle containing deionized water is then screwed onto the fitting and the system is purged with deionized water. Periodically, the immersion tube is removed from the flange and rinsed with 3 percent HCl. The reaction flasks are also rinsed with 3 percent HCl at regular intervals.

4.6.2 Graphite Furnace Atomic Absorption

Graphite furnace maintenance involves changing the graphite tubes when necessary. The contact rings are cleaned before each new tube is installed. The tube ends are wiped and the tube thermally conditioned. Pyrolitically coated grooved graphite tubes are used. The quartz windows to the furnace are cleaned with methanol and dried with a soft lint-free cloth. The work head surface is cleaned weekly.

Figure VI

Foth and Van Dyke Laboratory Training Form

Trainee: ______________________

Test: ______________________

Trainer: ______________________

Date of Certification: __/__/__

This is to certify that the trainee can perform the above test without supervision. The trainee has successfully completed the following steps in training:

1. Has been shown all steps of the test __
2. Has performed the test under supervision __
3. Has successfully analyzed EPA performance samples on two separate occassions __
4. Can independently complete all necessary calculations __

Signatures:

Trainee: ______________________

Trainer: ______________________

All other maintenance requirements are performed by a service engineer. An annual maintenance and operational check is performed to ensure that the instruments meet manufacturer's specifications.

4.6.3 Gas Chromatograph

On a daily basis, the response of a standard mixture is checked and compared with previous results. Deteriorating response may indicate that detector cleaning or other preventative maintenance procedures are needed.

4.7 Laboratory Pure Water

Foth & Van Dyke laboratory pure water is generated through the use of two systems:

- A Calgon Deionizing System Cation and Anion Beds
- Barnstead Nano Pure II System

Laboratory pure water (reagent grade water) shall be free of any impurities that may affect the quality of sample analysis. The quality control program used by Foth & Van Dyke will determine the quality of our laboratory pure water. In addition to this, a resistance meter is on line with the Nano Pure II System. Manufacturers' recommendations are followed for this system.

4.8 Records

All data sheets and instrument tapes are saved for a minimum of five years. Calculations and reports are performed by two IBM-PC compatible computers.

Figure VII

GC Maintenance Schedule

Procedure	Frequency
Standard Mixture Response Check	Daily
Carrier Gas Flow	Daily
Column Detector and Inlet Temperature Check	Daily
Column Performance Evaluation and Endrin Breakdown	Daily
Septum Replacement	As Required
Carrier Gas Drier	As Required
ECD Wipe Test	Every 6 Months

Figure VIII

Equipment Maintenance Procedures

Instrument	Procedure	Frequency
All Balances	Mettler Field Service	Annually
	Class S-1 Weight Check	Monthly
Mili-Q Water System	Check Conductivity	Every Use
	Check Deionizer Light	Every Use
	Check Pressure Gages	Every Use
	System Cleaning	As Required
	Replace Resin Cartridges	As Required
Drying Ovens	Temperature Monitoring	Daily
Refrigerators	Temperature Monitoring	Daily
	Temperature Adjustment	As Required
Vacuum Pumps/Air Compressor	Drained	Monthly
	Belts Checked	Monthly
	Lubricated	As Required
pH Meter	pH Calibration (2 Buffers)	Daily
	pH Electrode Maintenance	As Required
Spectrophotometer	Calibrate Wavelength	Monthly
	Replace Lamps	As Required
	Replace Phototubes	As Required

4.9 Chain-of-Custody Procedures

4.9.1 Sample Labels

Will include:

- Name of collector;
- Date and time of collection;
- Place of collection; and
- Sample number.

4.9.2 Sample Seals

Will be used to preserve the integrity of the sample and will include:

- Name of collector;
- Date and time of collection; and
- Sample number.

4.9.3 Field Log Book

Will be bound and include sufficient information to reconstruct the sampling and:

- Purpose of sampling;
- Location of sample point;
- Name and address of field contact;
- Producer of waste and address;
- Type of process producing the waste;
- Type of waste;
- Suspected waste composition;
- Number and volume of samples taken;
- Description of sampling point and sampling methodology;
- Date and time of collection;

- Sample identification numbers;
- Sample distribution (to what lab) and means of transportation (UPS, Federal Express, etc.);
- Any references such as maps or photographs of the area;
- Field observations; and
- Any field measurements made, such as pH.

4.9.4 Chain-of-Custody Record

Will include:

- Sample number;
- Signature of collector;
- Date and time of collection;
- Place and address of collection;
- Waste type; and
- Signature of persons involved in the chain of possession and inclusive dates of possession.

4.9.5 Sample Analysis Request Sheet

Will include any pertinent information noted in log book and:

- Name of person receiving the sample;
- Laboratory sample number;
- Date of sample receipt;
- Sample allocation; and
- Analyses to be performed.

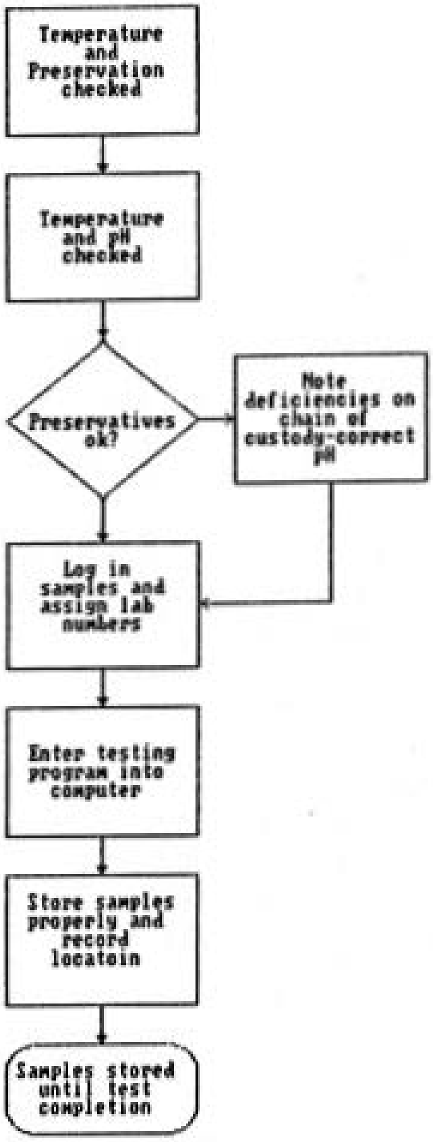
4.9.6 Sample Delivery to the Laboratory

- Deliver as soon as possible
- Sample will be accompanied by:
    - Chain of custody record
    - Sample analysis request sheet
- Delivered to person authorized to receive samples in the lab

4.9.7 Shipping of Samples

- A material identified in the DOT Hazardous Material Table (49 CFR 172.101) must be transported as prescribed in the table.
- All other hazardous waste samples must be transported as follows:
  - Collect sample in appropriately sized glass or polyethylene container;
  - Allow sufficient room for sample expansion (about 10% by volume);
  - Up to one gallon may be collected if the sample's flashpoint is $\geq$ 23°C; if so, the flashpoint must be marked on the outside container;
  - Seal sample and place in a 4 ml thick polyethylene bag, one sample per bag.
  - If the sample is solid,
    - Place bag inside a cushioned over pack.
    - Dry or wet ice may be used to preserve the sample;
  - If the sample is liquid,
    - Place bag inside a metal can with noncombustible, absorbent, cushioning material (vermiculite), close the can and clip or tape the lid securely;
    - Mark the can with:
      - Name;
      - Address;
      - "Flammable Liquid N.O.S." - this refers to the class of packing needed to comply with DOT regulations, not that the sample is necessarily flammable;
    - Place one or more cans in a strong outside container (cooler or fiberboard box);
    - Dry or wet ice may be used to preserve the samples;
  - Complete carrier's certification form;

Figure IX



Temperature and Preservation checked
Temperature and pH checked
Preservatives ok?
Note deficiencies on chain of custody-correct pH
Log in samples and assign lab numbers
Enter testing program into computer
Store samples properly and record locatoin
Samples stored until test completion

Figure X

CHAIN OF CUSTODY RECORD

PROJECT NO.	PROJECT NAME
	Pittsburgh Linoleum

SAMPLERS: (Signature) Henry Sampler

STA. NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	1L Amber	500 ml Plastic/H_2SO_4	1L Plastic/HNO_3				REMARKS
	5/21/87	8:00 A.M.		X	MW 18 A	3	X	X	X				

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)
Henry Sampler	5/21/87 8:55 A.M.	Laurie Woelfel			

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED FOR LABORATORY BY: (Signature)	DATE/TIME	REMARKS:
				Received OK - Temp OK - pH OK LW

White - Foth & Van Dyke
Yellow - Lab
Pink - Sampler

FORM #304 W-1 (5/80)

- Samples may be transported by rented or common carrier truck, bus, railroad, or Federal Express, etc., but not by air.

4.9.8 Receipt and Logging of Sample

Person receiving samples in the lab will:

- Inspect condition of sample and seal;
- Assign the sample a lab number;
- Store the sample in a secured sample room or cabinet; and
- Resolve all discrepancies in information accompanying the sample.

4.9 Assignment of Sample for Analysis

- The sample is split, if necessary, to cover all the desired analyses; and
- Assigned to at least one analyst who is responsible for its custody and care.
- The lab notebook should include:
  - Identifying information about the sample;
  - Date of receipt; and
  - Testing and calculations.

4.10 Equipment List

Atomic Absorption Spectrophotometer, Perkin-Elmer Model 3030B

- Flame
- Graphite Furnace
- Cold Vapor
- Hydride
- EDL Power Supply

Gas Chromatograph, Perkin-Elmer, Model Sigma 1B
- Electron Capture Detector
- Flame Ionization Detector
- Nitrogen-Phosphorus Detector

Gas Chromatograph, Hewlett-Packard, Model 5890
- Hall Electrolytic Conductivity Detector
- Photoionization Detector
- Electron Capture Detector

Purge and Trap, Tekmar, Model LSC-2

Autosampler, Tekmar, Model ALS

Spectrophotometer, Bausch and Lomb, Model 70

Analytical Balance, Sartorius, Model A200S

Top Loading Balance, Scientific Products Model Z-3000-I

Ion Analyzer, Orion Research, Model 701A

Water system, Barnstead, Nanopure II

Autoclave

Hamilton Fume Hoods, two

E.P. Toxicity Extraction Apparatus

IBM PC-Compatible Computers, Zenith Z-100, two

IBM PC-Compatible Computer, Leading Edge Model D, with Millipore Dynamic Solutions Software for Chromatographic Processing and Archiving

IBM System 38

Monitoring Equipment

- Composite Samplers, Isco, with battery or line connection, eight

- Sequential Samplers, Isco, with battery or line connection, two

- Flow meter, Isco, Model 1870, eight

- Flow Meter, Polysonics, Model DHT-P, one

Figure IX

SIGNIFICANT FIGURES BY PARAMETER

Parameter	Significant Figures
Alkalinity	10 - 1000 = 10
Ammonia	0.1 - 10 = 0.1 10 - 1000 = 1
B.O.D.	5 - 100 = 1 100 - 1000 = 10 1000 - 10,000 = 100
Boron	0.02 - 0.10 = 0.02 0.10 - 1.0 = 0.10 1.0 - 10 = 0.1
Chloride	1 - 100 = 1 100 - 1000 = 10
Chromium - Hex.	0.01 -0.10 = 0.01 0.10 - 1.0 = 0.1
Conductivity	2 Significant Figures
C.O.D.	5 - 100 = 1
Cyanide	0.02 - 0.10 = 0.02 0.10 - 1.0 = 0.10 1.0 - 10 = 0.1
Flashpoint	1 degree F
Flouride	0.01 - 1.0 = 0.04 1.0 - 10 = 0.1
Hardness	2 - 10 = 4 10 - 1000 = 10
Kjeldahl-N	1 - 100 = 1
Oil, Fat, Grease	2 - 10 = 1 10 - 100 = 10 100 - 1000 = 100
P.C.B.	2 Significant Figures
Phenols	0.05 - 1.0 = 0.01
Phosphorus	0.10 - 1.0 = 0.01 1.0 - 10 = 0.1
Nitrate-N	0.01 - 1.0 = 0.01
Nitrate-N	0.01 - 1.0 = 0.01
Solids	1 - 100 = 1 100 - 1000 = 10
Sulfate	1 - 100 = 1 100 - 1000 = 10
Sulfide	0.2 - 10 = 0.1 10 - 100 = 1

APPENDIX

LABORATORY CERTIFICATION

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Carroll D. Besadny
Secretary

BOX 7921
MADISON, WISCONSIN 53707

July 6, 1987

IN REPLY REFER TO: 4810

Gerald Berg
Foth & Van Dyke, Inc.
P.O. Box 19012
Green Bay, WI 54307-9012

Dear Mr. Berg:

I am pleased to inform you that your renewal for laboratory certification under ch. NR 149, Wis. Adm. Code, has been granted. Your certification is valid until June 30, 1988, for the following test categories:

1. Oxygen Utilization (BOD's)
2. Nitrogen (Ammonia, Kjeldahl - Nitrogen, Nitrate & Nitrite)
3. Phosphorus
4. Physical (solids)
5. General I
6. General II (COD, Cyanide, Fluoride, and Phenols)
7. General III
8. General IV
9. Metals I
10. Metals II (Arsenic, Mercury and Selenium)
17. Organics; PCB's

Your laboratory ID# is 405051240. This number should be recorded before the laboratory name in the appropriate space on any Discharge Monitoring Report Forms, Groundwater Monitoring Turnaround Documents, or Sludge Characteristic Report Forms. If your laboratory is contracted to do laboratory work for a facility, but you aren't completing the form, notify the facility of your laboratory ID#.

Reference samples for the next renewal will be available from the State Laboratory of Hygiene in February 1988. Other reference sample sources are also acceptable (see s. NR 149.13, Wis. Adm. Code).

The creditability of this program is built on records which you are required to keep on the quality of data you generate. These records will provide data users with confidence in the data generated and give them the ability to make management judgment with knowledge that the data base is reliable.

Sincerely,

Lloyd A. Lueschow, Director
Office of Technical Services
Division of Environmental Standards

LAL:RA:mf:4572C

cc: Linda Vogen - Lake Michigan District