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Preliminary environmental report: Flambeau Mining Corporation copper mine, Rusk County, Wisconsin. 1975

Madison: State of Wisconsin, Department of Natural Resources, 1975

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THE ENVIRONMENTAL IMPACT STATEMENT PROCEDURE

The Wisconsin Environmental Policy Act (WEPA), Section 1.11, Wisconsin Statutes, became effective on April 29, 1972. This law requires that all state agencies prepare an environmental impact statement for every recommendation or report on proposals for legislation and other major actions significantly affecting the quality of the human environment, and that a public hearing be held on those proposals other than for legislation. The Department of Natural Resources, therefore, is required to prepare environmental impact statements on Department proposals and proposals over which it has permitting authority, if the proposal is determined to be a major action significantly affecting the quality of the human environment.

Governor's Executive Order Number 69 established guidelines to be used by state agencies for implementing WEPA. The guidelines require that the agency prepare a preliminary environmental report, followed by an environmental impact statement and a public hearing. Under these guidelines, the preliminary environmental report (PER) is circulated for a 45-day review to state, federal, and local agencies with expertise or concerns related to the project, and it is also made available to the public. Comments and questions submitted to the Department on the PER are used to develop an Environmental Impact Statement (EIS). The EIS is circulated to the commenting agencies and the public for a 30-day review. A hearing is then held to receive the views of the public on the Department's environmental impact statement. Following the public hearing, the Department formulates a conclusion on its decision for the proposed action. This decision is circulated to commenting agencies and the public.

Both the PER and the EIS are full-disclosure documents which provide a full description of the proposed project, the existing environment and an analysis of the anticipated environmental effects.

The review schedule for the proposed Flambeau Mining Corporation Copper Mine, Rusk County, Wisconsin, is as follows:

Date PER released: August 6, 1975
Review Deadline on PER: September 22, 1975
Date EIS released:
Review Deadline on EIS:
Hearing Date:

Comments should be addressed to:

Mr. C. D. Besadny
Department of Natural Resources
Box 450
Madison, Wisconsin 53701

City & County

Flambeau Mining Corporation Copper Mine
Rusk County, Wisconsin

(XX) Preliminary Environmental Report ( ) Environmental Impact Statement

Department of Natural Resources, Bureau of Environmental Impact

1. Type of Action:
   (X) Administrative Action
   ( ) Legislative Action

2. Description of the Proposed Action: The Flambeau Mining Corporation, a wholly-owned subsidiary of Kennecott Copper Corporation, proposes to establish an open pit copper mine southwest of Ladysmith in Rusk County, Wisconsin. The copper-sulfide ore would be concentrated at the project site and transported out of Wisconsin for smelting.

   The project would create a pit, 55 acres at the surface and approximately 285 feet deep, which would be rehabilitated as a lake. The tailings and other waste rock would be held in a 186-acre diked, waste containment area which would be dewatered and vegetated to form a terraced, flat-topped hill. A total of 349 acres would be premanently altered because of the project.

   The project would create a maximum of 220 jobs during the construction phase and 78 jobs during the operating phase. The normal annual payroll is estimated at $1,020,000. Total capital investment would range from $15 to $18 million.

3. Summary of Adverse Environmental Impacts: The following adverse impacts are anticipated:

   a. Minor deterioration of air quality due to fugitive dust and heating plant emissions.
   b. Minor increase in noise levels.
   c. Alteration of the groundwater gradient around the open pit.
   d. Elimination of a small intermittent stream.
   e. Possible degradation of water quality of the Flambeau River depending on the method of final disposal of waste process water and tailings leachate.
   f. Possible contamination of groundwater due to seepage from the waste containment area.
   g. Alteration of the landscape in the form of the open pit and waste containment area.
   h. Substantial relocation of soil material and some soil loss through erosion or covering.
   i. Loss of some agricultural fields and mixed deciduous-coniferous upland forest. Possible heavy metal contamination of wetland vegetation.
   j. Some loss of wildlife habitat and reduction of wildlife populations.
   k. Some local housing shortages due to the influx of workers from outside of Rusk County.
   l. Some unemployment at mine closing.
   m. Periodic traffic delays on Highway "27" due to blasting operation and rail shipments of concentrate.

4. Alternatives Considered:

   a. Defer development
   b. Abandon development plans
   c. Mine by underground methods
   d. Fill the open pit with tailings
   e. Allow groundwater and precipitation to fill the open pit
   f. Pump untreated process water into bottom of pit lake
   g. Relocate the waste containment area
   h. Redesign the waste containment area
   i. Relocate the haul road
   j. Use existing rail facilities at Ladysmith
   k. Provide a rail siding along the existing rail line
   l. Connect to the Ladysmith sewer and water facilities
   m. Install a package sewage treatment plant

5. List of Federal, State, and Local Agencies from which Comments have been Requested:

a. Federal Agencies
Department of the Interior
Environmental Protection Agency
Department of Agriculture
    Forest Service
    Soil Conservation Service
Department of Commerce
    Economic Development Administration
Department of the Army, Corps of Engineers
Department of Health, Education, and Welfare
Department of Transportation
Federal Power Commission
Upper Mississippi River Basin Commission

b. State Agencies
Department of Administration
Department of Agriculture
Attorney General
Department of Business Development
Geological and Natural History Survey
Department of Health and Social Services
Highway Commission
State Historical Society
Department of Industry, Labor, and Human Relations
Job Service
Department of Justice, Public Intervenor
Legislative Reference Bureau
Natural Beauty Council
Department of Public Instruction
Public Service Commission
Department of Revenue
Board of Soil and Water Conservation Districts
Department of Transportation
U.W. System
Wisconsin Environmental Education Council
Department of Local Affairs and Development

c. Agencies of Other States
Minnesota Pollution Control Agency
Minnesota Department of Natural Resources
Minnesota Geological Survey
Michigan Department of Natural Resources

d. Local Agencies
Northwest Wisconsin Regional Planning Commission
Rusk County Board of Supervisors
Rusk County Highway Commissioner
Rusk County Extension Department
Rusk County Zoning Administrator
Rusk County Soil and Water Conservation District
Town of Grant
City of Ladysmith
Ladysmith School District

e. Other
Scientific Areas Preservation Council
Mine Reclamation Council

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Figures and Tables

DESCRIPTION OF THE ENVIRONMENT AND OF THE PROPOSED ACTION

GENERAL DESCRIPTION

Kennecott Copper Corporation (KCC), through its exploration subsidiary Bear Creek Mining Company (BCMC), has discovered a minable copper deposit southwest of Ladysmith in Rusk County. The Flambeau Mining Corporation (FMC), a wholly-owned subsidiary of Kennecott, would be responsible for the mining phase of the project. The company proposes to mine by open pit methods for a period of approximately 11 years which would possibly be followed by an 11-year phase of underground shaft mining. The copper-bearing sulfide ore would be concentrated at the project site. The copper concentrate would be transported out of Wisconsin to be smelted. The open pit would be rehabilitated as a 50-acre lake, and the 186-acre waste containment area (tailings pond) would be revegetated and would form a terraced, flat-topped hill (see Figure 1).

LOCATION OF THE PROJECT SITE

The mine site is located in Rusk County in northwestern Wisconsin (see Figure 2). The center of the ore deposit (Flambeau Copper Deposit) is located south of Ladysmith 1.6 miles and 0.3 miles west of Highway "27" in the Town of Grant (see Figure 3). The 2,750 acres under control of the FMC are located in Sections 9, 10, 16, 17, 20, 21 and 22, Town 34 North, Range 6 West (see Figure 4). Significant landmarks in the project area include Highway "27" east of the ore deposit, the Minneapolis, St. Paul, and Sault St. Marie Railway (Soo Line) grade which runs NNW-SSE one mile east of the deposit, and the Flambeau River which meanders through the site west of the deposit.

HISTORY AND BACKGROUND

Purpose and Needs

The purpose of the project is to establish a business activity which would provide a return on the investment of the shareholders of Kennecott Copper Corporation and which would also generate capital to reinvest in the business. In the mining industry, it becomes necessary to develop new mineral resources as existing deposits become physically depleted, economically unprofitable, or inaccessible due to nationalization or political turmoil in foreign nations. Mining of the Flambeau copper deposit would increase Kennecott's copper production by approximately 11,000 tons per year over the 11-year life of the mine. This would be an increase of 2.3 percent of Kennecott's 1973 production.

Permits and Approvals

An environmental impact report was prepared by BCMC pursuant to s. 23.11(5), Wisconsin Statutes, prior to the preparation of this report.

The environmental impact statement process, of which this report is a part, is to fulfill the requirements of the Wisconsin Environmental Policy Act of 1971 (s. 1.11, Wisconsin Statutes) prior to action by the Department of Natural Resources (DNR) on applications for various required permits and approvals. The following statutory permits or authority will be required from the DNR:

a. Chapter 30.12 - Structures and Deposits in Navigable Waterways. A permit would be required for the box culvert to serve as the haul road crossing of Meadowbrook Creek in Section 16, T34N, R6W.

b. Chapter 30.18 - Diversion of Water from Lakes and Streams. A permit would be required to divert water from the Flambeau River to fill the pit lake.

c. Chapter 30.19 - Enlargement and Protection of Waterways. A permit would be required to create an artificial lake (open pit mine) within 500 feet of the ordinary high-water mark of an existing navigable stream (Flambeau River).

d. Chapter 30.195 - Changing of Stream Courses. A permit would be required to temporarily divert Meadowbrook Creek during construction of a box culvert.

e. Chapter 107.05 (2) - Water May be Conducted Across Land. A permit would be required to divert water from the Flambeau River for industrial make up water at the beginning of mining.

f. Chapter 144.025(e) - Department of Natural Resources - Water Resources. A permit would be required to construct a high capacity well.

g. Chapter 144.04 - Approval of Plans. Plan approval would be required for industrial and possibly for sanitary wastewater treatment facilities.

h. Chapter 144.39 - Notice Required for Construction. The company would be required to file a notice of intent to establish an air contaminant source.

i. Chapter 144.44 - License. A solid waste license would be required to bury wood wastes, bury demolition material, and for the possible disposal of sewage or water treatment facility sludges.

j. Chapter 144.85 - Mining Permit. A permit to engage in mining would be required.

k. Chapter 147 - Pollution Discharge Elimination. A permit to discharge effluent to ground and/or surface waters would be required.

l. Chapter NR 151 - Solid Waste Management. A license may be required for a solid waste disposal site for the disposal of wood residues, construction and demolition materials, water treatment sludges, waste treatment sludges, and hazardous wastes.

In addition, permits and approvals may be required from the following agencies:

a. Wisconsin Department of Industry, Labor and Human Relations - Regulations concerning occupational health and safety.

b. Wisconsin Department of Transportation - At grade railroad crossing of a state highway. Access road onto a state highway. Traffic stoppages on a state highway.

c. Wisconsin Department of Health and Social Services - Approval of plans for the sewerage disposal system.

d. Wisconsin Public Service Commission - Approval to build a railroad spur (Soo Line Railroad, applicant).

e. Rusk County - Zoning permit to establish an industrial operation in an Industrial District. Conditional use permit to establish a waste disposal facility in an Agricultural District. Rezoning of 20 acres from Resource Conservation to Agricultural or Forestry. Septic tank and sanitary permits for sewerage disposal system. Permission to construct an overpass over county highway "P".

f. Town of Grant - Approval of county zoning amendments and conditional use permits.

DESCRIPTION OF THE ENVIRONMENT

Climate

The project site is located in a humid continental (cool summer phase) climatic belt which stretches from New England, through the Great Lakes states, into south central Canada. The winters are long, snowy, and cold while the summers are relatively short with a few short periods that are hot and humid.

Weather

Weather observation data are available for Weyerhauser which is located 18 miles west of Ladysmith. Limited data are also available for Ladysmith from 1965 to 1971. A summary of temperature and precipitation data is presented in Table 1.

The long-term monthly mean temperature at Weyerhauser varies from a low of 12.4 degrees Fahrenheit in January to a summer high of 68.7 degrees in July. The lowest temperature recorded at Ladysmith in recent years was -33 degrees and the maximum was +94 degrees. The minimum-maximum range recorded at Weyerhauser is -41 degrees to +109 degrees.

FIGURE 1 FLAMBEAU MINING CORPORATION PROPERTY SCALE 1"=2400'

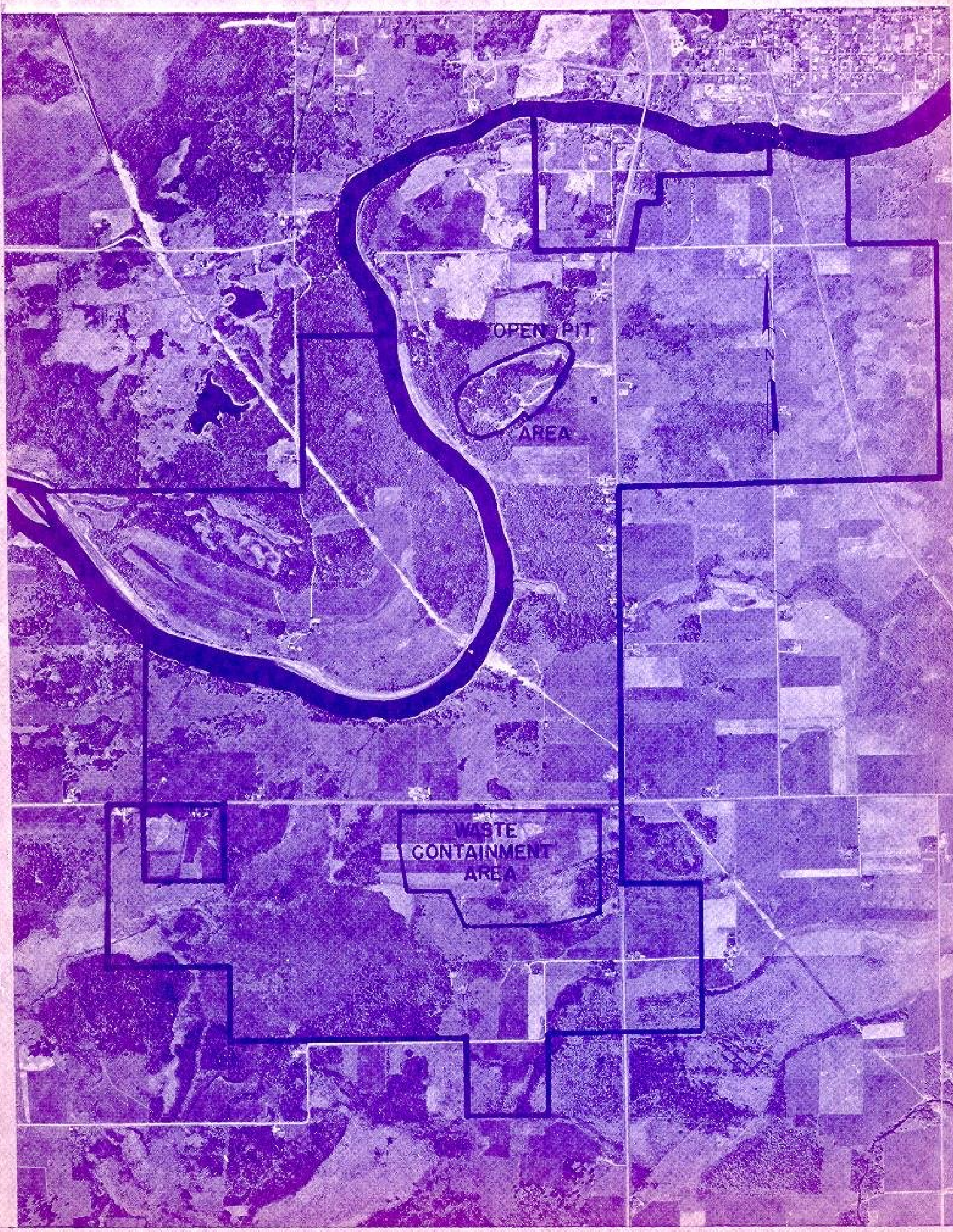
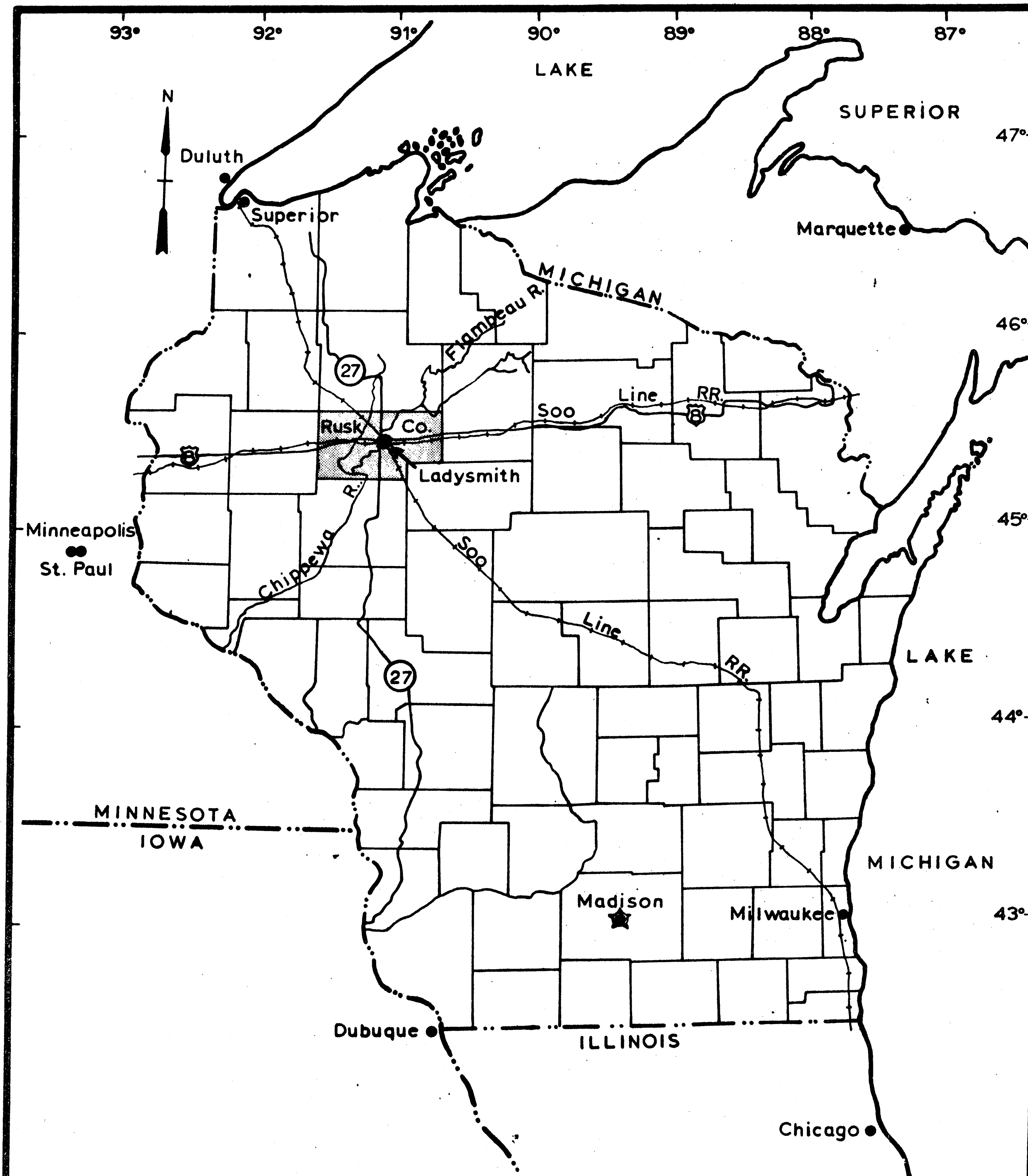


FIGURE 2

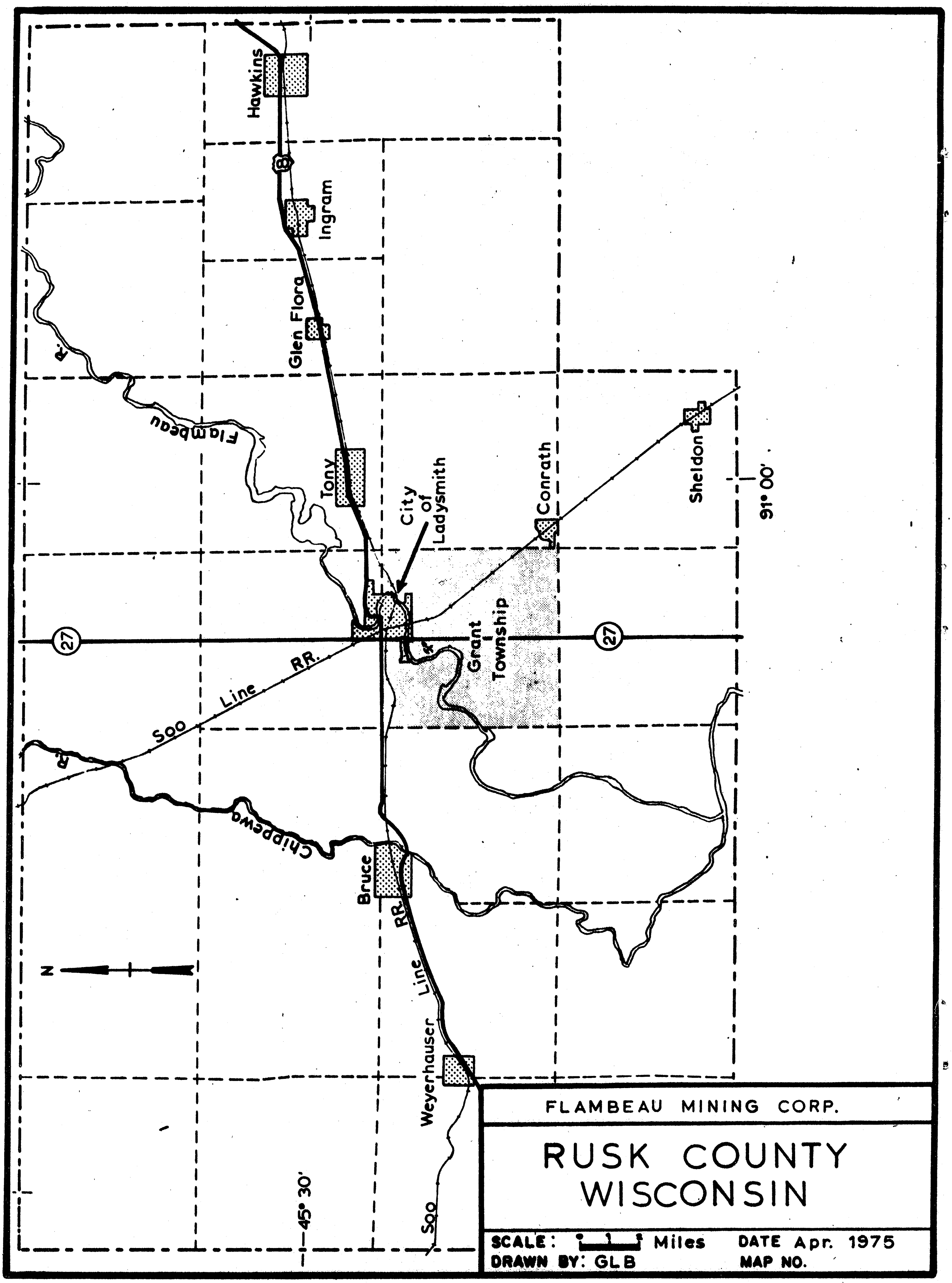


FLAMBEAU MINING CORP.

WISCONSIN
LOCATION MAP

SCALE 0 25 50 Mi. DATE July 1973
DRAWN BY GLB MAP NO

FIGURE 3



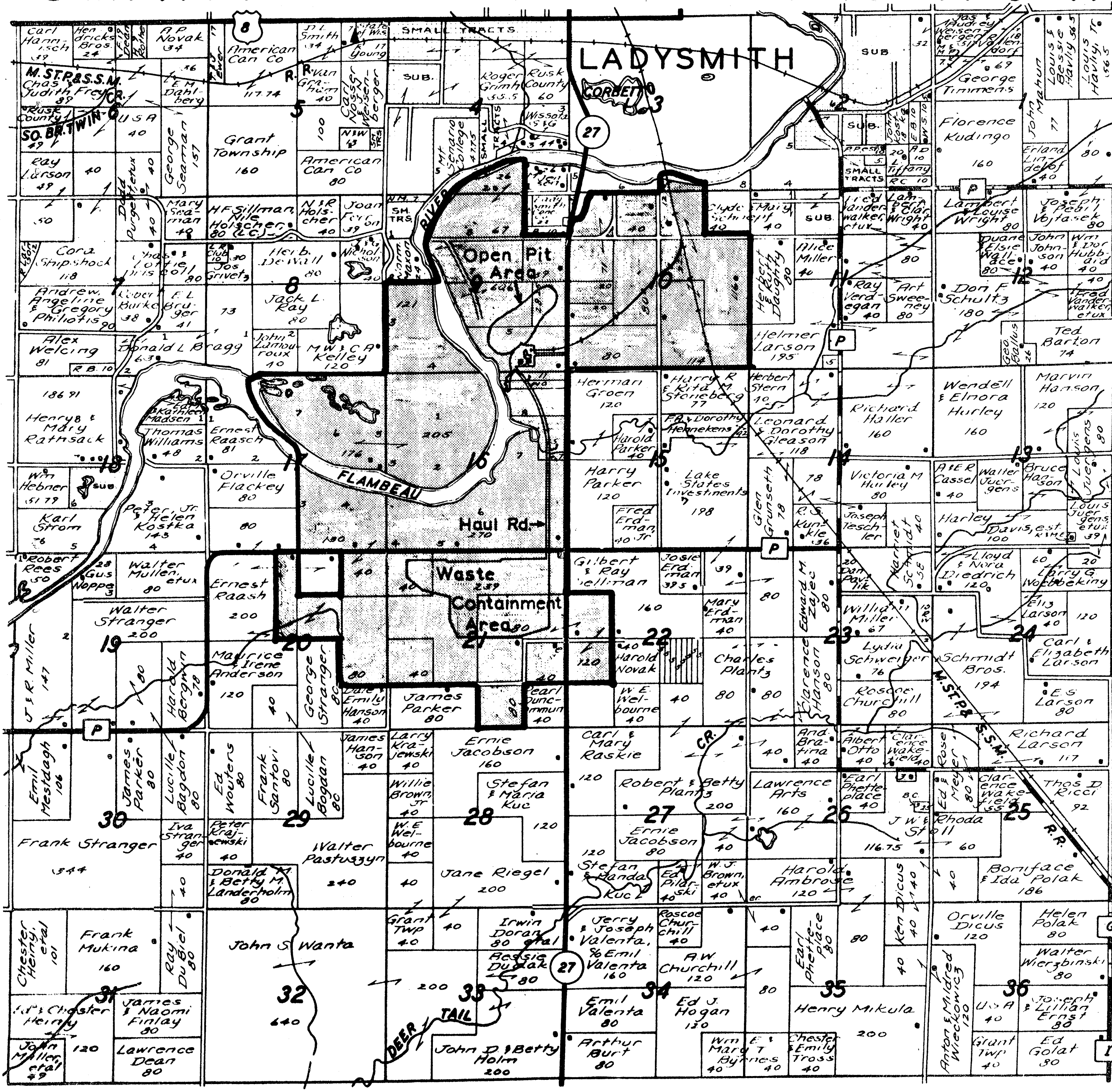
FLAMBEAU MINING CORP.

RUSK COUNTY
WISCONSIN

SCALE: 0 1 2 Miles DATE Apr. 1975
DRAWN BY: GLB MAP NO.

FIGURE 4

GRANT T. 34 N. - R. 6 W.



Land controlled by FMC

N

FLAMBEAU MINING CORP.

GRANT TOWNSHIP
LOCATION MAP

SCALE: 1" = 4000'
DRAWN BY: GLB

DATE April 1975
MAP NO.

Plat Map Courtesy of and Copywrited by:
Rockford Map Publs. Inc., C. 1971, Rev. 1973.

TABLE 1

TEMPERATURE & PRECIPITATION

	Temperature (^{O}F)				Precipitation (inches)		
	Monthly Mean		Extremes at Weyerhauser		Monthly Mean		Greatest Daily
	W*	L**	High	Low	W*	L**	W*
January	12.4	9.3	54	-41	0.77	2.18	1.06
February	15.5	14.1	58	-37	0.77	1.09	0.90
March	26.5	27.3	79	-26	1.31	1.95	1.08
April	42.6	43.4	87	4	2.48	2.36	3.20
May	54.8	53.9	107	21	3.62	3.46	3.10
June	63.7	64.1	98	30	4.92	5.71	2.66
July	68.5	67.7	109	39	3.90	4.49	3.70
August	66.5	65.4	102	34	4.14	3.17	4.06
September	57.5	57.2	99	21	3.42	4.12	2.70
October	46.8	47.8	86	6	2.22	3.35	2.53
November	30.6	31.3	77	-13	1.63	1.79	1.90
December	17.6	19.7	62	-30	0.92	2.06	1.44
YEAR	42.0	41.8	109	-41	30.10	35.73	

*W = Weyerhauser
**L = Ladysmith (1965-1971 only)

Precipitation at Weyerhauser averages 30.10 inches per year. Data taken at Ladysmith for 1965-1971 indicates an average annual precipitation of 35.73 inches. A comparison of these figures reveals a recent succession of years with above average precipitation. Long-term average monthly precipitation is lowest in January and February and highest in June, July and August. The greatest total precipitation for one day was 4.06 inches for a day in August 1941.

Wind data are not available for Weyerhauser. Data interpolation from Minneapolis and Wausau should approximate the long-term wind patterns. The prevailing winds are westerly from late fall through early spring and from south and westerly directions the remainder of the year. April and May are the windiest months, and July and August are the least windy. Wind direction and velocity at Ladysmith have been measured from April 1 to October 1 during recent years. Wind direction during those months is summarized in Figure 5. The highest monthly average wind velocity is 11 mph during May and the lowest average wind velocity is 7.9 mph during August.

Air Quality

Rusk County is located in the Northwest Wisconsin-Duluth Minnesota Interstate Air Quality Control Region. There has been no long-term air quality monitoring in Rusk County.

Air quality in Ladysmith can be assumed to be similar or better than that of Eau Claire (pop. 44,619) for which air quality data exists. A summary of air quality data and the National Ambient Air Quality Standards is presented in Table 2. From this data it appears that air quality near the mine site would comply with current standards.

The only major air pollution source in Ladysmith is Peavey Paper Mills, Inc., which emitted 720 tons of particulate and 605 tons of sulfur oxide in 1973. The mill is under order to control particulate emissions and should have been in compliance by July 15, 1975.

TABLE 2

AIR QUALITY AT EAU CLAIRE AND NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Time	Primary Standard**3	Secondary Standard**4	(Eau Claire ($\mu g/m^3$)) 1974	1973
Particulate matter	Annual (Geometric Mean)	75 μg	60 μg[1]	25.66	25.38
	24 hour	260 μg*	150 μg*	82.40	61.70
Sulfur Oxides (SO_x) (measured at SO_2)	Annual (Arithmetic Mean)	80 μg (0.03 ppm)	--------	8.19	4.28
	24 hour	365 μg (0.14 ppm)*	--------	76.30	34.90
	3 hour	---------	1,300 μg (0.05 ppm)*	-----	-----
Carbon Monoxide (CO)	8 hour	10 mg (9 ppm)*	Same as primary	-----	-----
	1 hour	40 mg (35 ppm)*	Same as primary	-----	-----
Hydrocarbons (HC) (nonmethane measured as CH_4)	3 hour (6 to 9 a.m.)	160 μg (0.24 ppm)*2	Same as primary	-----	-----
Nitrogen Dioxide (NO_2)	Annual (Arithmetic Mean)	100 μg (0.05 ppm)	Same as primary	25.20	-----
Photochemical Oxidants (O_x) (measured as O_3)	1 hour	160 μg (0.08 ppm)*	Same as primary	44.80	-----

**Concentration in weight per cubic meter (corrected to 25^{o} C and 760 mm of Hg)

*Concentration not to be exceeded more than once per year

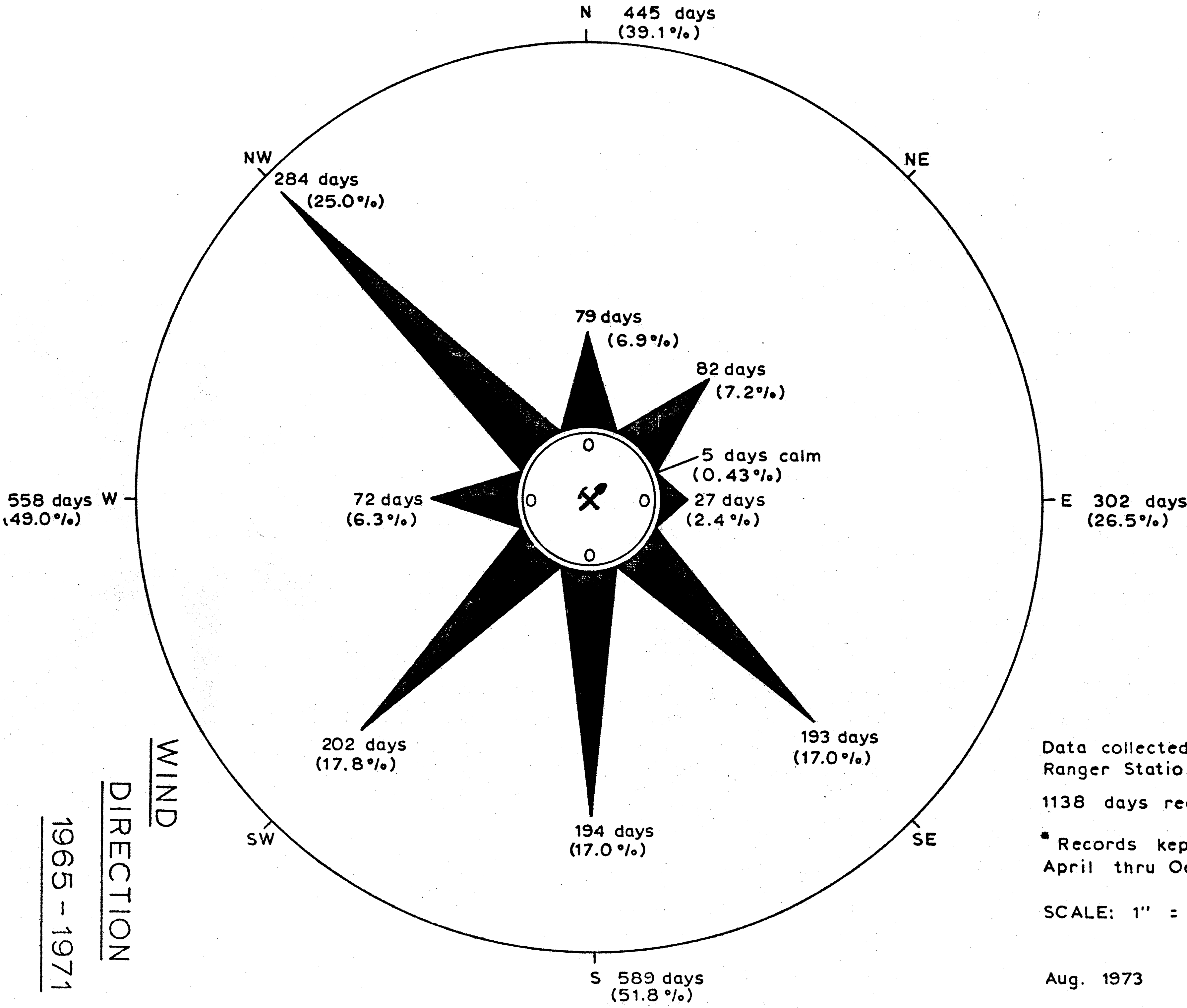
[1]As a guide to be used in assessing implementation plans in achieving the 24-hour STD.

[2]As a guide in devising implementation plans to achieve oxidant standards

[3]Primary standards are designed to protect public health

[4]Secondary standards are designed to protect public welfare

FIGURE 5



Data collected at Ladysmith Ranger Station

1138 days recorded *

* Records kept for months April thru October only

SCALE: 1" = 100 days

Aug. 1973 GLB

WIND DIRECTION

1965 - 1971

Noise

The company conducted a survey of background noise levels at 27 sites on or near the mine site. The results are presented in Table 3. The averge noise levels were elevated when the Ladysmith Sand and Gravel processing plant was in operation. There were no sustained noise levels during the surveys that exceeded the Occupational Safety and Health Administration standard of 90 dBA for an 8-hour period.

Surface Waters
Hydrology
Flambeau River

The project site includes an unimpeded 4.2-mile segment of the Flambeau River (see Figure 6). The river drains a total area of approximately 1,993 square miles, 1,838 of which are in Rusk County. The Flambeau has a low gradient of about 3 feet per mile. There are nine dams and impoundments on the river, four of which are in Rusk County. The nearest dams are the Thornapple Dam (13 foot head) located about 9 river miles southwest of the project site and the Peavey Paper Mill Dam (17 foot head) located approximately 3.8 miles above the site. The other dams on the Flambeau in Rusk County are the Dairyland REA Cooperative Dam (68 foot head) and the Big Falls Dam (50 foot head) both of which are located upstream from the project site.

Through the project site, the Flambeau River is a broad, meandering, entrenched stream with very little floodplain. The average width of the river is 350 feet and the average gradient is approximately two (2) feet per mile. The course of the river at the project site has apparently changed very little in postglacial time. The disproportionately large meanders were probably formed while the Flambeau River was receiving large quantities of glacial meltwater.

River flow data are kept at a U.S. Geological Survey gaging station located 2.5 miles downstream from the Thornapple Dam. Average (mean) discharge at the station is 1,776 cubic feet per second (cfs). Normal or median discharge is 1,500 cfs. The recorded maximum discharge was 17,400 cfs on May 1, 1954, and the recorded minimum was 100 cfs in August of 1957. The discharge rate which is equalled or exceeded 95 percent of the time has been established as 734 cfs at Ladysmith. River flows in the Ladysmith area are influenced by rainfall, snow melt and runoff, and the operation of several power plants, especially the Dairyland Dam.

Observations by the DNR since 1969 indicate an average water level of the Flambeau River west of the ore deposit of 1,085 feet above sea level (fas), and a normal high water mark of 1,086 fas. Prior to 1969, the average water level at this site was 1,094 fas, but removal of the Port Arthur Dam, six miles below the mine site, has lowered the average level by 9 feet. Flood elevation and flows for a 100-year reoccurrence flood have been estimated from data provided by the Big Falls gage station. A 22,500 cfs 100-year flow has been predicted which would crest at an elevation of 1,098 fas, or 13 feet above the average water level, (see Figure 7). These flood elevation calculations were based on a velocity of 4.5 feet per second using the Conger method.

Tributary Streams

There are seven small streams which drain into the Flambeau River from the project site (see Figure 8). Stream D (Meadowbrook Creek) and Stream G have continuous flows. Streams E, F and G have been channelized over parts of their lengths and generally exhibit sluggish flows. Maximum discharge rates of these streams in 1973, were measured or estimated by company personnel.

Stream	Maximum Discharge - 1973 cfs
A	1.0
B	1.4
C	6.2
D (Meadowbrook Creek)	No measurement
E	3.1
F	1.1
G	3.1

Discharge rates for streams A, B, C, F, and G were measured using the V-notch weir technique. The discharge of Stream E was estimated from data on stream G. The Meadowbrook Creek discharge rate was not measured in 1973; however, the 100-year occurrence flood discharge was estimated to be 1,800 cfs using the Conger technique.

TABLE 3
BACKGROUND COMMUNITY NOISE DATA

Reading No.	Location	1. dBC	2. dBC	3. dBC	1. dBA	2. dBA
1	Rest Home Parking Lot	68.3	72.7	73.0	51.3	55.3
2	Southeast Corner of Hospital Bldg.	72.7	82.3	74.0	56.0	60.7
2A	West end of Hospital Bldg.	69.5	76.3	71.3	48.5	54.3
3	Northeast of College Bldg.	73.3	71.0	68.0	48.7	48.7
4	South of College Bldg.	72.0	82.0	72.3	51.3	62.0
4A	North of College Bldg.	60.0	78.7	72.7	40.0	45.7
4B	West of College Bldg.		76.7	74.0		50.0
5	Northwest of College Dormitory	73.3	79.0	73.3	52.3	59.0
5A	STH 27 - South end of Bridge	63.5	71.3	70.3	46.5	54.7
5B	North of local Sand & Gravel Co.'s Ready Mix Plant		87.7	72.3		69.7
5C	East of local Sand & Gravel Co. crusher - Behind Tree Screen		64.3	66.0		61.3
6	Northeast of Gravel Screen	74.7	86.7	76.7	59.0	77.3
7	East of Gravel Screen	72.7	85.7	78.0	56.3	80.7
8	East of Gravel Crusher	73.3	90.7	87.0	52.7	83.3
9	South of Gravel Crusher	69.0	83.3	82.7	46.7	72.3
10	West of Gravel Crusher	66.0	91.3	91.7	46.7	88.0
10A	STH 27 - Northeast of Proposed Pit	69.0	72.3	62.6	46.0	54.7
11	North end of former Rusk Co. Gravel Pit	70.0	77.3	70.0	46.7	50.3
12	South end of former Rusk Co. Gravel Pit	65.3	68.7	58.7	47.3	44.0
13	STH 27 - North end of Proposed Pit	73.0	75.7	64.0	52.0	52.3
14	STH 27 - Plant Access Road	76.0	71.7	73.3	53.0	45.7
15	Haul Road - 1000 feet South of Proposed Pit	54.0	51.7	50.3	41.7	40.0
16	Haul Road - 3000 feet South of Proposed Pit	57.7	47.3	52.0	44.0	40.0
16A	STH 27 - East of Haul Road	69.0	69.7	66.7	53.0	49.7
17	CTH "P" - East Side of Haul Road Crossing	75.0	72.7	70.0	53.0	48.0
18	CTH "P" - West Side of Haul Road Crossing	75.0	72.7	72.7	52.3	45.0
19	CTH "P" NW Corner of Proposed Waste Containment Area	67.0	55.3	58.7	47.3	40.0
20	South Side of Proposed Waste Containment Area	69.0	64.7	62.3	47.0	41.7
21	STH 27 - East Side of Proposed Waste Containment Area	66.3	57.7	54.3	47.3	43.3
22	Town Road and Soo Line R.R. Tracks N.E. of Proposed Pit (Without Train)	68.7	66.0	62.0	44.0	46.7
22A	Town Road and Soo Line R.R. Tracks N.E. of Proposed Pit (With Train)	84.0			55.0	
23	STH 27 East of Proposed Haul Road			60.3		
24	STH 27 East of Proposed Pit			59.0		
25	West Bank of Flambeau River Across from local Sand & Gravel Co.			48.0		
26	West Bank of Flambeau River Across from West end of Proposed Pit			51.7		
27	STH 27 at Hospital (without traffic)			62.0		
28	STH 27 at Hospital (with traffic)			99.0		

FOOTNOTES:

1. All readings taken without local Sand and Gravel Co.'s Crusher Running and without tree leaves. Reading Dates: April 4, 1973 and April 5, 1973
2. All readings taken with local Sand and Gravel Co.'s Crusher running and without tree leaves. Reading Dates: May 10, 1973 and May 11, 1973.
3. All readings taken with local Sand and Gravel Co.'s Crusher running and with tree leaves. Reading Dates: June 21, 1973 and June 22, 1973.

NOTE: Wind screen was not used on meter and wind speeds varied from 8 mph to 17 mph.

NOTE: dBC and dBA readings listed under columns 1, 2 and 3 are an average of three (3) readings taken at separate times.

NOTE: dBA is a weighted measurement which closely reflects the human ear's perception of sound. dBC is a measurement of peak levels of noise.

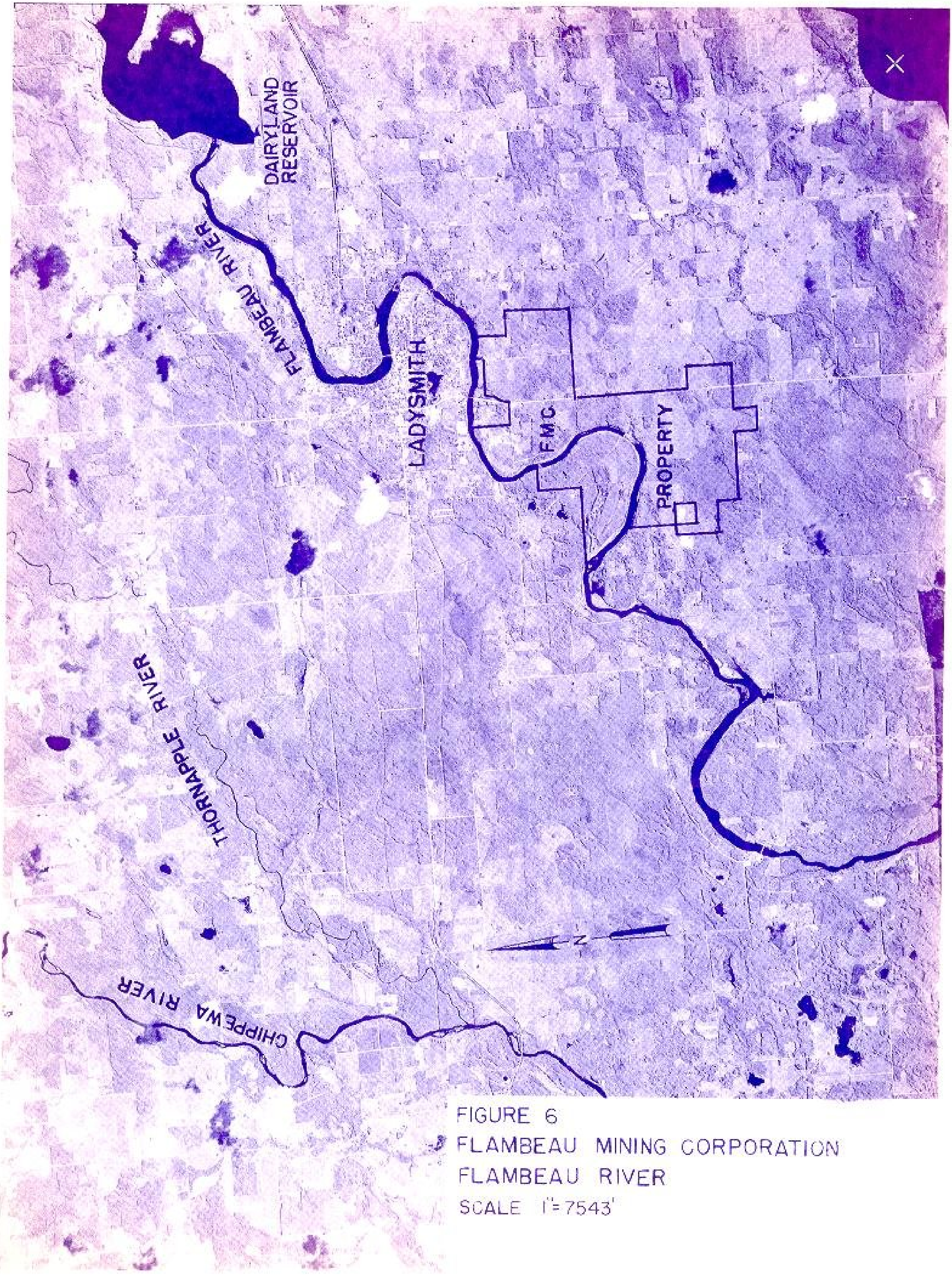
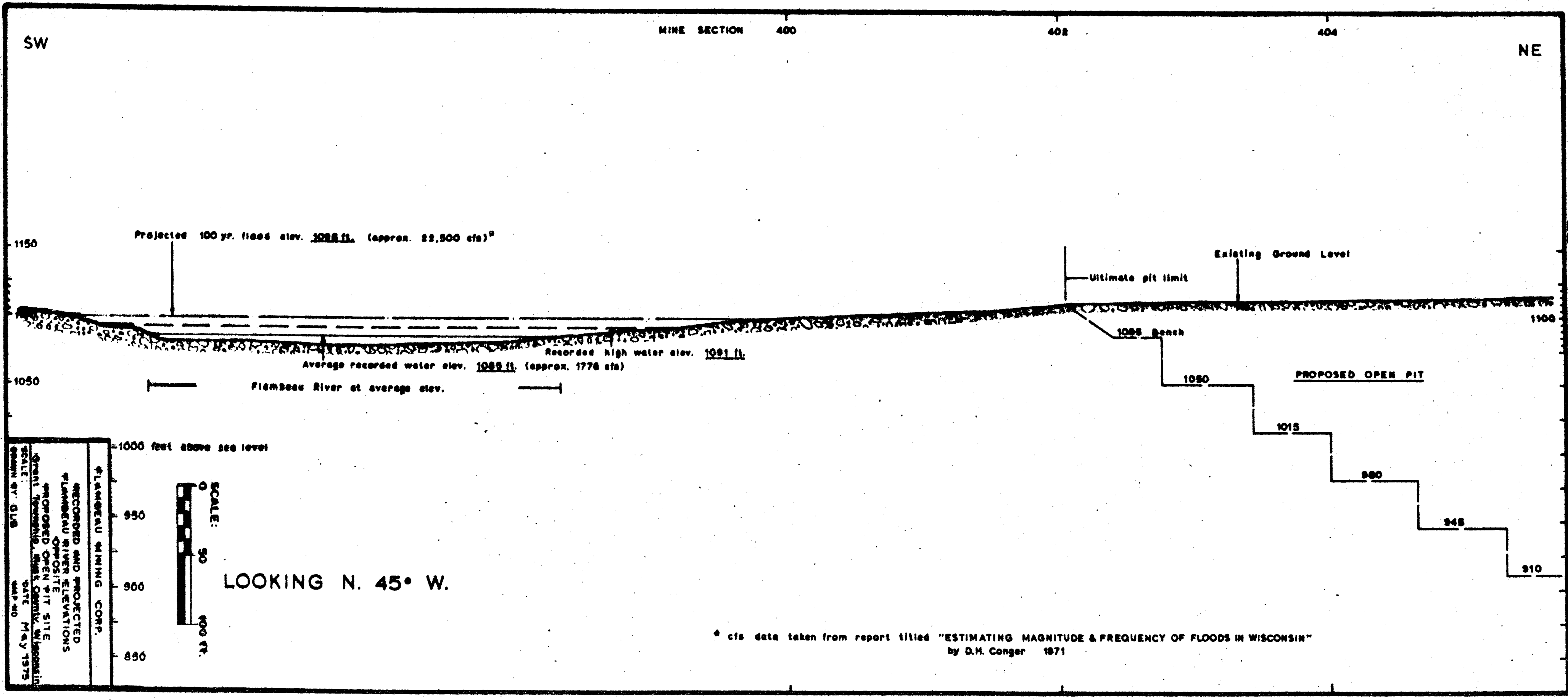


FIGURE 6
FLAMBEAU MINING CORPORATION
FLAMBEAU RIVER
SCALE 1"=7543'

FIGURE 7


SW
NE
MINE SECTION 400
402
404
1150
1100
1050
1000 feet above sea level
950
900
850
Projected 100 yr. flood elev. 1098 ft. (approx. 22,500 cfs)*
Existing Ground Level
Ultimate pit limit
1085 Bench
Recorded high water elev. 1091 ft.
Average recorded water elev. 1085 ft. (approx. 1776 cfs)
Flambeau River at average elev.
PROPOSED OPEN PIT
1050
1015
980
945
910
SCALE: 0 50 100 ft.
LOOKING N. 45° W.
* cfs data taken from report titled "ESTIMATING MAGNITUDE & FREQUENCY OF FLOODS IN WISCONSIN" by D.H. Conger 1971
23
FLAMBEAU MINING CORP.
RECORDED AND PROJECTED FLAMBEAU RIVER ELEVATIONS OPPOSITE PROPOSED OPEN PIT SITE
Grant Township, Rusk County, Wisconsin
SCALE:
DATE May 1975
DRAWN BY GLB
MAP NO

Ponds

There are two small man-made ponds located in the NE¼ SE¼ of section 9. Other small wetland areas and ponds of less than one acre are present in depressional areas throughout the project site.

Wetlands

Much of the eastern portion of section 20 and the western part of section 21 consists of wetlands (see Figure 9). These wetlands extend into the west half of Section 20 beyond the project area and occupy a total area of approximately 470 acres. This area is drained by Stream G which flows some 2.6 miles to its mouth at the Flambeau River in the SE¼, Section 24, T34N, R7W. Water usually stands over this area to a depth of one foot or more. The area is underlain by a few inches to several feet of peat.

Uses of Flambeau River

The principal uses of the Flambeau River are for power generation, disposal of sewage and paper mill effluent, recreation, wildlife habitat and livestock watering. In Rusk County, the river is not used for domestic water supplies and is not generally used for commercial navigation.

Tributaries and Ponds

The tributary streams which flow through the project site and the ponds and wetlands are used for agricultural purposes and by wildlife.

Quality

The Flambeau River is required to meet the water quality standards for recreation, and fish and aquatic life of Chapter NR 102 of the Wisconsin Administrative Code. The applicable standards are as follows:

Standards

NR 102.02

(3) STANDARDS FOR FISH AND AQUATIC LIFE. Except for natural conditions, all waters classified for fish and aquatic life shall meet the following criteria:
(a) Dissolved oxygen: Except for waters classified as trout streams in Wisconsin Trout Streams, Publication 213-72, the dissolved oxygen content in surface waters shall not be lowered to less than 5 mg/l at any time.
(b) Temperature: 1. There shall be no temperature changes that may adversely affect aquatic life.
2. Natural daily and seasonal temperature fluctuations shall be maintained.
3. The maximum temperature rise at the edge of the mixing zone above the existing natural temperature shall not exceed 5°F for streams and 3°F for lakes.
4. The temperature shall not exceed 89°F (31.7°C) for warm water fish.
(c) pH: The pH shall be within the range of 6.0 to 9.0, with no change greater than 0.5 units outside the estimated natural seasonal maximum and minimum.
(d) Unauthorized concentrations of substances are not permitted that alone or in combination with other materials present are toxic to fish or other aquatic life. Questions concerning the permissible levels, or changes in the same, of a substance, or combination of substances, of undefined toxicity to fish and other biota shall be resolved in accordance with the methods specified in "Water Quality Criteria," Report of the National Technical Advisory Committee to the Secretary of the Interior, April 1, 1968. The committee's recommendations will also be used as guidelines in other aspects where recommendations may be applicable.

(4) STANDARDS FOR RECREATIONAL USE. A sanitary survey and/or evaluation to assure protection from fecal contamination is the chief criterion in determining the suitability of a surface water for recreational use. In addition, the following bacteriological guidelines are set forth:
(a) The membrane filter fecal coliform count shall not exceed 200 per 100 ml as geometric mean based on not less than 5 samples per month, nor exceed 400 per 100 ml in more than 10% of all samples during any month.

Discharges to the Flambeau River

There are seven major discharge points in the Flambeau River basin, all of which are above the mine site. Table 4 summarizes these major effluent sources.

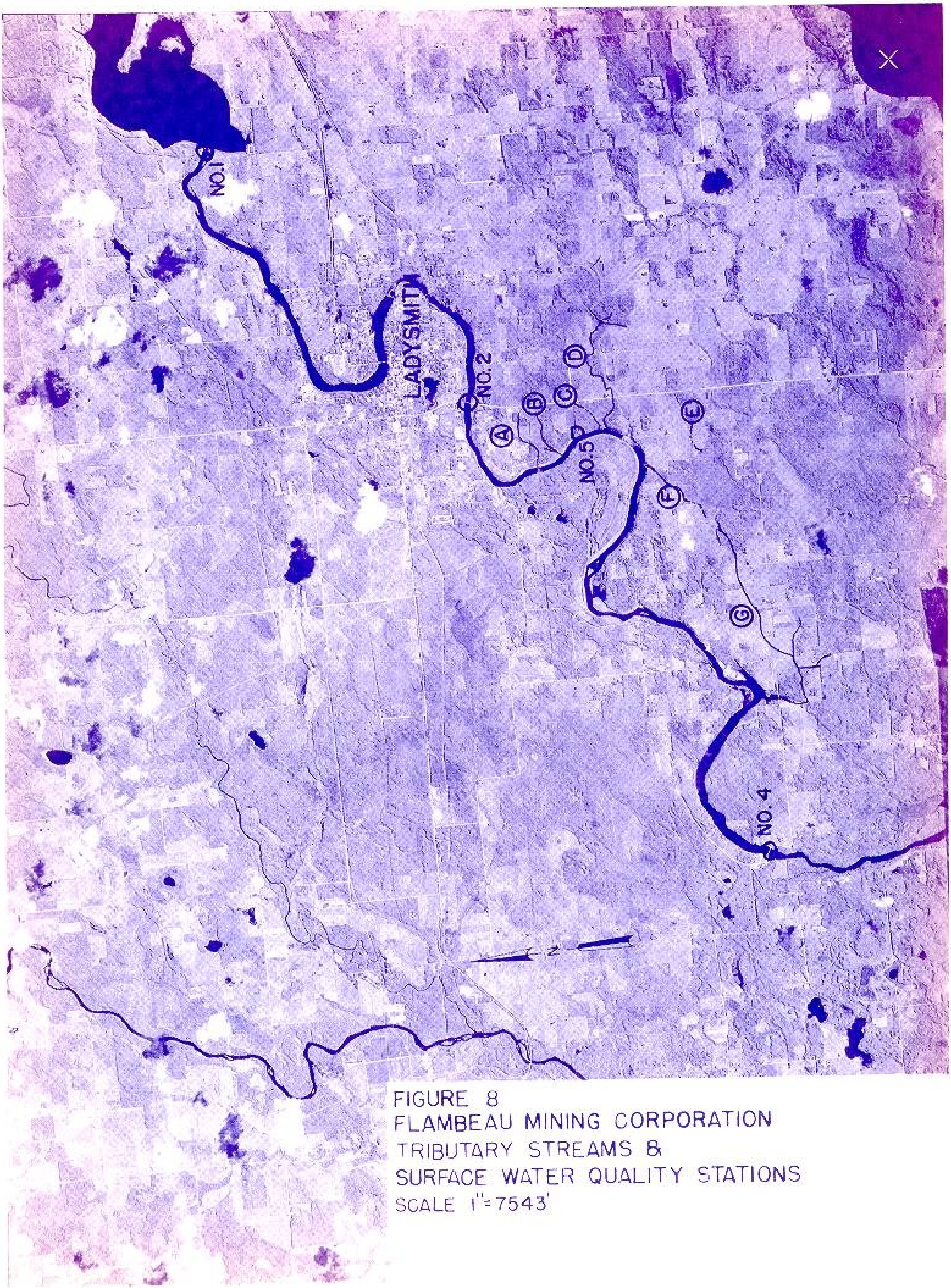


FIGURE 8
FLAMBEAU MINING CORPORATION
TRIBUTARY STREAMS &
SURFACE WATER QUALITY STATIONS
SCALE 1"=7543'

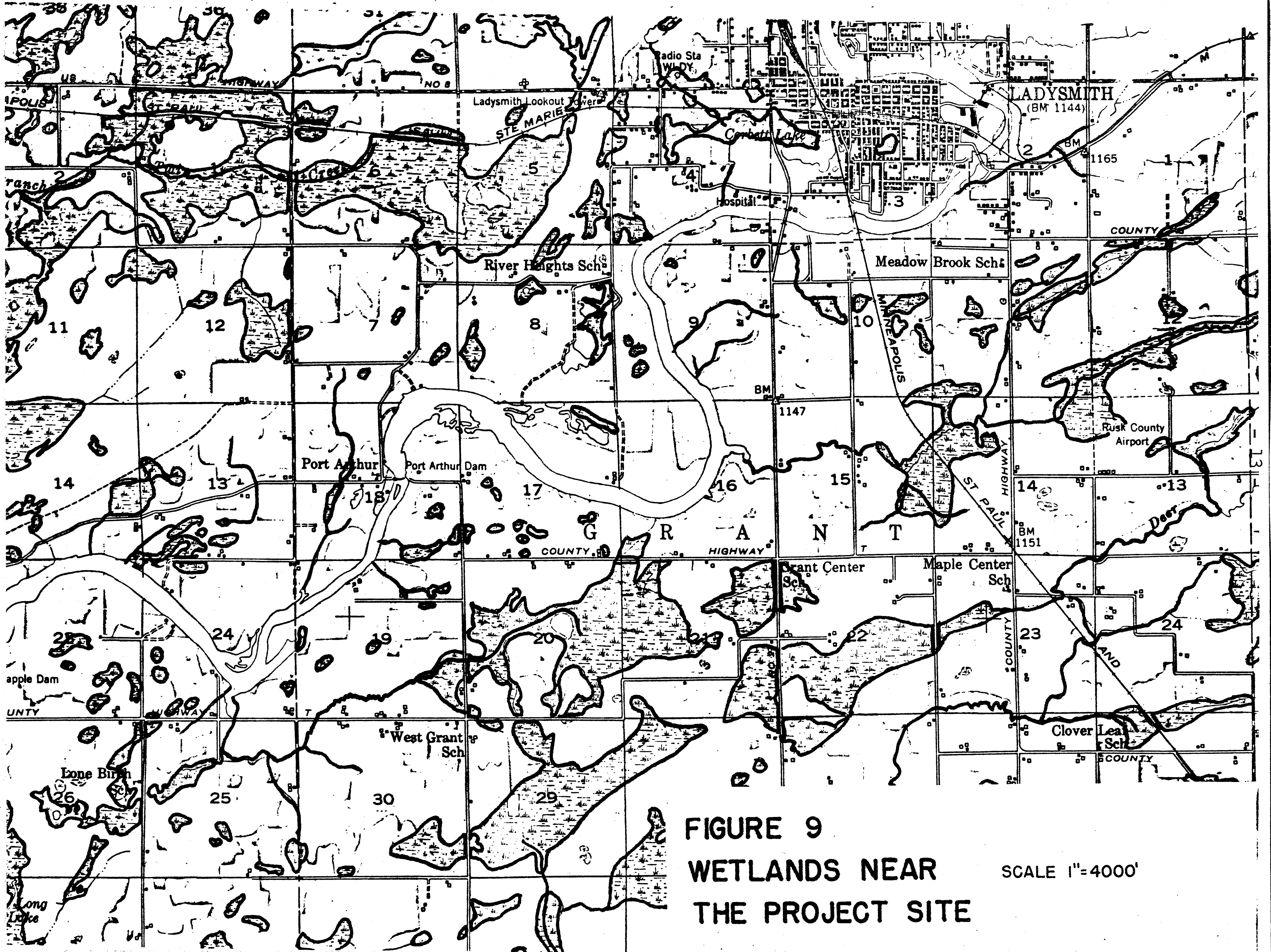


FIGURE 9
WETLANDS NEAR
THE PROJECT SITE

SCALE 1"=4000'

TABLE 4

Major Discharge in the Flambeau River Basin

Source	Type of Waste	Treatment	Average Daily Discharge Gal./Day	BOD5 (lbs.)	T.S.S.* (lbs.)	Date
City of Ladysmith	Sewage	Secondary	541,000	125	103	4/75
Peavey Paper Mills	Paper	Fiber Recovery	1,612,000	1,765	1,905	3/75
City of Park Falls	Sewage	Secondary	614,000	133	---	4/75 10/69
Flambeau Paper Company	Sulfite Pulp and Paper	Fiber Recovery, Evaporation & Disposal	6,560,000	17,051	10,808	3/75
Mercer S.D. #1	Sewage	Secondary	38,000	14	---	10/69
Village of Butternut	Sewage	Lagoon	190,000	30	33	10/69 4/75
City of Phillips	Sewage	Secondary	281,700	79	95	4/75

*Total Suspended Solids

The effluent sources which most directly affect the surface water quality at the mine site are the City of Ladysmith sewerage treatment plant and the Peavey Paper Mill discharge.

Water Quality Surveys

The DNR did water quality sampling of the Flambeau River near the project site in 1969. The results of that year's survey are presented in Table 5.

Flambeau Mining Company has conducted more detailed water quality analysis along the Flambeau River since April 1970 and continues to the present. The sampling stations are shown on Figure 8. The results of the company's survey from 1970 to June 1973 are presented in Table 6. (The upper values in the table are an average and the lower values are the range. All values are in mg/l unless otherwise indicated.)

The survey results show that, generally, State water quality standards are satisfied. However, there are significant concentrations of iron, manganese, nitrate, and phosphates.

The following parameters are considered to be indicative of Flambeau River quality within the project area:

Hardness - The water is considered to be soft or moderately soft. Total hardness ($CaCo_3$) averages less than 50 mg/l, total alkalinity (bicarbonates) less than 40 mg/l and the pH is within a neutral range and meets state standards.

Dissolved Oxygen - The dissolved oxygen (DO) content varied mainly with seasonal changes of temperature and remained above the 5 mg/l minimum standard with the exception of the Ladysmith sewage effluent.

Solids - More than half of the total solids in the river were volatile or probably organic in nature. Increases in total, suspended and volatile solids immediately downstream from the Ladysmith sewerage outfall as well as increases in soluable phosphorus, chlorides, BOD and fecal coliform counts document that organic effluents are being introduced from the sewerage treatment plant.

Phosphorus - Soluble phosphorus may be a limiting factor for plant growth during certain periods of the year. The required range of available phosphorus for growth of most algal species is 0.01 to 0.05 mg/l. Soluble phosphorus concentrations in the Flambeau averaged 0.04 mg/l with a minimum concentration of 0.006 mg/l.

TABLE 5. DNR WATER QUALITY SURVEY - 1969

Location	Date	BOD mg/l	Temp. °C	pH	DO mg/l	MFFCC Per 100 ml
Dairyland Dam	6/24/69	1.2	18	7.3	7.5	< 5
	8/12/69	<1.0	24	7.3	5.6	< 5
	9/10/69	3.0	21	7.4	6.1	< 5
State Hwy "8" Bridge	1/29/69	<1.0	0	6.8	8.3	5
	6/25/69	1.5	18	7.2	7.2	35
	8/12/69	1.2	24	7.2	5.1	20
Peavey Dam	1/29/69	<1.0	0	6.8	8.4	< 5
	6/25/69	1.8	18	7.3	7.2	240
	8/12/69	1.5	24	7.1	5.1	20
	8/19/69	2.5	23	6.9	5.8	---
Peavey Paper Mills	1/29/69	75.0	9	8.1	9.5	<10,000
	6/26/69	43.0	26	7.7	7.7	< 5
	8/19/69	165.0	28	7.4	6.6	<10
County Hwy "G" Bridge	1/29/69	1.2	0	6.8	9.3	< 5
	6/26/69	2.5	19	6.7	7.9	20
	8/19/69	2.0	22	7.2	5.2	30
	10/22/69	2.0	13	7.4	4.5	5
Ladysmith Sewerage Outfall	1/29/69	33.0	7	7.4	6.9	480,000
	6/26/69	31.0	20	7.2	4.3	320,000
	8/19/69	21.0	22	7.3	3.6	89,000
	10/21,22/69	25.0	--	7.5	---	---
State Hwy "27" Bridge	1/29/69	2.4	0	6.8	10.3	900
	6/26/69	<1.0	19	7.2	7.7	220
	8/19/69	2.0	23	7.3	6.2	270
	10/22/69	1.0	12	7.1	10.4	5
Port Arthur Dam	1/29/69	1.5	0	6.8	9.3	160
Thornapple Dam	6/26/69	<1.0	18	7.2	7.4	470
	8/19/69	1.5	24	7.3	7.2	5

TABLE 6

ANALYSES OF SURFACE WATER FROM FOUR STATIONS ON THE FLAMBEAU RIVER NEAR LADYSMITH, WISCONSIN

	Stations 1	2	4	5
Temperature [°C]*	11.0 0.0-26.0	10.9 0.0-26.0	11.0 0.0-26.0	11.9 0.0-26.0
Dissolved Oxygen*	8.8 6.3-13.4	9.5 6.9-14.0	9.1 6.7-14.6	9.6 6.6-14.1
pH [Standard Units]*	6.7 6.5-7.0	6.7 6.5-7.2	6.7 6.5-7.1	6.8 6.5-7.2
pH [Standard Units - Lab]	7.2 6.6-8.2	6.9 6.6-8.0	7.2 6.8-8.6	7.2 6.6-7.7
Carbonates ($CaCO_3$)	0	0	0	0
Bicarbonates ($CaCO_3$)	37.1 5-60	34.9 15-76	37.8 13-79.1	35.5 14-56
Total Hardness ($CaCO_3$)	45.7 11.5-77.0	47.6 8.7-90.0	49.4 7.7-87.0	48.3 9.6-83.0
Total Solids	116 45-254	138 60-306	119.3 50-245	106.7 15-200
Total Volatile Solids	49.2 3-90	68.1 3-206	63.4 4-137	56.8 8-139
Suspended Solids	6.0 1-20	16.3 1-176	5.4 1-11	5.9 1-10
Suspended Volatile Solids	3.2 0.5-10	12.5 0.8-174	2.8 0.5-6	2.8 1-4
Color [Standard Units]	76.6 20-140	77.1 50-120	79.3 25-200	77.8 50-150
Ammonia Nitrogen (N)	0.25 <0.01-1.20	0.21 <0.01-0.80	0.18 <0.01-0.50	0.12 <0.01-0.88
Nitrate Nitrogen (N)	0.29 <0.01-1.00	0.27 <0.01-0.85	0.26 <0.01-0.80	0.28 <0.01-1.00
Organic Nitrogen (N)	1.22 <0.01-7.20	0.90 <0.01-3.90	0.88 <0.01-3.80	0.60 <0.01-2.00
Total Phosphorus (P)	0.10 <0.02-0.50	0.11 <0.02-0.42	0.09 <0.02-0.80	0.10 <0.02-0.26
Soluble Phosphorus (P)	0.034 <0.006-0.16	0.044 <0.006-0.16	0.031 <0.006-0.12	0.036 <0.006-0.12
Chlorides	7.3 2.0-50.0	8.8 2.3-60.0	7.8 1.9-50.0	8.0 2.2-50.0
Sulfates	7.0 0.8-15.0	6.5 0.7-11.0	6.2 0.6-11.0	5.7 0.6-11.0
Surfactants	0.02 <0.01-0.07	0.02 <0.01-0.06	0.03 <0.01-0.07	0.03 <0.01-0.10
BOD (5-day)	1.8 0.7-4.1	4.1 0.8-43.0	1.9 0.2-4.0	2.1 0.2-4.0

Table 6 (cont.)

Iron	.64 <0.04-2	0.99 <0.04-6	0.81 <0.04-6	0.87 <0.04-6
Manganese	0.085 <0.025-0.8	0.069 <0.025-0.4	0.055 <0.025-0.2	0.046 <0.025-0.1
Zinc	0.35 <0.01-4.80	0.10 <0.01-0.45	0.35 <0.01-3.90	0.24 <0.01-2.40
Copper	0.07 <0.01-0.40	0.06 <0.01-0.40	0.08 <0.01-0.80	0.04 <0.01-0.05
Arsenic	0.03 <0.01-0.05	0.03 <0.01-0.05	0.03 <0.01-0.05	0.03 <0.01-0.05
Phenol [ug/l]	3.1 <1-18	1.9 0.16-8	1.5 0.16-2	1.9 <1-6
Odor [Threshold No.]	1.3 1-4	1.5 1-8	1.2 1-4	1.6 1-8
Hexane Extraction	6.2 0.2-14	4.5 0.2-10	3.7 0.3-13	5.2 0-10
Fecal Coliform Count [no./100 ml]	22 0-127	1.387 41-10,000	245 0-890	420 1-2,100

*These parameters were measured in the field.

Available Nitrogen - Although the technique used for nitrate analysis is regarded as inaccurate, the estimated nitrate concentrations appear quite normal for stream waters of this type. However, the ammonia values are excessively high. In oxygenated systems, ammonia is converted to nitrites or nitrates and a concentration of more than 0.1 mg/l is indicative of organic pollution. In the Flambeau system, the excessive ammonia levels present may reflect the decay of organic matter in the oxygen-poor waters of wetlands tributary to the river. Deposits of peat and other materials are abundant in backwater areas of the Flambeau and the man-induced water level changes in this stretch of the river cause large fluctuations which periodically flush water out of these areas of anaerobic decomposition and ammonia production. Total available nitrogen is not a limiting factor for plant growth in the river.

Heavy Metals - Reported levels of heavy metals varied considerably in the company testing.

Arsenic - Levels of this metal were quite consistent and normal for this environment.

Iron and Manganese - Average levels of these metals were not found to be unusual for this drainage basin, but the excessive variation between samples (more than 100-fold with iron) revealed days when iron and/or manganese levels would have exceeded U.S. Public Health Service drinking water standards. Even at the observed high levels, little effect on the biota is expected.

Zinc and Copper - Values of up to 4.8 ppm zinc and 0.40 ppm copper were reported. Such concentrations could have retarded plant growth. At an average hardness concentration of the Flambeau and 22 degrees Centigrade, 4.29 mg/l of zinc would reduce the growth of a diatom population by 50 percent; however, at 30 degrees Centigrade, only 1.32 mg/l produces the same effect. Therefore, the zinc concentrations of 4.8 and 3.9 mg/l reported from Stations 1 and 4, respectively, during July 1970, probably had an adverse effect. Lower values of 1.2 and 2.4 mg/l zinc were recorded during June 1970. Copper in excess of 0.15 mg/l produces a noticeable effect on Scenedesmus (algal species). Copper sulfate concentrations as low as 0.05 mg/l have been found to be harmful to certain algal species. Toxic effects may have been present during April and May 1970 when concentrations exceeded the indicated harmful values.

Fecal Coliforms - Coliform counts vary considerably in both surveys. Downstream of the Ladysmith sewerage outfall fecal coliform counts alone regularly exceed the 200/100 ml total coliform standard established for recreational use. This could constitute a public health hazard for swimming.

The water quality of Stream G (see Figure 8) is much lower than the Flambeau River itself. Dissolved oxygen concentrations met state standards only twice during the survey. Total solids averaged 260 mg/l higher than at the highest station on the Flambeau. Suspended solids average 91 mg/l higher, total iron averaged 2.74 mg/l higher, soluble phosphates averaged 0.26 mg/l higher, total volatile solids averaged 72 mg/l higher, chlorides averaged 1.8 mg/l higher, color averaged 80 s.u. higher, hexane extraction averaged slightly higher, nitrates averaged higher by 0.26 mg/l, and odor averaged slightly higher than the Flambeau River. This tributary is a very small stream flowing through a swampy area. At times during the warmest months, the company reported difficulty in taking samples because of the extremely low stream flow. The decaying vegetation in the area no doubt contributed much to these results. No conclusion other than the different nature of the drainage area is drawn from the relatively poor water quality shown by the survey.

The excessive variation of several water quality parameters plus man-caused water level changes in the Flambeau result in a mixed water quality. Poorest water quality exists immediately downstream from Ladysmith, as a result of the combined effluents from the municipal sewage treatment plant, the paper mill, and the water level fluctuations. Fecal coliform counts and dissolved oxygen were the only parameters that might frequently fail to meet state water quality standards. Copper and zinc concentrations may be harmful to plant and invertebrate populations during certain times of the year.

Lowered water levels, due to the removal of the Port Arthur Dam, coupled with spring runoff and man-caused surges resulting from power generation above the mine site, combine to physically disrupt the river ecosystem. Periodic flushing of stagnant waters from shoreline areas could be one cause of the high levels of ammonia and heavy metals that appear in the river waters both above and below the project site. Heavy metals associated with scattered areas of mineralization in the greenstone belts that are contacted by groundwaters could also be drawn into the river when the water levels are lowered. It is quite clear that the ecological condition of the river at present is unstable.

Groundwater Hydrology

Within the project site, and throughout the surrounding region, free groundwater is contained, with minor exceptions, in the unconsolidated glacial materials and Cambrian sandstone which lie above the Precambrian bedrock. The highly impermeable clay saprolite developed during ancient weathering of the Precambrian rocks serves as an effective barrier to further downward movement of groundwater. As a result of this controlling factor, the slope of the present water table roughly parallels the nearly-horizontal ancient bedrock surface. The thickness of the zone of saturation above this surface ranges from 18 to 80 feet. Perched water tables of limited areal extent occur in isolated areas above shallow layers of impermeable glacial material. Seasonal fluctuations in the depth to the main water table are on the order of four to five feet.

Movement of groundwater in the saturated zone above bedrock takes place through horizontally discontinuous but vertically interconnected aquifers. The Cambrian sandstone, which is absent over most of the project site, is characterized by low permeabilities and is a poor aquifer at its basal contact with the underlying saprolite.

Two basic types of glacial materials are present. The areas inside the large meanders of the Flambeau River are occupied by glacial outwash deposits consisting of moderately well-sorted sands and gravels. Elsewhere, the project site is largely underlain by glacial till consisting of an unsorted mixture of material. Aquifers are more abundant, extensive and better interconnected in the outwash deposits than in the till. Confined aquifers and perched groundwater tables are more abundant in the areas underlain by till than in the outwash area.

Mine Area Study

To determine groundwater conditions in the mine area, the company drilled 20 wells during June 1970 at the locations shown in Figure 10. Low-capacity and short-duration pumping tests were conducted in eight of these. A total of sixteen field permeameter tests from wells drilled in July 1973 were also conducted at selected locations around the planned pit perimeter. Additional information was obtained from nearby domestic wells, from the mineral exploration core holes, from soil test borings and from three shallow pits excavated to bedrock along the proposed southwest perimeter of the mine.

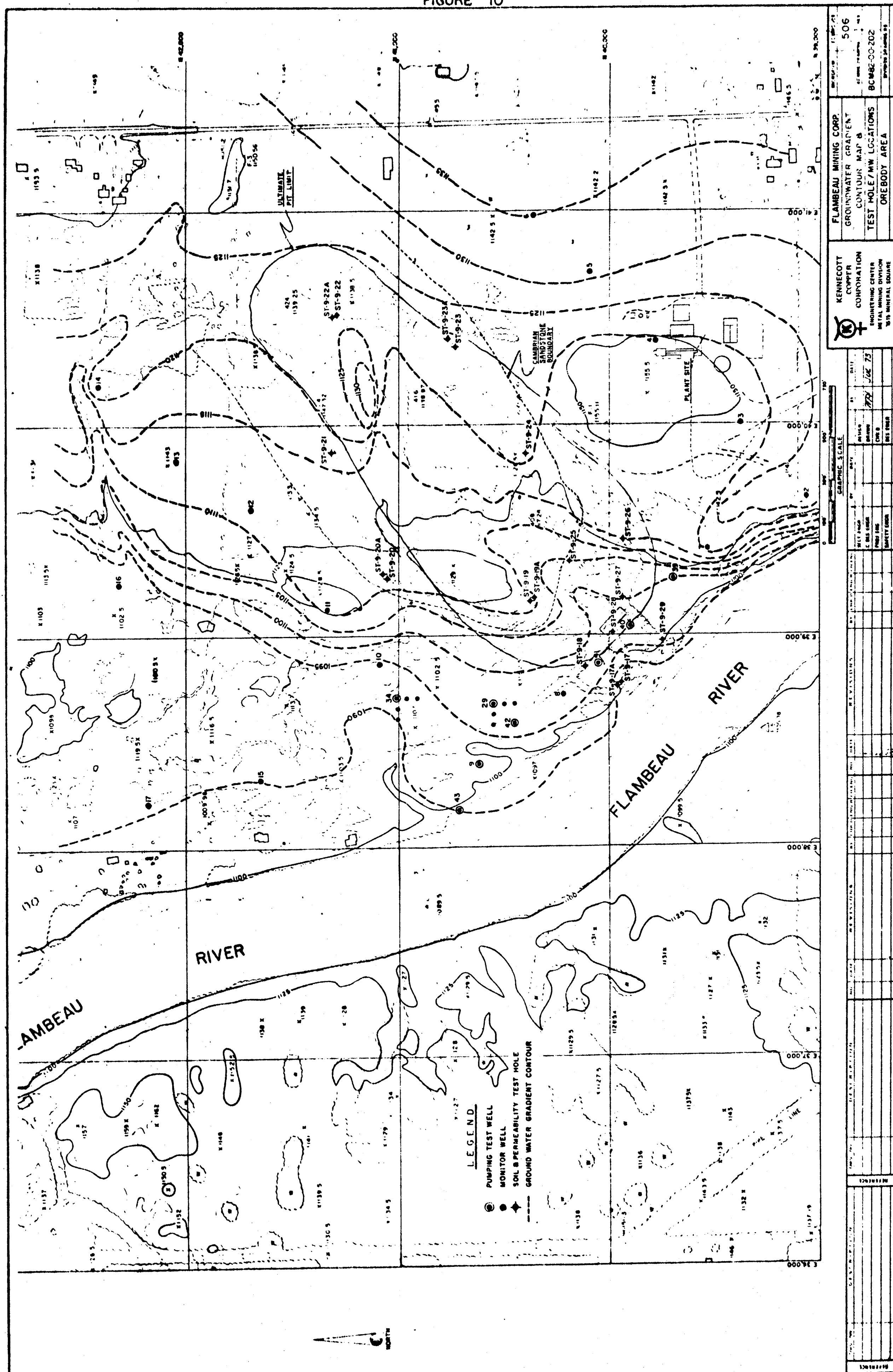
Slope to Northwest

The average depth and configuration of the water table in the mine is shown in Figure 10. The water table, which reflects the hydraulic gradient, slopes approximately 1.5 percent to the northwest across the mine area, steepens to 6 percent in the NNE-trending transition zone between glacial till and glacial outwash deposits, then flattens to 2 percent in the outwash material inside the large meander of the Flambeau River northwest of the orebody. The water table roughly parallels the slope of the Precambrian bedrock surface which appears to slope 2 percent to the northwest into the ancestral Flambeau Valley.

Fluctuations of the water table, measured in wells 6 and 12 in the area underlain by till and wells 8 and 15 in outwash, coincide closely in time and relative magnitude with fluctuations of the level of water in the Flambeau River. The coincidence in time of the fluctuations indicates that water table levels are controlled by precipitation and runoff rather than river levels.

The transition zone between glacial till and glacial outwash, as determined by drill hole data, soil test borings, and geomorphological studies, is from 250 to 400 feet wide and follows the line defined by test wells 20, 12 and 40, as shown in Figure 11. Table 7 summarizes the field test data and aquifer characteristics for well 8, 9, 29, 34, 39, 42, and 43, and for the 16 field

FIGURE 10


FLAMBEAU MINING CORP.
GROUNDWATER GRADIENT CONTOUR MAP &
TEST HOLE/MW LOCATIONS
OREBODY AREA
KENNECOTT COPPER CORPORATION
ENGINEERING CENTER
METAL MINING DIVISION
1515 MINERAL SQUARE
SALT LAKE CITY UTAH
BCM82-00-202
506
AS NOTED
GRAPHIC SCALE
LEGEND
PUMPING TEST WELL
MONITOR WELL
SOIL & PERMEABILITY TEST HOLE
GROUND WATER GRADIENT CONTOUR
FLAMBEAU RIVER
FLAMBEAU
RIVER
ULTIMATE PIT LIMIT
CAMBRIAN SANDSTONE BOUNDARY
PLANT SITE
NORTH

permeameter tests in the mine vicinity. The wells were located between the proposed pit and the Flambeau River in the outwash zone to test the area of greatest permeability, where aquifer yields were expected to be greatest. The highest permeability values were found in wells 8, 29, and 43. Well 43, located in outwash materials 300 feet from the river and 800 feet from the proposed pit, had the highest values. Drawdown tests performed on wells 29 and 34 (each surrounded by four monitor wells) supplied data that indicated very low values and yields for the outwash deposits. These data suggest that interaction of the Flambeau River with groundwater in the mine area is slight.

TABLE 7

SUMMARY OF FIELD PERMEABILITY TESTS

Test No.	Permeability Ft/Day	Permeability GPD/Ft^2	Material Tested
T.W. 8	7.15	53.48	Outwash (SW)
9	5.07	37.92	Outwash (SW)
29	7.06	52.80	Outwash (SW)
34	0.53	3.96	Outwash (SW) (?)
39	1.47	11.00	Till (SM)
42	3.51	26.25	Outwash (SW)
43	136.2	1018.8	Outwash (SW)
ST-9-17 A	3.96	29.4	Outwash (SW)
18	5.57×10^{-6}	4.17×10^{-5}	Till (SM)
19	5.66	42.34	Bedrock - Sandstone
19A	10.63	79.51	Outwash (SW)
20A	4.42×10^{-3}	3.31×10^{-2}	Bedrock - Sandstone
21	1.32	9.87	Bedrock - Sandstone
22	7.94×10^{-5}	5.94×10^{-4}	Bedrock - Sandstone
22A	2.66	19.90	Till (SM)
23	2.85	21.32	Bedrock - Sandstone
23A	4.25	31.79	Till (SM)
24	3.19	23.86	Bedrock - Sandstone
25	2.06	15.41	Till (SM)
26	1.46×10^{-2}	0.11	Till (SM)
27B	4.83×10^{-2}	0.36	Till (SM)
28B	1.13	8.45	Till (SM)
29	1.16×10^{-1}	0.87	Till (SM)

<u>Permeabilities: By Lithology</u>

Soils - SW	20 to 80 gpd/ft^2	50 Avg.
Soils - SM	0.1 to 20 gpd/ft^2	5 Avg.
Bedrock-Sandstone	10 to 50 gpd/ft^2	20 Avg.
Till Section		20 Avg.

<u>By Pit Sector</u> (in till - sandstone section)

West Side	50 gpd/ft^2	(approx. from ST-9-18 to 20)
Southwest Side	10 gpd/ft^2	(approx. from ST-9-26 to 18)
Remainder	20 gpd/ft^2	

Waste Containment Area

Groundwater conditions in the waste containment area were determined from data developed in eight monitor wells and sixty soil test holes.

The Precambrian bedrock surface appears to slope toward the northwest into the ancestral Flambeau valley in this area as it does in the mine area. A layer of clay saprolite of variable thickness is also present at the bedrock surface. A thin remnant of Cambrian sandstone overlies bedrock west of the area. Glacial deposits overlying bedrock range in thickness from 55 to at least 124 feet and, except in the northwest corner of the area, consist of till overlain by a continuous mantle of silty materials ranging from 3.5 to 11.5 feet in thickness. The northwest corner of the area is underlain by coarser-grained sandy materials which were deposited along the edges of a large stagnant-ice mass which formerly occupied the present wetland area to the west. The wetlands occupy the site of a basin in the original ground moraine surface which, after the stagnant-ice mass melted, filled with lacustrine silts and a thick accumulation of peat.

Because of the presence of extensive layers of relatively-impermeable silty materials at shallow depths over most of the area, perched water tables are common. The depth of the soil to the normal groundwater table varies from over 20 feet along highway "P" to less than one foot in the lowland area just west of the proposed waste containment area. The existing groundwater flow pattern is to the west-northwest into the wetlands which adjoin the waste containment area. One variance to this pattern may occur in the northwest corner of Section 21 where more permeable materials, deposited at the edge of the ancient stagnant-ice mass, may direct some of the subsurface flow northward.

In general, soil permeabilities are low to very low and uniform under the waste containment area. Presently, most incident precipitation runs off this area into the adjacent wetlands because of the low capacity of the soils to transmit water. Table 8 lists the average permeabilities of the soils which underlie the area. All samples analyzed, except two, exhibited low permeabilities in the range of 10^{-6} cm per second or less. The two higher permeability values represent the coarser soils present in the northwest corner of the area.

TABLE 8

PERMEABILITIES OF REPRESENTATIVE BASE SOILS UNDER THE WASTE CONTAINMENT AREA

Sampling Station	Depth & Thickness of Soil Tested	Soil Type	Averaged Cm/Sec	Permeabilities Feet/Day
27	6.0 - 7.0	Silt over Silty Sand	1.7×10^{-6}	4.81×10^{-3}
33	2.0 - 3.5	Clayey Silt over Silty Sand	1.1×10^{-6}	3.11×10^{-3}
38	0.0 - 8.0	Silt over Silty Sand	1.7×10^{-6}	4.81×10^{-3}
53	2.0 - 5.0	Silt over Silty Sand	6.6×10^{-8}	1.87×10^{-4}
40	0.0 -11.5	Silt over Silty Sand	9.1×10^{-7}	2.57×10^{-3}

Ground Water Quality

Mine Area

BCMC has sampled groundwater quality at the proposed mine area and at the proposed waste containment area. The results of their survey at the mine site are presented in Table 9. In all wells iron and manganese levels exceeded the respective standards of 0.3 mg/l and 0.05 mg/l established by the U.S. Public Health Service and by chapter NR 111, Wisconsin Administrative Code as the maximum acceptable levels for potable water supplies (for aesthetic reasons). Copper, zinc and lead were also present in excess of normal background levels. Test wells 40 and 41 were found to average more than a 1.0 part per million of copper which exceeds state and federal drinking water standards. The same wells also had high lead levels which exceeded drinking water standard of 0.05 mg/l. Fecal coliform were found in all wells but the test results are considered invalid because of the well construction and sampling methods.

The presence of high levels of zinc, copper and lead in several wells indicates interaction with the orebody, as does the pattern of pH recorded for the test wells. Wells 6, 40, 41, 29 and 17, sited at points across the strike of the orebody and progressively down the hydraulic gradient, had average pH's of 7.1, 6.2, 6.2, 6.4, and 6.7, respectively. The trend established by these data indicates interaction of groundwater with the orebody as the waters move down slope across the body and then recovery by dilution to near neutrality in the sands and gravels to the northwest (see Figure 11a).

FIGURE 11

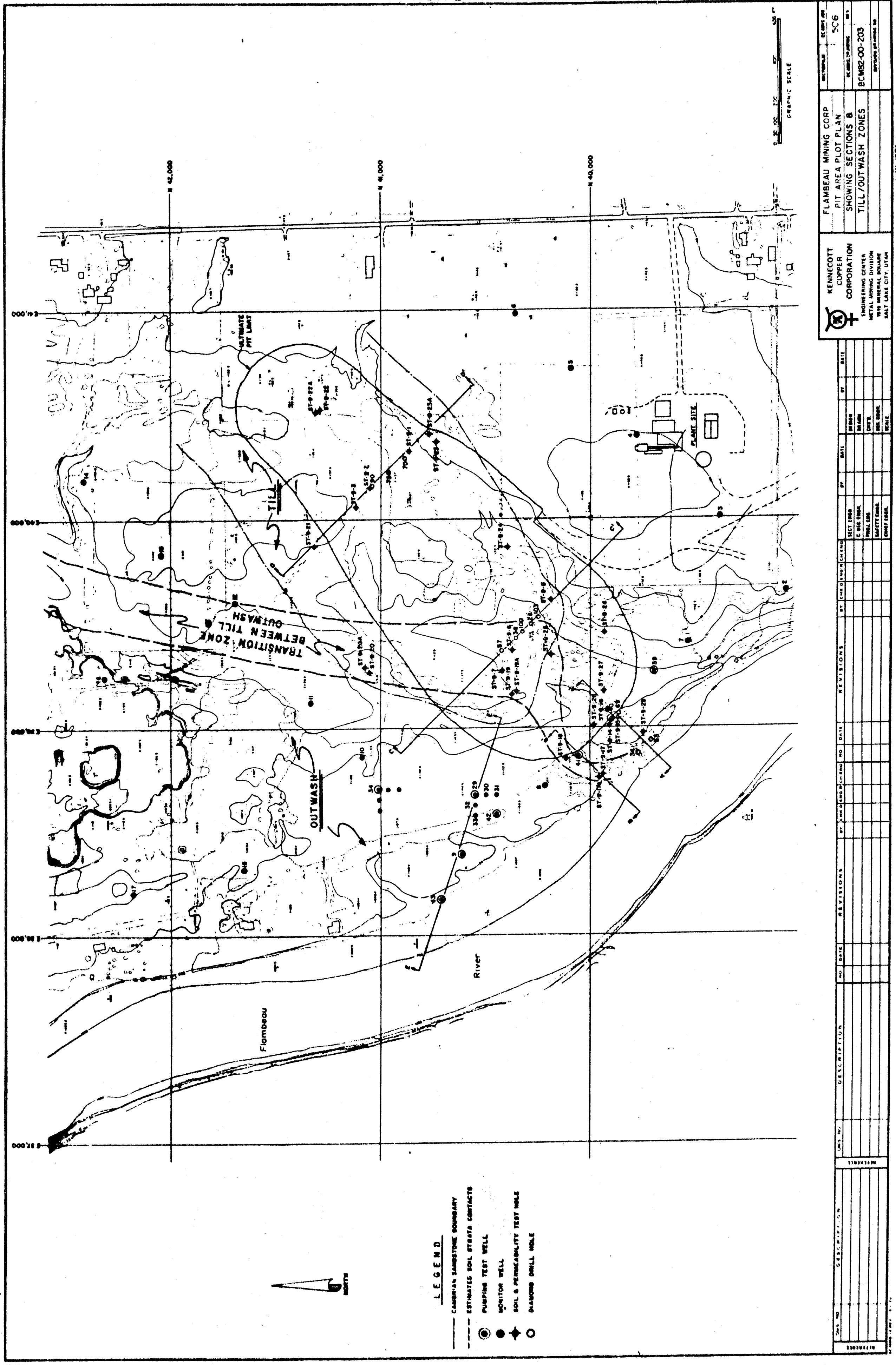
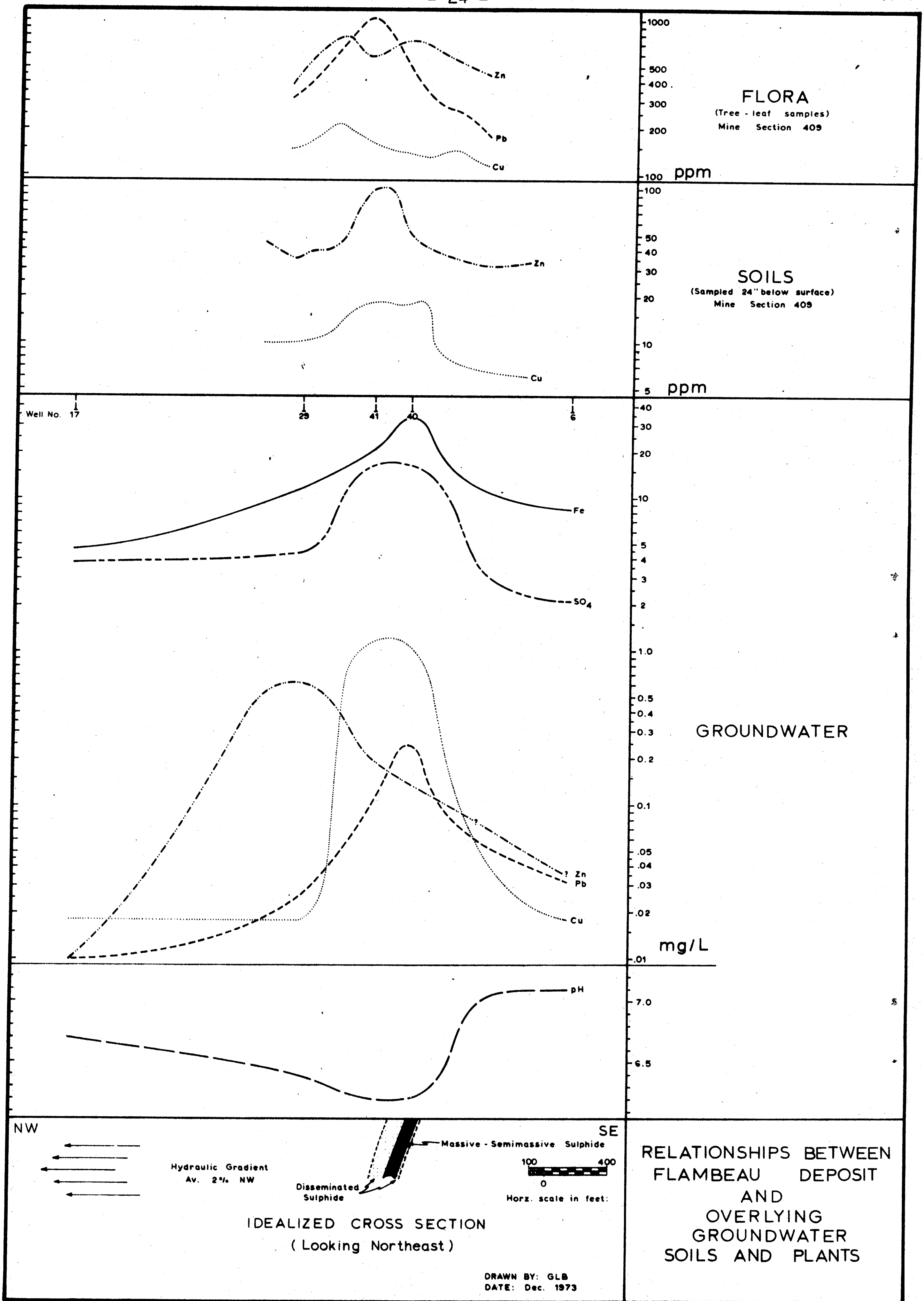

FLAMBEAU MINING CORP
PIT AREA PLOT PLAN
SHOWING SECTIONS &
TILL/OUTWASH ZONES
KENNECOTT
COPPER
CORPORATION
BCM82-00-203
MAY, 1974
GRAPHIC SCALE
ULTIMATE PIT LIMIT
TILL
TRANSITION ZONE
BETWEEN TILL &
OUTWASH
OUTWASH
PLANT SITE
Flambeau
River
LEGEND
CAMBRIAN SANDSTONE BOUNDARY
ESTIMATED SOIL STRATA CONTACTS
PUMPING TEST WELL
MONITOR WELL
SOIL & PERMEABILITY TEST HOLE
DIAMOND DRILL HOLE
NORTH

FIGURE 11A



RELATIONSHIPS BETWEEN FLAMBEAU DEPOSIT AND OVERLYING GROUNDWATER SOILS AND PLANTS

TABLE 9

ANALYSES OF GROUNDWATER WELLS, MINE SITE, FLAMBEAU DEVELOPMENT PROJECT, LADYSMITH, WISCONSIN

ANALYSIS[6]	TEST WELL NUMBERS 6[1]	14[1]	17[3]	18[4]	29[2]	40[5]	41[5]
pH (Standard Units)	7.1 6.9-7.2	6.2 5.8-6.7	6.7 6.5-6.9	6.7 6.3-6.9	6.4 6.0-6.6	6.2 6.1-6.4	6.2 5.9-6.3
pH (S.U. - Laboratory)	7.2 6.9-7.6	6.5 6.0-7.6	7.1 6.6-7.6	6.6 6.3-7.0	6.6 6.1-7.2	6.8 6.1-7.6	6.4 6.1-6.7
Total Hardness ($CaCo_3$)	191 170-206	43 28-72	99 92-110	90 80-112	54 40-92	63 44-104	76 62-88
Total Solids	250 170-330	110 20-320	165 15-550	124 80-176	105 60-195	101 10-143	146 65-250
Nitrate Nitrogen (N)	0.6 0.2-2.3	0.2 0.1-0.5	0.3 0.3-1.2	1.4 0.8-1.8	0.5 0.3-0.8	0.7 0.4-1.0	0.4 0.1-0.8
Sulphates	2.1 <1-11	4.2 0.1-10	3.8 2-5	3.5 0.2-12	4.4 0.1-9.0	16.2 8-32	16.5 11.32
Aluminum ug/l	<5.5 <1-<6	<5.5 <1-<6	<6	<5.5 <1-<6	<5.5 <1-<6	3.2 <0.5-<6	3.2 <0.5-<6
Arsenic	<.03 <.01-<.05	<.03 <.01-<.05	<.05	<.03 <.01-<.05	<.03 <.01-<.05	<0.01	<0.01
Barium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Boron	<.02 <.02-.06	<.02 <.02-.04	<.02	<.02 <.02-.02	<.02 <.02-.03	.14 .02-.24	.13 .06-.24
Cadmium	.010 <.001-<.02	.010 <.001-<.02	0.02 <.01-<.02	.010 <.001-<.02	.010 <.001-<.02	.01 <.001-<.02	.01 <.001-<.02
Chromium	<.02	<.02	<.02	<.02	<.02	.07 <.02-0.2	.06 <.02-.15
Copper	<.018 <.025-<.05	<.018 <.025-<.05	<.018 <.025-<.05	<.018 <.025-<.05	<.018 <.025-<.05	1.01 .025- 2.35	1.17 .025-4.35
Fluoride	<.018 <.02-.14	<.026 <.02-<.08	<.02	<.026 <.02-<.08	<.026 <.02-<.08	0.09 .02-.14	0.10 .02-.14
Iron	8.4 1.1-12	5.5 1.1-13	4.7 <.025-8	1.3 1.5-3.5	11.6 7.4-18.5	33.3 31-100	21.1 10-48
Lead	.033 <.001-<.1	.022 <.001-<.1	0.009 <.001-<.05	.009 <.001-<.05	.026 <.001-<.1	.250 .001-1.000	0.100 .001-.400
Magnesium	17.8 15.3-42	4.4 1.2-14	6.6 4.5-10	9.8 6-17	8.7 .3-42	9 7-16	9 6-10
Manganese	.32 <.025- .51	.51 <.025-0.7	.13 <.025- .18	.04 <.02- .06	.35 <.025- .5	0.21 <.03- .63	0.99 .78-1.29
Mercury ug/l	<1	<1	<1	<1	<1	<1	<1
Molybdenum	.178 <.001-<.4	.178 <.001-<.4	.178 <.001-<.4	.178 <.001-<.4	.178 <.001-<.4	<.001	<.001
Nickel	.02 <.01-<.05	.02 <.01-<.05	.02 <.01-<.05	.02 <.01-<.05	.02 <.01-<.05	0.11 <.01-.18	0.9 <.01-.15
Selenium	.24 <.01-<.3	.24 <.01-<.3	.24 <.01-<.3	.24 <.01-<.3	.24 <.01-<.3	<.01	<.01
Silver	.13 <.01-<1	.13 <.01-<1	.13 <.01-<1	.13 <.01-<1	.13 <.01-<1	<.01	<.01
Zinc	.86 .17-1.32	.02 <.025- .06	.01 <.005-<.01	.02 <.025- .06	.64 <.005-2.3	.14 .07-.23	0.20 .09-.51

[1]Sampling commenced July 1971
[2]Sampling commenced September 1971
[3]Sampled July 1971 to December 1971
[4]Sampling commenced January 1972
[5]Sampling commenced December 1972
[6]All values are in mg/l unless indicated otherwise

Waste Containment Area

Groundwater quality in the waste containment area is somewhat different than at the mine area. In all wells sampled, iron and manganese levels exceeded the USPHS and DNR aesthetic standards for potable water. Color and odor also exceeded the USPHS and DNR aesthetic standards for drinking water in the very limited testing for these parameters. Total hardness, present at average levels of 203 to 420 mg/l, is a potentially objectionable quality in all of the wells. Individual samples from wells 21 and 27 showed dissolved solids concentrations above the USPHS recommended upper limit of 500 mg/l. The base metal content of all wells sampled was relatively low and is believed to approximate local background levels. The best water quality of the area was observed in well 26, located in an area underlain by permeable sand-sized materials. All wells sampled in the waste containment area possessed coliform bacteria at some test period. Although the levels were lower than those of the mine area, the test results are thought to be unreliable because of well construction and sampling methods.

Geology

Precambrian Shield

The Canadian Shield is an extensive region of Precambrian-age rock that forms the bedrock for a land area of about 1,800,000 square miles. Most of this area lies in Canada, but about 93,000 square miles lie in the northern parts of Minnesota, Wisconsin and Michigan (Figure 12). Major rock types of the Shield consist of gneisses, mixed-volcanic suites and the so-called greenstone belts, and sediments including banded iron formations. Surrounding, intruding and replacing these rock types are intrusive igneous rocks of varying compositions. All of these rocks have been subjected to structural deformation (folding or faulting) during Precambrian time. However, they have been little disturbed since Cambrian time, and the Shield now forms one of the most geologically stable areas on the earth's crust. Present-day seismic activity in the region and in Rusk County is extremely low.

It is within the greenstone volcanic belts that a considerable portion of the massive sulfide deposits are found. The term greenstone is frequently used when no accurate rock determination is possible and includes rocks that have been so altered that they have assumed a distinctive green color because of the presence of the mineral chlorite. Greenstone belts consisting of volcanic and volcani-sedimentary rocks are found in northern Wisconsin and are generally covered by a thin mantle of Pleistocene glacial material or, further to the south, by ever-increasing amounts of younger Paleozoic sediments.

One of many such covered greenstone belts lies south of Ladysmith in Rusk County. It is within this steeply-dipping northeast-trending complex suite of volcanic rocks that the Flambeau deposit was identified in 1968. The volcanics are terminated west of the project site by a granite intrusion which is believed to be the southern extension of a large granite body underlying Ladysmith. There is no indication that sulfide mineralization extends beneath Ladysmith (Figure 13).

Glacial Material

The Flambeau deposit is completely covered by Pleistocene glacial material. The glacial material varies in thickness from ten feet over the mineralization between the river and pit to thirty feet at the east end of the proposed pit. Rapid thickening of the glacial material to the northwest suggests the presence of an ancestral Flambeau valley now filled with at least ninety feet of gravel-rich outwash. These outwash deposits are currently being mined for gravel and are locally an important source of well water. East of the outwash is a south-southwest-trending transition zone. This zone, of variable width, composition and permeability, is a transition between the outwash material and the more silt-rich till deposits to the east (Figure 11). Glacial till, characterized by high silt content, variable composition and generally low permeabilities, overlies the southwest, south and east half of the orebody. Interbedded with and overlying the till is a silty sand probably derived from windblown material.

Cambrian Sandstone

Overlying the Precambrian bedrock but beneath the glacial material is a thin outlier of flat-lying Cambrian sandstone. The sandstone, a clean, well-sorted friable rock, lies directly over the copper mineralization. Absent over the western one-third of the orebody, it reaches a maximum thickness of thirty feet over the northeast end of the orebody and thins to zero feet approximately 500 feet on either side of the orebody. It continues northeastward for an unknown distance.

FIGURE 12

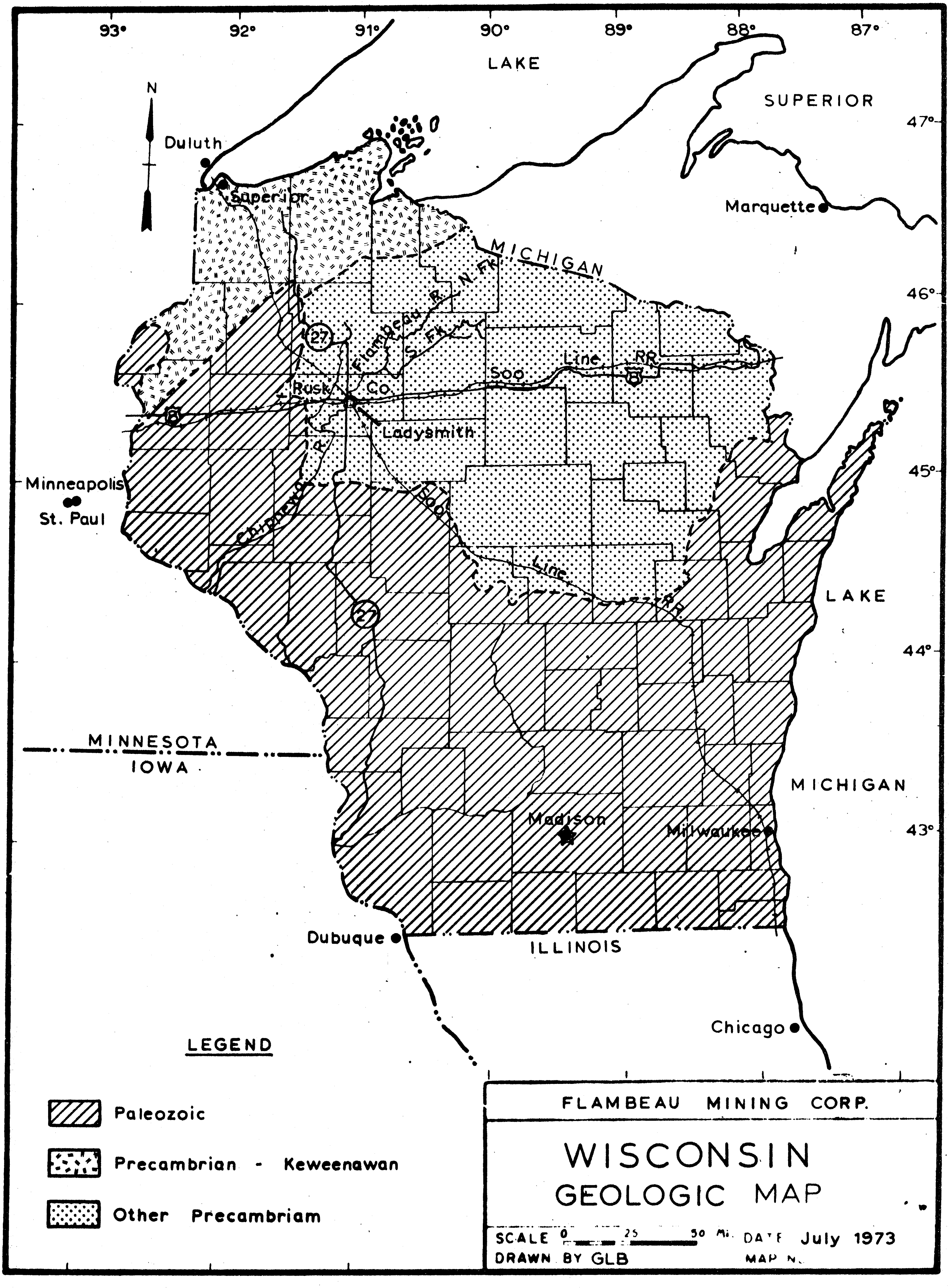
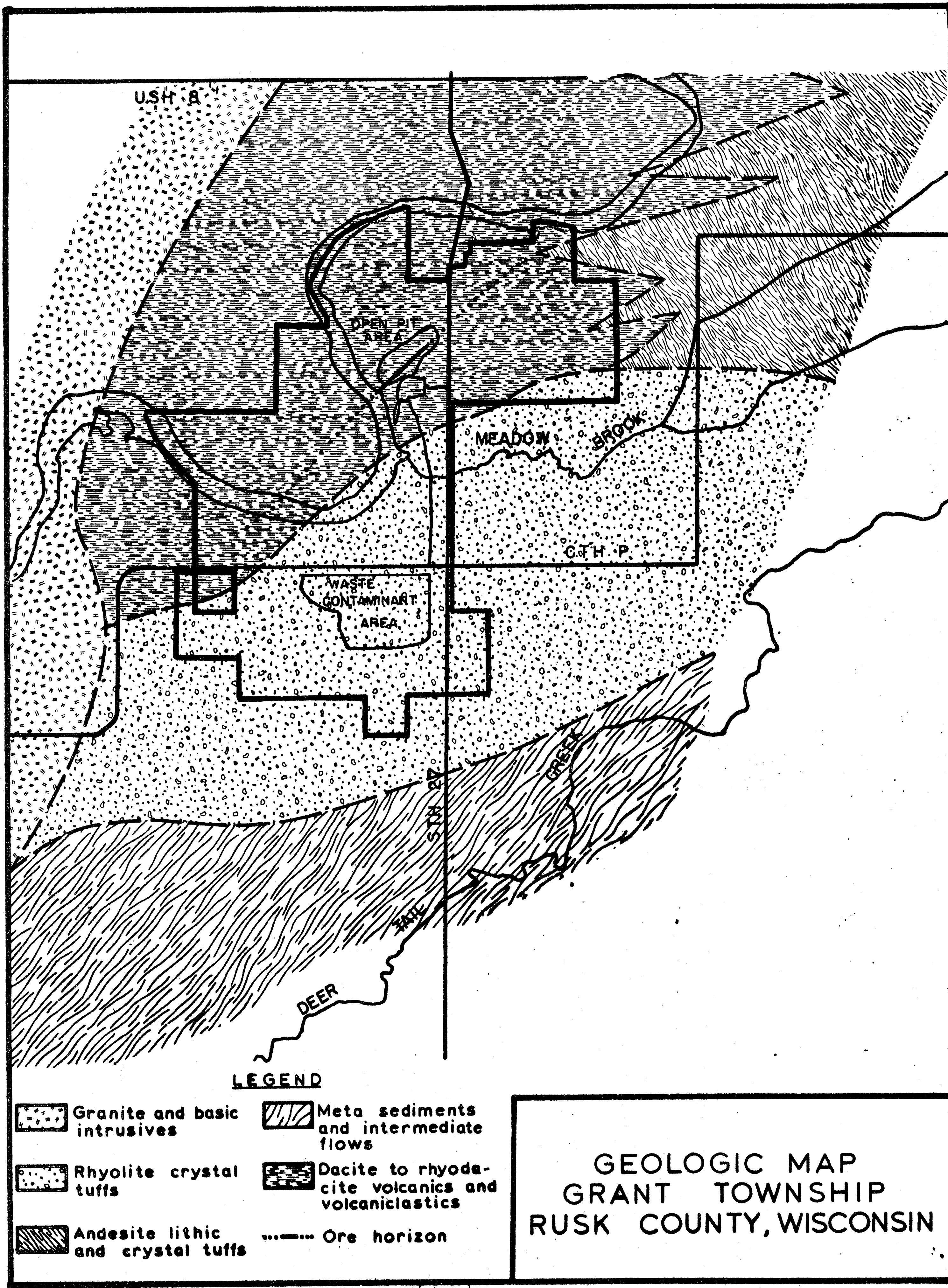

93°
92°
91°
90°
89°
88°
87°
47°
46°
45°
44°
43°
N
LAKE
SUPERIOR
Duluth
Superior
Marquette
MICHIGAN
Flambeau R. N. Fk.
S. Fk.
Soo Line RR
27
8
Rusk Co.
Ladysmith
Minneapolis
St. Paul
Chippewa R.
Soo Line RR
LAKE
MICHIGAN
MINNESOTA
IOWA
Madison
Milwaukee
Dubuque
ILLINOIS
Chicago
LEGEND
Paleozoic
Precambrian - Keweenawan
Other Precambriam
FLAMBEAU MINING CORP.
WISCONSIN
GEOLOGIC MAP
SCALE 0 25 50 Mi.
DATE July 1973
DRAWN BY GLB
MAP N.

FIGURE 13



GEOLOGIC MAP
GRANT TOWNSHIP
RUSK COUNTY, WISCONSIN

Saprolite Clay

In late Precambrian time, intensive weathering and disintegration of the steeply-tilted volcanic rocks formed a clay-rich layer, termed saprolite, at the Precambrian bedrock surface. The saprolite layer is thickest adjacent to the orebody and beneath the Cambrian sandstone, and thins rapidly away from the mineralization under the glacial cover. Saprolite is particularly well developed in those rocks rich in plagioclase feldspar such as the actinolite schist. The presence of this impervious saprolite layer prevents groundwaters from entering into the Precambrian bedrock.

Orebody

The Precambrian bedrock consists of a complex interfingering suite of volcanic and volcaniclastic rocks now metamorphosed and altered to schists and phyllites (Figure 14). These rocks were probably volcanic flows, ash beds, pumice deposits and volcanic-derived sediments of Middle Precambrian age. Within this complex volcanic pile is a distinctive rock type, a quartz-sericite schist, termed the ore horizon, since it contains the copper orebody. The ore horizon pinches and swells along strike for 15,000 feet and varies in width from 25 to 200 feet. Only the one ore horizon containing the single known orebody has been found (Figure 15).

The ore horizon, because it contains more quartz than the adjoining rocks, has resisted erosion to form a gentle broad northeast-trending ridge in the Precambrian bedrock surface. This bedrock ridge is of great significance to the development and operation of the open pit mine, for it acts as a natural impermeable barrier between the river and the pit located some 300 feet to the east (Figure 16). The buried ridge rises beneath the east bank of the river to reach a subsurface elevation of 1,095 feet under the west pit perimeter. This elevation is approximately 10 feet higher than the average river level.

Massive Sulfides

The Flambeau orebody lies conformably within a quartz-sericite schist and is intimately associated with lenses of metachert. The orebody strikes north 45 degrees east and dips approximately 70 degrees to the northwest. Diamond drilling has outlined a tabular-shaped massive sulfide deposit 2,400 feet long, averaging 50 feet in width, and extending to 800 feet beneath the surface. Deeper drilling has not intersected economical mineralization. Massive sulfide mineralization, greater than 50 percent sulfide, grades at depth into semimassive sulfides which vary from 20 to 50 percent sulfide. An envelope of disseminated sulfides, predominantly pyrite with minor amounts of chalcopyrite, encloses the orebody and is found along strike within the ore horizon. The width of this pyrite halo averages 110 feet to the north of the orebody but only 55 feet to the south. Contacts between the massive-semimassive orebody and the enclosing rock vary from knife-edge sharp to gradational over 15 to 20 feet. Therefore any improvements in mining technology or higher copper prices would not have an appreciable effect in increasing ore reserves.

Minerals

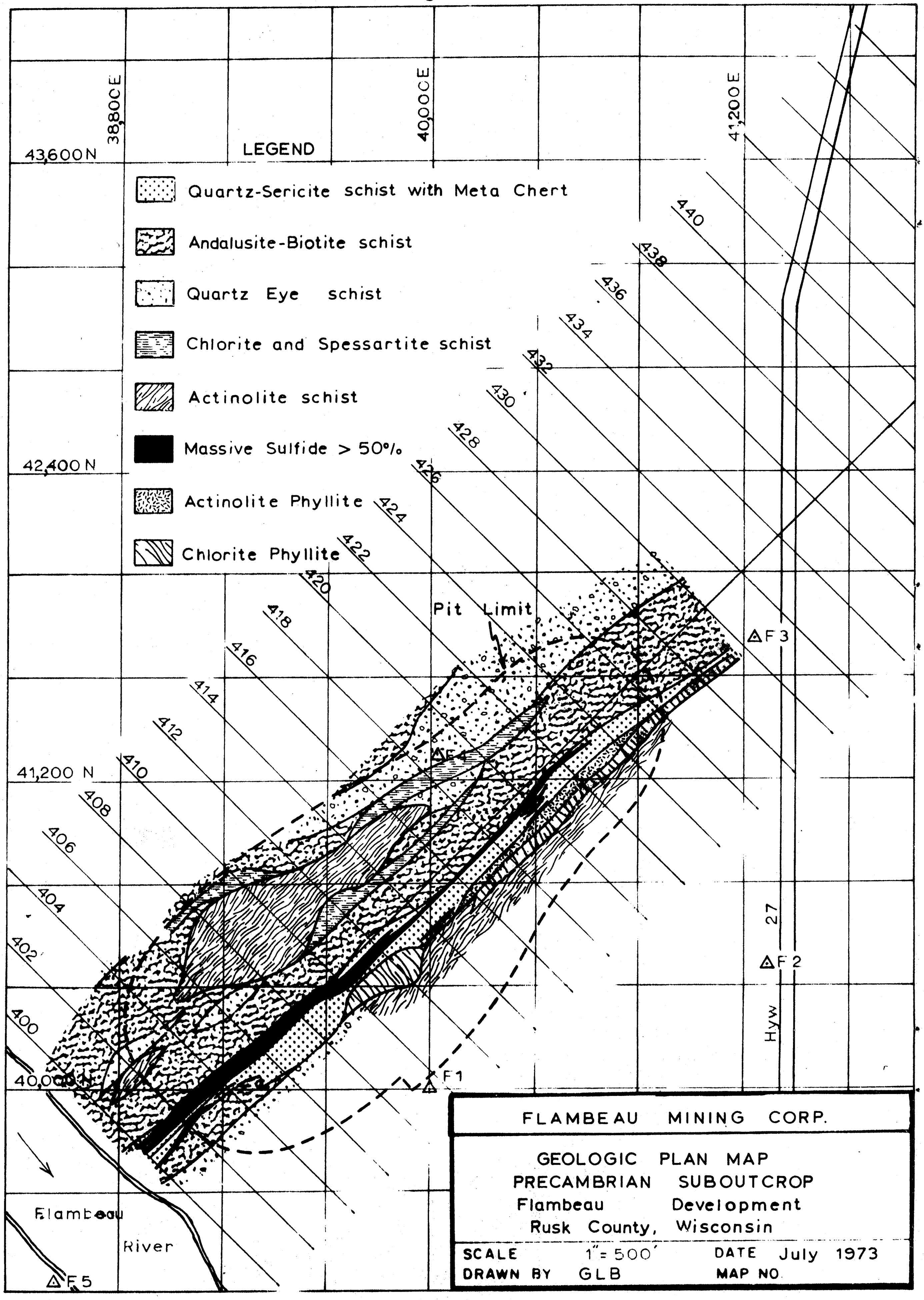
Pyrite is the predominant sulfide mineral. The chief copper mineral is chalcopyrite which is found scattered throughout the pyrite. In the upper or north wall of the orebody the sulfides are crudely banded; however, the character of the mineralogy changes across the orebody as well as with depth. Sphalerite, a zinc sulfide, increases noticeably toward the lower contact of the orebody, imparting a well-banded appearance to the orebody when mixed with pyrite and chalcopyrite. At depth, pyrite decreases, sphalerite is reduced to minor amounts, and the chalcopyrite grains coalesce to form irregular masses. The uppermost 50 to 150 feet of the orebody were enriched in copper during the ancient weathering interval which produced the clay saprolite. Chalcocite is the predominant copper mineral in the upper portion of the enriched zone, whereas bornite predominates in the lower half. The disseminated pyrite halo has been enriched on either side of the massive sulfide vein. Zinc minerals are virtually absent in the enriched zone.

Copper with trace amounts of gold and silver would be produced from the Flambeau orebody. Although small amounts of zinc are found in the lower wall and in satellite lenses beneath the vein, the company reports insufficient tonnage to warrant recovery under present economic conditions.

No Asbestos

The company has tested the ore for asbestos. They report that "no cummingtonite (asbestos) or other problem fibrous silicate minerals" are present in the Flambeau ore. Their absence is important from a public health standpoint since asbestos fibers are suspected to cause lung cancer when inhaled in large quantities.

FIGURE 14



LEGEND
Quartz-Sericite schist with Meta Chert
Andalusite-Biotite schist
Quartz Eye schist
Chlorite and Spessartite schist
Actinolite schist
Massive Sulfide > 50%
Actinolite Phyllite
Chlorite Phyllite
38,800 E
40,000 E
41,200 E
43,600 N
42,400 N
41,200 N
40,000 N
Pit Limit
F1
F2
F3
F4
F5
Hyw 27
Flambeau River
400
402
404
406
408
410
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414
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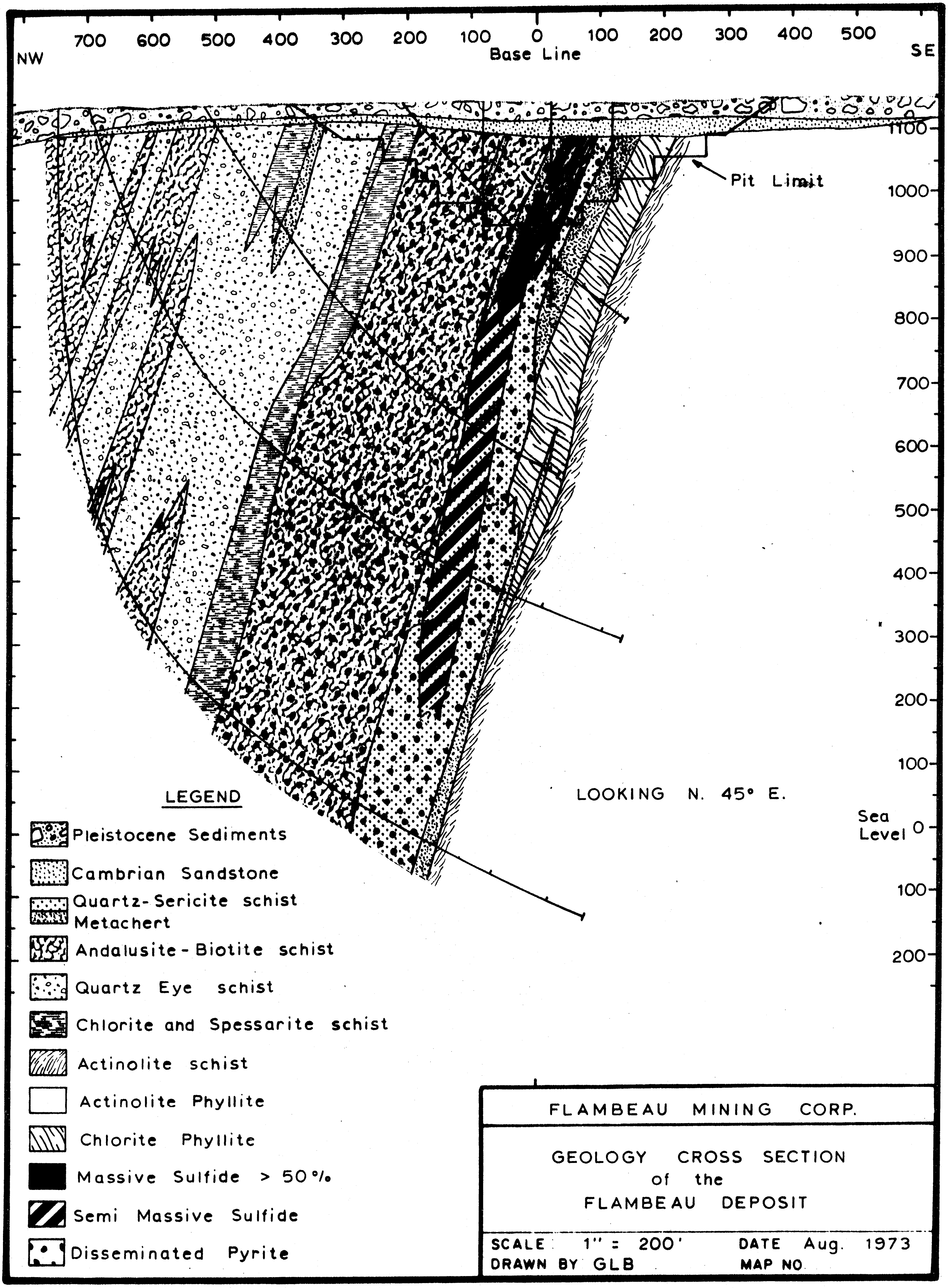
436
438
440
FLAMBEAU MINING CORP.
GEOLOGIC PLAN MAP
PRECAMBRIAN SUBOUTCROP
Flambeau Development
Rusk County, Wisconsin
SCALE 1" = 500'
DATE July 1973
DRAWN BY GLB
MAP NO.

FIGURE 15



NW
700 600 500 400 300 200 100 0 100 200 300 400 500
Base Line
SE
1100
1000
900
800
700
600
500
400
300
200
100
Sea Level 0
100
200
Pit Limit
LOOKING N. 45° E.
LEGEND
Pleistocene Sediments
Cambrian Sandstone
Quartz-Sericite schist
Metachert
Andalusite - Biotite schist
Quartz Eye schist
Chlorite and Spessarite schist
Actinolite schist
Actinolite Phyllite
Chlorite Phyllite
Massive Sulfide > 50 %
Semi Massive Sulfide
Disseminated Pyrite
FLAMBEAU MINING CORP.
GEOLOGY CROSS SECTION
of the
FLAMBEAU DEPOSIT
SCALE 1" = 200'
DATE Aug. 1973
DRAWN BY GLB
MAP NO.

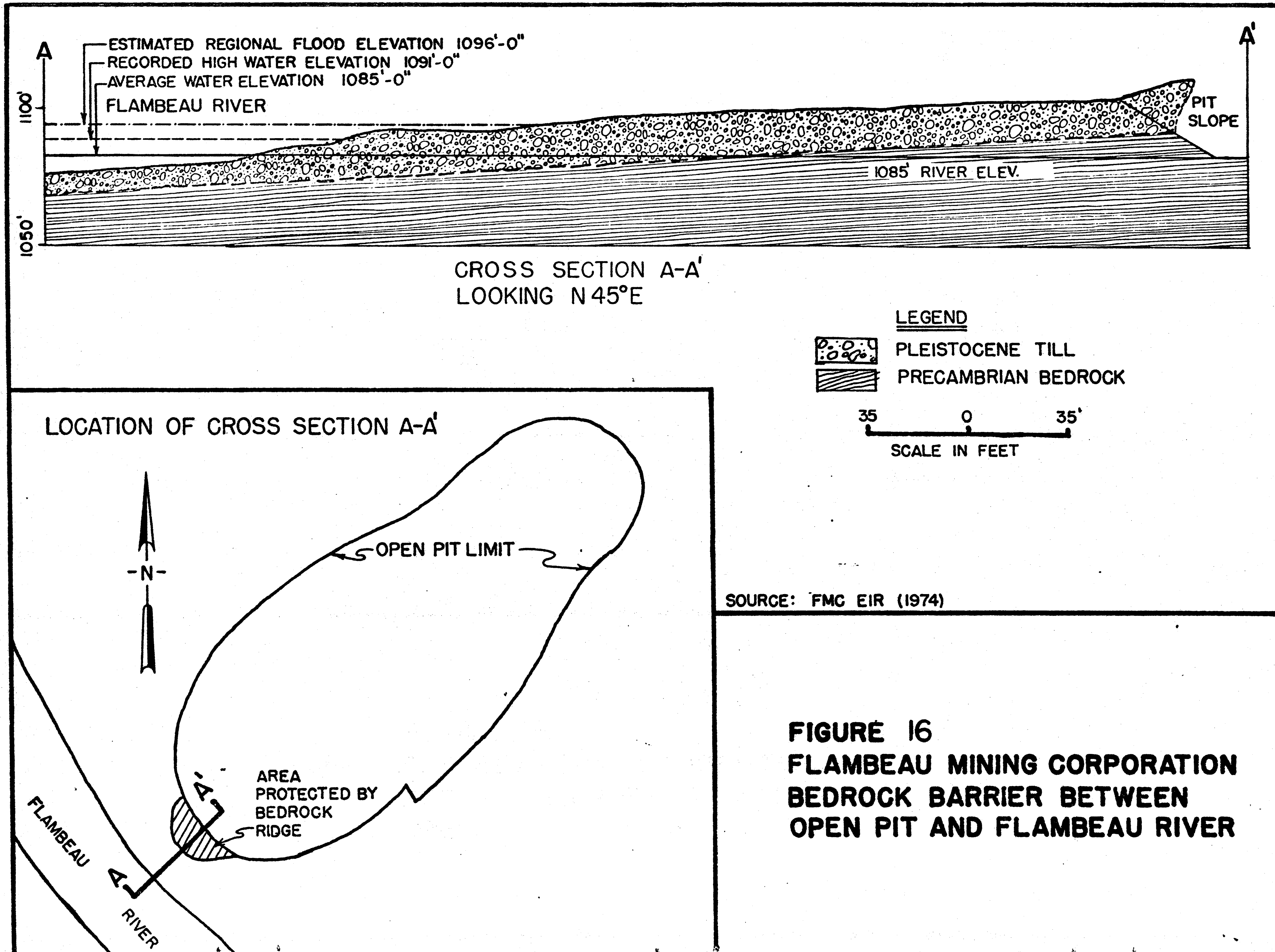


FIGURE 16
FLAMBEAU MINING CORPORATION
BEDROCK BARRIER BETWEEN
OPEN PIT AND FLAMBEAU RIVER

Geomorphology

Excluding the valley of the Flambeau River, the majority of the landforms within the project area were formed during the last glacial period, about 12,000 to 16,000 years ago. This period was the Woodfordian substage of the Wisconsin stage of the Pleistocene epoch. Glacial deposits average 30 to 50 feet thick and in some localities exceed 100 feet.

Relatively Flat

Although sizable flatland tracts do exist, most of the area varies between undulating to slightly hilly. With few exceptions, the flat areas occupy the floors of depressions and are poorly drained. Elevations range from a low of approximately 1,090 feet, where the Flambeau River exits the site, to a high of approximately 1,170 feet east of the deposit. Steep slopes and greatest relief are generally restricted to the outside banks of the meandering Flambeau River. These river bluffs typically range between 30 and 50 feet, but rarely exceed 60 feet in relief.

No rare or particularly unusual landforms have been identified within the area controlled by FMC. Along the bank of the Flambeau River the land features have some scenic value.

In general, the geomorphology of the project area occupies a transitional location between stagnant-ice features to the west and predominantly active-ice features to the east. Grant Township is located approximately 18 miles northeast of the terminal moraine of the southwest-flowing Chippewa lobe of the continental glacier (Figure 17).

Linear Topography

East of the Flambeau River, the project area consists of numerous northeast-southwest trending, poorly developed drumlins separated by shallow poorly-drained linear depressions (Figure 18). Reflecting this topographic pattern, the streams and swamps, particularly east of State Highway 27 and south of U.S. Highway 8, display a marked parallelism. The predominant surface material of the ground moraine is till which is characteristically stony with poor surface drainage. Overlying the relatively impermeable till is a thin mantle of silt-rich material. On the uplands, the silt, believed to be derived from windblown material from nearby outwash plains, rarely exceeds one to two feet in thickness. However, the silt of the lowland areas is often contained in distinct basins in the original ground moraine surface. A sandy layer often separates the silt from the underlying till, thus suggesting a lacustrine or deltaic origin. These interglacial or postglacial lakes have since been drained by downcutting of their outlets or filled with inorganic and/or organic sediments. The presence of this silty layer accentuates the near-surface low permeability of the ground moraine soils. Filled postglacial lakes are believed present in the north half of Section 10, upstream of Meadowbrook Creek in Sections 14 and 15, and in the center of Sections 20 and 21.

Stagnant-ice features increase in frequency west of the Flambeau River, particularly south of the old Port Arthur Dam site. The most distinctive and extensive stagnant ice landform consists of small, steepsided hills and intervening closed depressions. Collectively, the hills and depressions are called hummocky stagnation moraines, or knob and kettle moraines.

Kettle Moraine

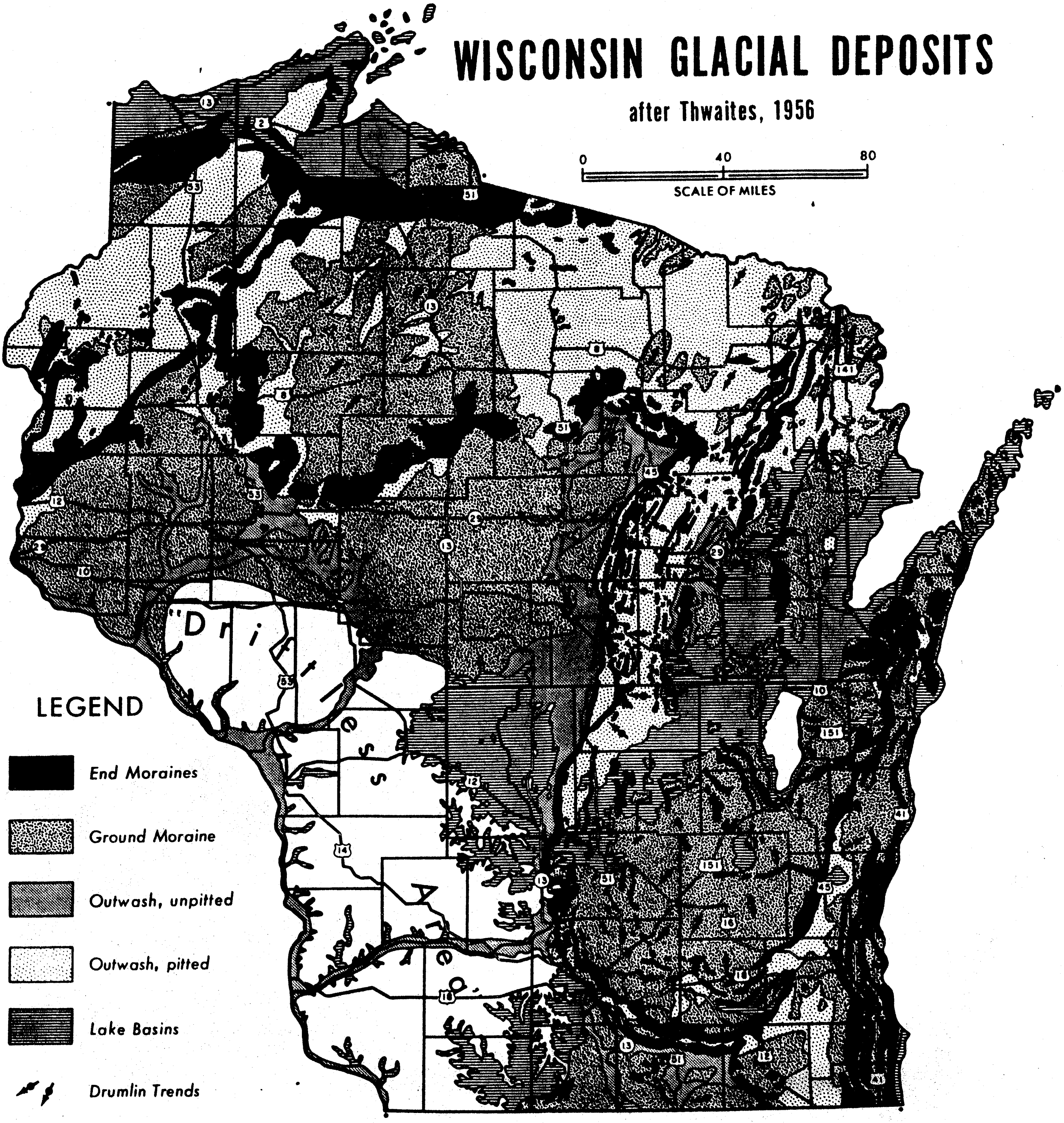
Hummocky stagnation moraine consists of till but with less silt and clay than the till of ground moraine areas. Within the project site small tracts of hummocky stagnation moraine are found in the south half of Section 10, the northwest quarter of Section 20, and the west half of Section 9.

Two northeast-southwest-trending, irregularly-shaped, linear gravelly ridges cross County Highway P approximately one mile west of State Highway 27. These ridges appear to be ice contact features deposited along the edges of a large stagnant-ice mass occupying the present large swamp, formerly a postglacial lake, in Sections 20 and 21.

Flambeau Valley

The outwash deposits of the Flambeau Valley are located inside (enclosed by) the large meanders of the Flambeau River. Normally, outwash plains are quite flat, but because the Flambeau outwash was deposited on irregularly-shaped stagnant ice, basins or pits were created by subsequent melting of the ice. It is difficult, based on topography, to distinguish valley

FIGURE 17

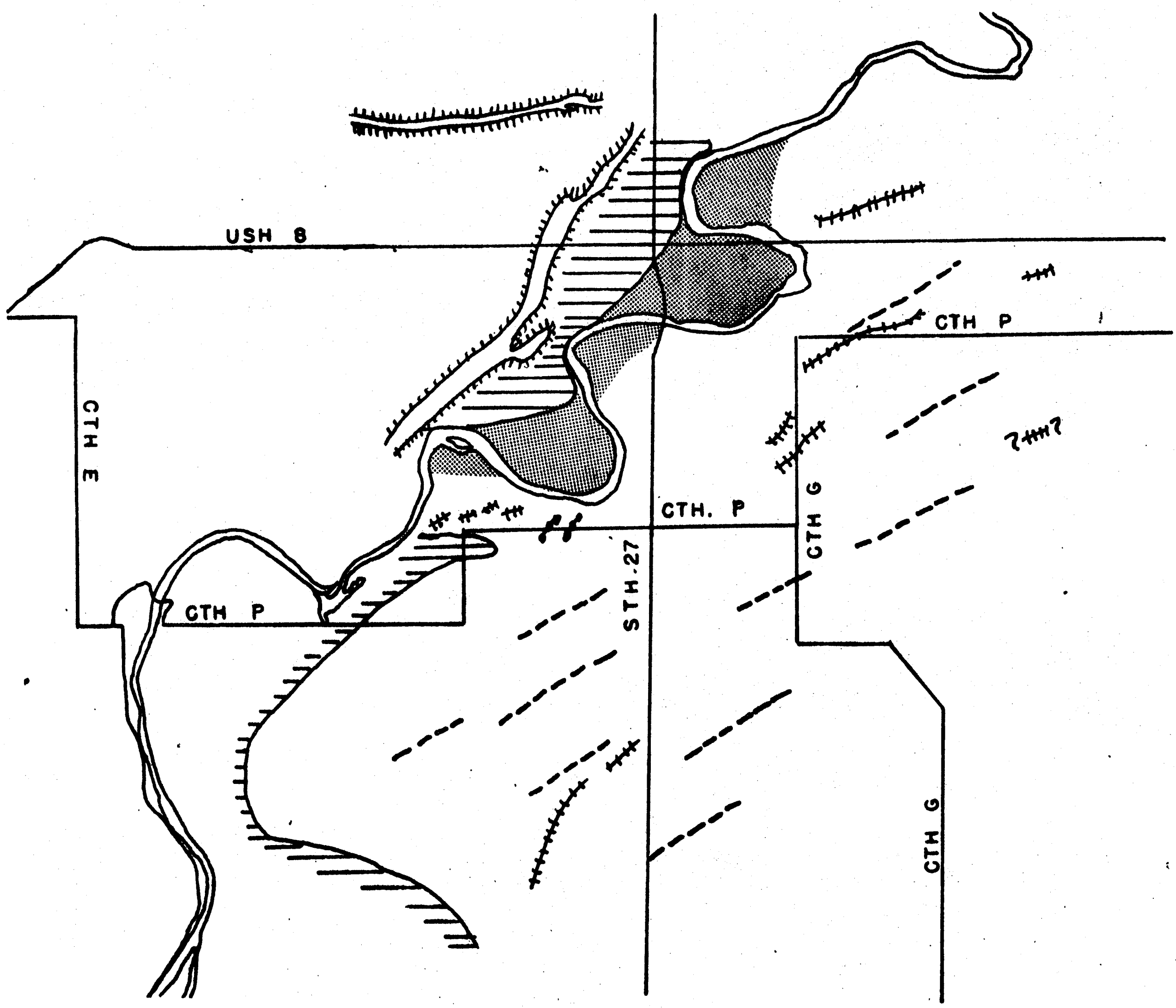


University of Wisconsin

Wisconsin Geological and Natural History Survey

George F. Hanson, Director and State Geologist

FIGURE 18



LEGEND

- Hummocky Stagnation Moraine
- Esker
- Linear Gravelly Ridge (Stagnant Ice Feature)
- Ice-walled Gravel Train
- Trend of Drumlinoid Ridge
- Outwash

GLACIAL FEATURES
of the
Proposed Project Site & Surrounding Area
Grant Township, Rusk County, Wisconsin

outwash from adjoining areas of hummocky stagnation moraine or from the ground moraine to the east in Section 9. Further complicating the differentiation between the permeable outwash and the less permeable ground moraine in the mine site is the presence of a thick aeolian blanket of sand which overlies and obscures the contact. This sand blanket, up to 10 feet thick, is derived from sand blown from the outwash to its immediate west.

The most significant characteristic of the Flambeau River Valley in the area covered by this report is its distinctive meandering form. Meandering streams usually have floodplains, however the distinctly meandered segment of the Flambeau River between the Diaryland and Thornapple Dams possesses virtually no floodplain. The valley is typically asymmetrical in cross-profile with steep, high relief, undercut slopes on the outside of the meander curves and gentle, low relief, slipoff slopes on the inside. The meanders of the Flambeau River are disproportionately large for its present discharge. In fact, the radius of curvature of these meanders is greater than that of the meanders on the Chippewa River near its mouth. They appear to have formed late in the glacial period after outwash deposition had ceased, and after the glacier had receded from the immediate area, but while the Flambeau was still receiving large quantities of glacial meltwater. If this is correct then the course, depth and form of the Flambeau River valley have changed very little in all of postglacial time - about 10,000 years.

Soils

Soils in the project area include sand and gravel-rich alluviums, sandy loams and acidic loamy glacial till. The predominant soil type is a reddish brown sandy loam which, when drained and water-erosion controlled, results in good agricultural land. Generally, the low-lying soils are richer in silt and have very poor drainage creating swamps and bogs in perched water tables.

Mine Area

The Soil Conservation Service has mapped soils over the northern end of the project site (Figure 19). The Onamia (#38) soil is a well drained loamy soil over sand and gravel outwash. The Brill series (#48) is a moderatley, well drained silty soil underlain by sand and gravel at 20 to 40 inches. At the southwestern end of the proposed pit are Chetek (#33) series soils. These are loamy soils on a small set of stream terraces. The major soil series over the northeast end of the proposed pit is Poskin (#324). This soil type is a somewhat poorly drained silt over acidic sand and gravel. The water table is 1 to 3 feet below the surface.

Plant Site

The company has tested soils in the proposed plant area to determine their suitability for construction. The soils consist of an upper layer of silty sand to 8 or more inches below the surface. This deposit is underlain by cleaner gravelly fine to coarse-grained sands. Clay deposits were found beneath the sands approximately 20 to 35 feet below the surface. The clays are quite firm, with low water contents and unconfined strengths in excess of 4.5 TSF (tons per square foot). Below the clay is a dense silty and clayey sand or silty sand with varying amounts of gravel to either the sandstone or bedrock.

Haul Road

Soils along the proposed haul road route are primarily the Freer (#156) and Alban (#330) series. Although no particular problems would be expected with the Alban series, the Freer soils are poorly drained with a water table at less than 3 feet. This soil is highly susceptible to frost action.

Waste Containment Area

Soils in Section 20 and 21 consist of two associations: Almena-Auburndale and Peat. Almena-Auburndale association occupies a broad nearly level to gently undulating glacial till plain. The Almena soils are a somewhat poorly drained silt loam found on low broad interstream ridges. Auburndale soils are poorly drained and found at the foot slopes of the Almena. These silt loams have a well developed but thin silt-rich cap. Because of the above average silt content and the topographical position of the Auburndale soil in broad depressional areas, perched water tables or surface water areas are commonly found.

The company has conducted extensive soil testing in the proposed waste containment area (Figure 20). The borings generally revealed at least 42 to 48 inches of tight silts or clayey silts (Auburndale). Two interior borings, 21-44 and 21-45, had 30 and 24 inches respectively. Table 10 illustrates some of the soil permeabilities in the waste containment area.

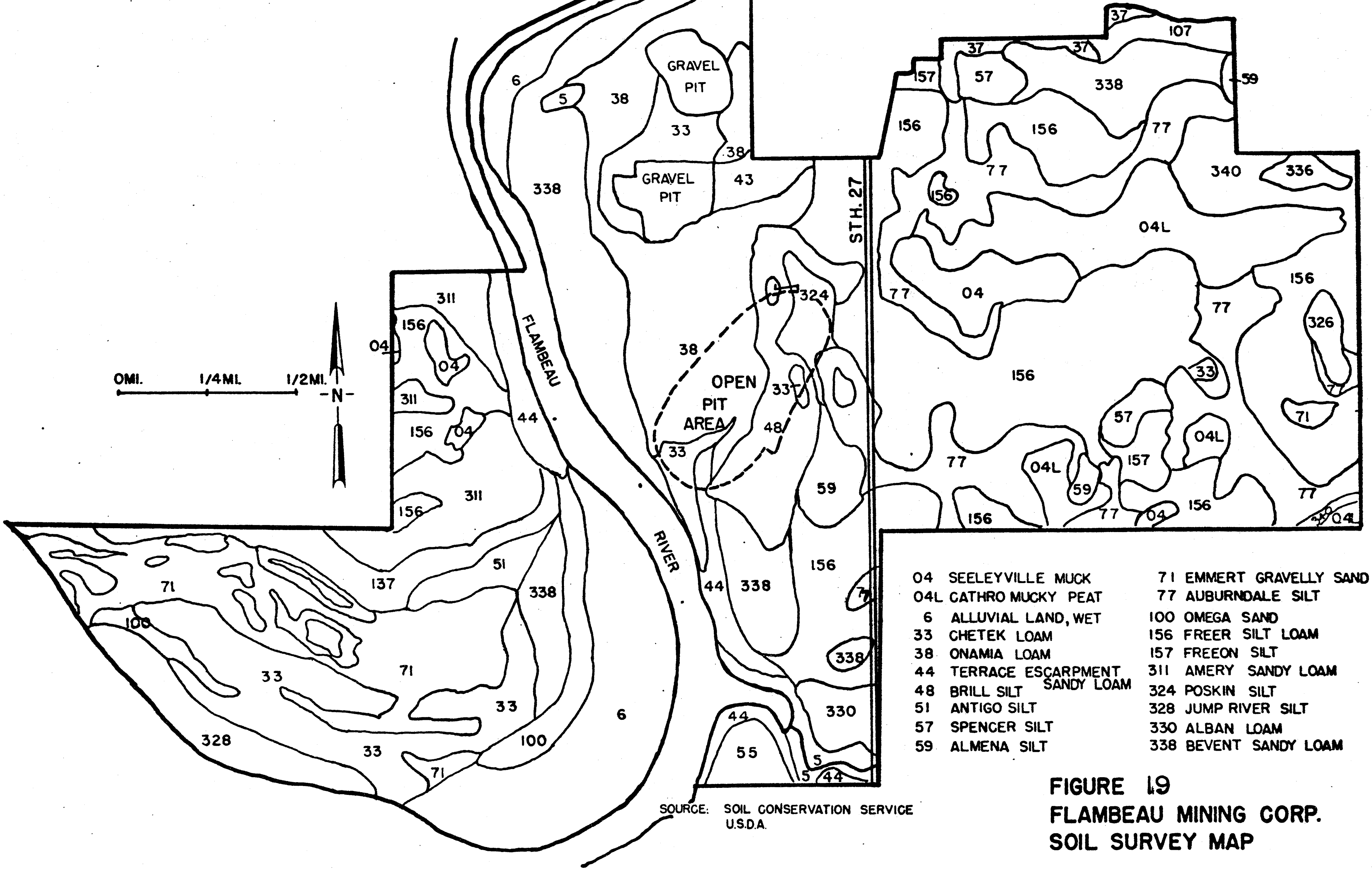
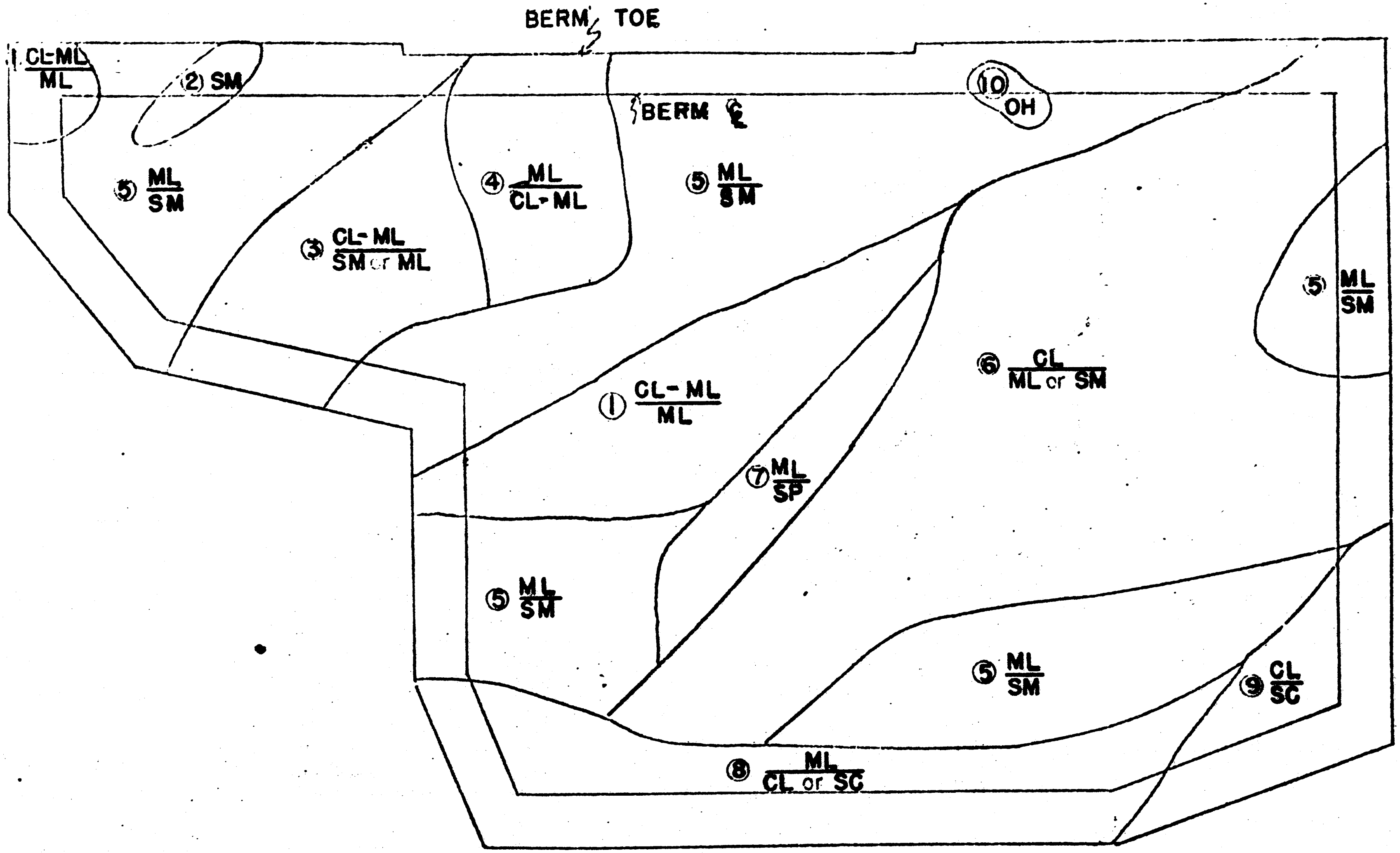


FIGURE 19
FLAMBEAU MINING CORP.
SOIL SURVEY MAP

STH 27



①	CL-ML / ML	clayey silt over silt	⑥	CL / ML or SM	silty clay over silt or silty sand
②	SM	silty sand	⑦	ML / SP	silt over clean sand
③	CL ML / SM or ML	clayey silt over silty sand or silt	⑧	ML / CL or SC	silt over silt clay or clayey sand
④	ML / CL ML	silt over clayey silt	⑨	CL / SC	silty clay over clayey sand
⑤	ML / SM	silt over silty sand	⑩	OH	organic clay

FIGURE 20

GREAT LAKES EXPLORATION CO.

GENERALIZED SOIL MAP
OF UPPER 5'

SOLID WASTE DISPOSAL AREA
Section 21, Grant Township, Rusk Co. Wis.

SCALE: 1" = 500' DATE: 12-11-72
DRAWN BY: GLB.

Low Permeabilities

Most of the soils tested had permeabilities near $1x10^{-6}$ cm/sec, and some permeabilities were as low as $2.8x10^{-8}$ cm/sec. The thickness of these relatively impermeable strata range from the surface down to 3.5 feet to more than 11 feet deep. In the northwest corner of the proposed waste containment area the 3.5 feet of impermeable soil (Soil 4, 1×10^{-6} cm/sec) is underlain with a layer of more permeable sands (Soil 5, $1 x10^{-3}$ cm/sec). All of the testing consistently showed that the permeability of the near-surface soils was quite low, and in fact the underlying soils also had quite low permeabilities. This is due to the high percentage of silt and generally dense nature of the underlying till. The major exception is a layer of the cleaner sands found along the northerly section of the dike and in the northwest area lying between borings ST21-36, to the north to ST21-9, and to the east to ST21-14. Permeabilities in these areas are approximately 10^{-4} cm/sec. These cleaner more permeable sandy subsoils are underlain by dense impermeable silty sands which are located at a depth of 13 to 15 feet below the surface.

Vegetation

The basic plant communities of the Flambeau project site are shown on Figure 21. The Point-Quarter Method was used for the analysis of the woody species in the communities of the study area, whereas the lists and abundance estimates of the herbaceous flora relied on the expertise of the botanical investigator, Robert Matson.

Lowland Forest

The mixed deciduous-coniferous lowland forest occupies the most acreage of any plant community in the study area (Table 11). Of 1,000 acres in the study area, the mixed deciduous-coniferous lowland forest comprises approximately 280 acres, or 28 percent. The forest is classified as lowland because of the relative closeness of the groundwater table to the surface of the forest floor. This forest community borders the marshes and swamps.

The predominant species are the trembling aspen (Populus tremuloides), red maple (Acer rubrum), the elms (Ulmus sp.), black ash (Fraxinus nigra) and white birch (Betula papyrifera). The forest is being disturbed at the present time. Some of the more mature trembling aspen south of the waste containment area were cut for pulp in 1972 by former owners. There is evidence from the old stumps in the forest that this area had suffered a fire many years ago; local residents claim that the present pulp cutting is the third crop from this land. Burned sites are the most favorable to the trembling aspen (a prolific seeder) which makes up 47 percent of the trees in this lowland forest.

If this forest is allowed to remain undisturbed, it will be unstable. The aspen and red maple will provide a very good canopy for the growth of shade tolerant species such as sugar maple, iron wood, and basswood. With the arrival of these species and their eventual dominance, this forest will succeed toward the mesic classification. During the period of time of the company study (spring of 1973), the predominant groundlayer species that were examined were those species that were in flower. A floristic summary by families reveals that most of the species were found to be in the Crowfoot buttercup, lily, violet, and dogwood. Some of the species that indicate the high degree of soil moisture were: jack-in-the-pulpit (Arisaema triphyllum), Trillium, and swamp buttercup.

Shrub Swamp

The shrub swamp occupies approximately 240 acres or 24 percent of the study area. This community has two locations; one is a border to a sedge marsh while the other is a major stand. The dominant vegetative species in the shrub swamp is the tag alder which is so dominant that only an occasional willow can be seen reaching to a competitive height. Near the outer boundaries of this community, tamarack, aspen, red maple, and black ash are frequently observed. Within the groundlayer the families with a high degree of representation are: Balsam touch-me-not, Crowfoot buttercup, rose, fern, dogwood, violet, arum, grass, sedge, mint, and madder. Small openings where no tag alder grows are present in this alder swamp community. These "gap-phase" examples of microsuccession are dominated by cattail and narrow leaved cattail. However, because there are also many small tag alder present near the borders of these spaces, it seems likely that in time the cattail will be replaced by tag alder. The shrub swamp soil is waterlogged, black and mucky. Often it is covered by a foot or more of water, and if kept

TABLE 10

PERMEABILITIES AND EXPECTED TRAVEL TIME OF TAILINGS WATER THROUGH REPRESENTATIVE BASE SOILS UNDER THE WASTE CONTAINMENT AREA

Sampling Station	Depth & Thickness of Soil Tested	Soil* Type	Averaged Permeabilities Cm/Sec	Feet/Day	Time in Days Required for Water to Pass Through Soil Stratum at a 1-Foot Head
27	6.0 - 7.0	SM	1.7×10^{-6}	4.81×10^{-3}	1559
33	2.0 - 3.5	ML	1.1×10^{-6}	3.11×10^{-3}	1125
38	0.0 - 8.0	OL-SM-ML	1.7×10^{-6}	4.81×10^{-3}	2391
53	2.0 - 5.0	ML-SM	6.6×10^{-8}	1.87×10^{-4}	21,390
40	0.0 - 11.5	ML-SM	9.1×10^{-7}	2.57×10^{-3}	4475

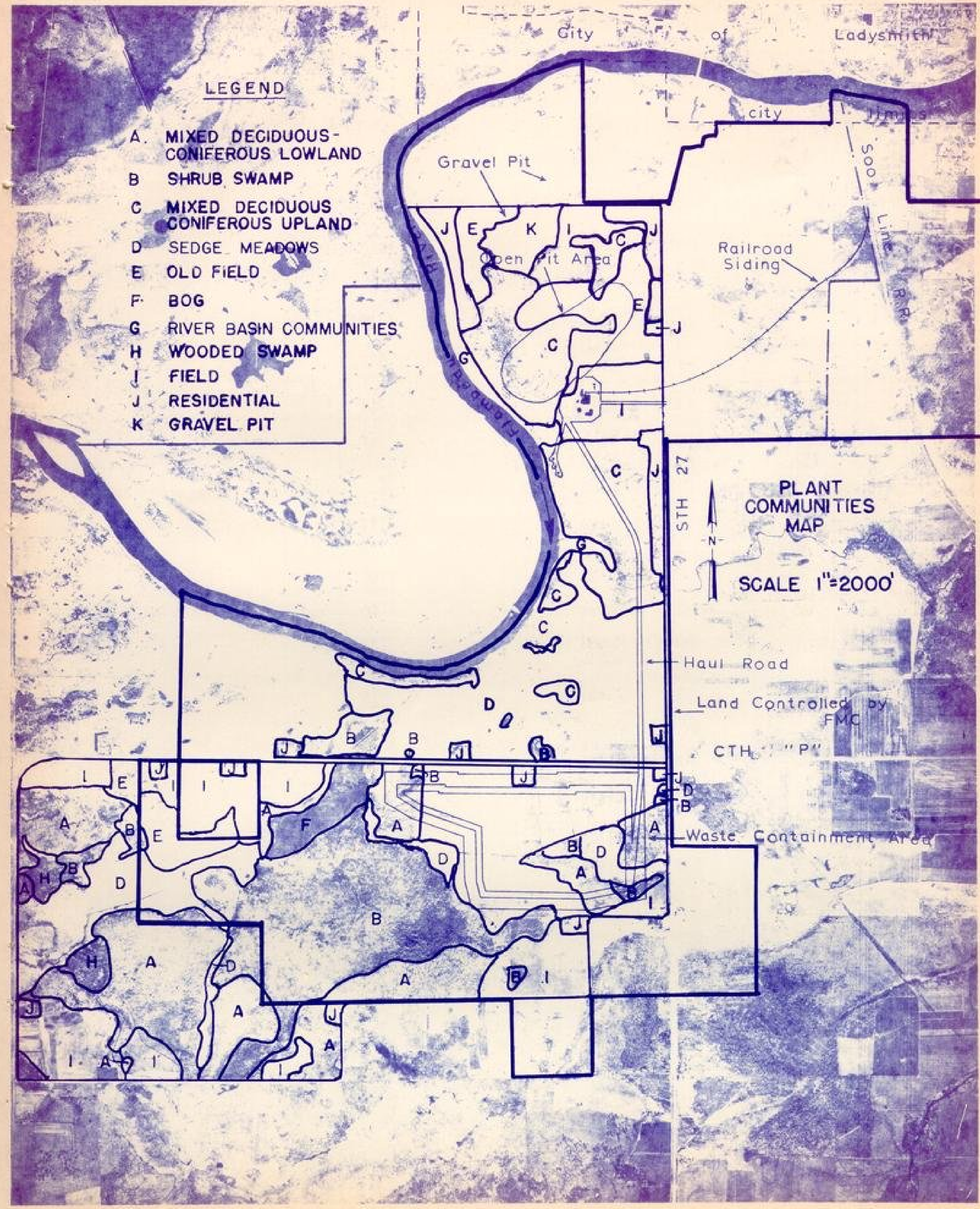
*As per Unified Soil Classification System.

TABLE 11

DESCRIPTION AND DISTRIBUTION OF PLANT COMMUNITIES

Letter	Name	Major Species	Acreage	Percent of Total Area	Percent of Major Communities
A	Mixed deciduous-coniferous lowland	Aspen, red maple, ash, elm, white birch	282	16.6	28.2
B	Shrub swamp	Alder, willow, dogwood	262	15.4	26.2
C	Mixed deciduous-coniferous upland	White birch, red maple, aspen, sugar maple, black ash, basswood, elm, hemlock, bur oak, butternut	176	10.3	17.6
D	Sedge meadow	Sedges, cattails, grasses, rushes	111	6.5	11.1
E	Old field	Grasses	103	6.1	10.3
F	Bog	Sphagnum mat, ericads	28	1.6	2.8
G	River Basin Community	Grasses, sedges, willow, silver maple	23	1.3	2.3
H	Wooded swamp	Tamarack	15	.9	1.5
			1,000	58.7	100
	OTHER REGIONS WITHIN AREA (not studied)				
I	Field	Disturbed annually	618	36.3	
J	Residential	Disturbed continuously	60	3.5	
K	Gravel pit	Disturbed recently	23	1.3	
			1,701	99.8	

FIGURE 21



LEGEND
A. MIXED DECIDUOUS-CONIFEROUS LOWLAND
B SHRUB SWAMP
C MIXED DECIDUOUS CONIFEROUS UPLAND
D SEDGE MEADOWS
E OLD FIELD
F BOG
G RIVER BASIN COMMUNITIES
H WOODED SWAMP
I FIELD
J RESIDENTIAL
K GRAVEL PIT
City of Ladysmith
city limits
Gravel Pit
Open Pit Area
Railroad Siding
Soo Line R.R.
STH 27
PLANT COMMUNITIES MAP
N
SCALE 1"=2000'
Haul Road
Land Controlled by FMC
CTH "P"
Waste Containment Area

in this condition the alder swamp has a high degree of stability. One factor that has helped to maintain the stability of a major part of this swamp is a beaver dam located about one-half mile west of the west dike of the proposed waste containment area. This damming may have preserved the tag alder as the climax vegetation.

The importance of this community is its value to wildlife. Due to the presence of the beaver pond, there is a potential brood area for ducks. Adjacent to the beaver pond, the shrub swamp community provides a feeding area for woodcock and a nesting and feeding area for ruffed grouse. During the winter months the alder swamp is populated by snowshoe hare.

Upland Forest

The mixed deciduous-coniferous upland forest is the third largest plant community consisting of approximately 176 acres or 17.6 percent of the area that was studied. Transects through this forest habitat showed that it is more complex than the lowland deciduous-coniferous forest. In fact, it contains more species of trees than any other woody plant community and is the most advanced plant community on the basis of natural succession. The most numerous trees (in descending order) are: white birch, red maple, aspen, sugar maple, black ash, basswood, elm, hemlock, bur oak, butternut, and balsam fir. This community is not very homogeneous. There are almost pure stands of various species of trees isolated within the general community. The few hemlock found in this community are isolated and quite large. Basswood exhibits the same phenomenon, only to a lesser degree.

This forest is classified as wet mesic. Left undisturbed, this forest will succeed to the mesic classification. The red maple, white birch and black ash will slowly be replaced by more shade-tolerant species such as sugar maple, hemlock and basswood. In this geographical area these three species are the climax vegetation.

A complete list of the woody species in the upland mixed deciduous-coniferous forest is provided in Appendix A. The most prevalent springtime herbaceous groundlayer families include the lily, Crowfoot buttercup, fern and violet. A detailed list of ferns and fern allies is found in Appendix B.

Dead Trees

Of special interest is the number of dead trees in the mixed deciduous-coniferous upland forest in the area designated for the open pit mine. After analyzing a one-acre quadrat, it was discovered that 23 percent of the trees were dead (Table 12). Of the 362 trees with a minimum two-inch d.b.h. counted, 277 were alive and 85 were dead. Several of the elms and ashes had dead branches but were counted as being alive since there was some green foliage. Of the 85 dead trees, 75 of them were bitternut hickory. The exact cause of death of these trees has only been hypothesized. One probable cause is the eight to twelve-foot lower groundwater table as a result of the removal of the Port Arthur Dam in 1969. Since the bitternut hickory is normally found on wet bottomlands, an eight to twelve-foot drop in the water table may have caused severe "die-back" in the trees. A U.S. Soil Conservation forester and their plant pathologist were contacted and their consensus is that the ash and hickory have definitely been affected by the lowering of the water table. These species can tolerate high water table levels, but probably cannot tolerate this much lowering of the water table. The Ladysmith DNR forester has indicated this could be a cause, but also that these trees are on the edge of their range and often do not live to maturity. Bitternut hickory are often affected by a disease that forms numerous galls on their twigs. Since there are known diseases of bitternut hickory, and since this is the northernmost part of its range (where it probably is less hardy), the water table drawdown and "die-back" combination seems the most probable explanation.

TABLE 12
SURVIVAL OF TREES IN A
ONE-ACRE QUADRAT IN OPEN PIT AREA
(All Trees Over Two Inches d.b.h.)

Species	Alive	Dead
Basswood	1	-
Bitternut hickory	4	75
Black ash	130	4
Black Cherry	1	-
Blue beech	3	-
Bur oak	12	-
Butternut	5	2
Elm	70	4
Ironwood	13	-
Red oak	3	-
Sugar maple	33	-
White birch	2	-
	277 (77%)	85 (23%)

Sedge Meadow

The sedge meadow comprises about 111 acres or 11.1 percent of the study area. It is an open community where the soils are wet but without standing water during the growing season. During the spring runoff and after a heavy summer rain the soil may become covered with a few inches of water. The soil is a combination peat and muck. Sedges are the dominant vegetation although cattails appear toward wetter conditions. The outer boundaries of the sedge meadow are fringed with tag alder and willows. Just inside these shrubs red-osier dogwood and Spirea alba are located, whereas most of the sedge meadow vegetation is composed of sedges of the genus Carex, grasses, mints (Scutellaria galericulata), the swamp milkweed (Asclepias incarnata), the cattails (Typha latifolia and Typha angustifolia), and Iris versicolor.

Old Field

The old field community comprises approximately 103 acres or 10.3 percent of the study area. Parcels are classified as old field because they have not been disturbed (plowed) for two to three years and were allowed to revert to forest. If this process is allowed to continue, the old field will eventually succeed to a shrubland and then to a climax forest in several hundred years. The old field community within the study area already exhibits a range of succession from small trees to shrubs to grassland. The invading trees are trembling aspen, large-toothed aspen, red pine, white birch, red oak, and bur oak. Some of the prevalent shrubs include staghorn sumac, pin cherry, and chokecherry. The predominant families with representatives in the groundlayer vegetation are grass, composite, sedge, pink rose and pea. In one section of the old field community, near the eastern boundary of the pit site, a perched water table enables the soil to remain quite moist. The predominant shrubs here under these conditions are willows, whereas much of the groundlayer species is in reed canary grass and goldenrod.

Bog

The bog in this study area comprises 28 acres or 2.8 percent of the total area that has been studied. The term bog refers to a soil-vegetation complex in which a rather specialized group of herbs and low shrubs grow on a wet, acid soil composed of peat. This particular bog is quite old, has filled in any open water spaces and is being invaded by wet-lowland and wet-mesic species of trees. Tamarack, white birch, trembling aspen, and white pine can be seen growing on the sphagnum mat. The pattern of natural succession would be for the bog to become a wooded (tamarack) swamp, then a lowland wet mesic forest, and finally a mesic forest exhibiting climax vegetation. If left undisturbed, this is the pattern that would undoubtedly be followed here; tamarack is already the most prevalent tree. The two most important families of plants growing on the mat are heath and the sedges.

River Basin Community

The river basin community comprises approximately 23 acres or 2.3 percent of the total study area and was formed as a result of the removal of the Port Arthur Dam. The removal of the dam caused the level of the Flambeau River to drop eight to twelve feet along the project site. The drop in water level exposed a considerable amount of land that is now being invaded by terrestrial vegetation. The environmental conditions along the river basin range from semi-aquatic to xeric (dry soils). The semi-aquatic areas are where cool springs run down the bank to the river. There is very dense vegetation along these miniature streambanks. The xeric conditions exist in open areas where the river had deposited large amounts of sand and gravel.

Because of the wide range of conditions, there is also a wide variance in the invading plants. The most prevalent woody species is the willow. However, there has been considerable invasion by the silver maple, box elder, and tag alder. Other woody species that are invading but are not numerous are red maple, cottonwood, balsam fir, and elm. The silver maple invasion is interesting because there are no known natural stands of it in the immediate area. Of the herbaceous plants the most predominant families are grass, sedge, composite, Crowfoot buttercup, and the rush.

Wooded Swamp

The wooded swamp comprises approximately 15 acres of 1.5 percent of the total study area. The characteristic vegetation of the wooded swamp is the tamarck. Coupled with a sphagnum mat and a high number of ericads (heather) in the understory, the tamarack swamp is very closely related to the bog. Associating with the tamaracks are tag alder, white birch, and an occasional white pine. The prevalent families of the groundlayer species are heath, dogwood, sedge, lily, orchid, primrose, and Crowfoot buttercup. This wooded swamp, if left undisturbed, would undoubtedly succeed to a lowland mixed coniferous-deciduous forest as has been described earlier. Black ash, red maple, and aspen would slowly invade the fringes of the wooded swamp until they had completely crowded out the tamarack.

Wildlife

The company carried out a three phase quantitative-qualitative vertebrate study which entailed: (1) a qualitative vertebrate survey in the fall of 1972; (2) a qualitative large mammal survey in the fall of 1972 through the spring of 1973; and (3) a quantitative small mammal survey conducted from April 14 through June 18, 1973. The quantitative survey was carried out to determine species populations and densities. Because of the low capture success, the results of that survey are not presented. However, the results of the qualitative survey indicate the species which are known to inhabit the project site.

Large Mammals

A composite list of all mammal species identified on the project site is presented in Table 13. The bobcat is listed as having changing status in Wisconsin. Deer were found over most of the project site. Deer browsing in the Meadowbrook Creek area during winter came from east of Highway 27. Otter, in addition to moving in the bog area, plied the river edge itself but did not venture up Meadowbrook Creek. Although fox were numerous in the early winter of 1972, reduced numbers were observed later probably due to trapping. Beaver may have also been lost through trapping. A more detailed list of large mammal observations is given in Appendix C. Mammals seen on the west bank of the Flambeau include white-tailed deer, otter, red fox, raccoon, striped skunk, muskrat, gray squirrel, red squirrel, and chipmunk.

Hunting and Trapping

Many of the larger mammals, such as the otter, bobcat, fox, muskrat, mink, weasel, raccoon, skunk and beaver, are considered furbearers and are either hunted or trapped. There are specific hunting and trapping seasons on most of these species and all species have been taken. DNR estimates of the hunting and trapping harvest on the project site are presented in Table 14. The range of values reflect changing populations, changing hunting regulations, and the amount of hunting pressure.

TABLE 13
SPECIES LIST
ALL MAMMALS OBSERVED AND/OR TRAPPED
Interval 9-16-72 - 6-10-73

Family	Common Name	
Canidae	Red fox	*Vulpes fulva*
Castoridae	Beaver	*Castor canadensis*
Cervidae	White-tailed deer	*Odocoileus virginianus*
Cricetidae	Deer mouse	*Peromyscus* sp.
	Meadow vole	*Microtus pennsylvanicus*
	Muskrat	*Ondatra zibethica*
	Red-backed vole	*Cletherionomys grapperi*
Felidae	Bobcat	*Lynx rufus*
Leporidae	Snowshoe hare	*Lepus americanus*
Muridae	White-footed mouse	*Peromyscus leucopus*
Mustelidae	Badger	*Taxidea taxus*
	Mink	*Mustela vison*
	River otter	*Lutra canadensis*
	Striped skunk	*Mephitis mephitis*
	Weasel	Probably three species but *Mustela erminea* positive
Pyrocynida	Raccoon	*Procyon lotor*
Sciuridae	Eastern chipmunk	*Tamias striatus*
	Least chipmunk	*Eutamias minimus*
	Franklin's ground squirrel	*Citellus franklinii*
	Thirteen-lined squirrel	*Citellus tridecemlineatus*
	Northern flying squirrel	*Glaucomys sabrinus*
	Southern flying squirrel	*Glaucomys volans*
	Eastern gray squirrel	*Sciurus carolinensis*
	Red squirrel	*Tamisciurius hudsonicus*
	Woodchuck	*Marmota monax*
Soricidae	Masked shrew	*Sorex cinaerious*
	Short-tailed shrew	*Blarina brevicauda*
Talpidae	Starnose mole	*Condylura cristata*
Zapodidae	Meadow jumping mouse	*Zapus hudsonicus*
	Woodland jumping mouse	*Napaeozapus insignis*

TABLE 14
AVERAGE ANNUAL HUNTING AND TRAPPING HARVEST
1963 to 1973

Hunted Species	Range
Bear	1 - 2
Deer	10 - 20
Hare - snowshoe	10 - 30
Rabbit - cottontail	10 - 30
Squirrel	30 - 80
Trapped Species	
Beaver	10 - 15
Coyote	5 - 7
Fox (red preferred)	10 - 15
Mink	5 - 10
Muskrat	50 - 100
Otter	5 - 10
Raccoon	20 - 40
Skunk (unprotected)	20 - 50
Weasel (unprotected)	10 - 20

Small Mammals

Among the small mammals, deer mice were the predominate species captured. Chipmunks and grey squirrels were also captured in large numbers.

Birds

Avian populations were studied quantitatively and qualitatively from March 3, 1973, to July 12, 1973, as a part of the company's impact study. The different species of birds present in this area were also noted as part of a vertebrate population study conducted in the months of October and November 1972. More data were accumulated from December 1972 through early March 1973. The areas under study are quite typical of north central Wisconsin. In the study areas are found a small pond, marshlands, creeks, old fields, meadows, plowed ground, wooded swamp, upland hardwoods, lowland hardwoods, brushy areas or thickets and roadsides.

The results of the spring 1973 study are presented in Appendix D. A composite species list, including winter observation is given in Appendix E.

The bird populations in the various habitats were normal as compared to records of previous years compiled by the Wisconsin Ornithological Society (W.O.S.). One exception was the numbers of purple martins seen. For reasons unknown, the martin population of the Mississippi River Valley was only 15 percent of normal during the 1972 season. Since martins often return to the same nesting area where they are hatched, it was expected that the martin numbers would again be low in 1973. This proved to be true. Not all of the species that migrate through this area were seen, nor were all species seen identified. No owls were seen during the spring and summer period, although one species was seen during the fall and winter surveys. An immature bald eagle was sited in the vicinity of the proposed waste containment area by DNR personnel during November 1974. Bald eagles are on the Wisconsin List of Endangered Species. The Upland Plover is listed as having changing status in Wisconsin.

Rare Species

Amphibians & Reptiles

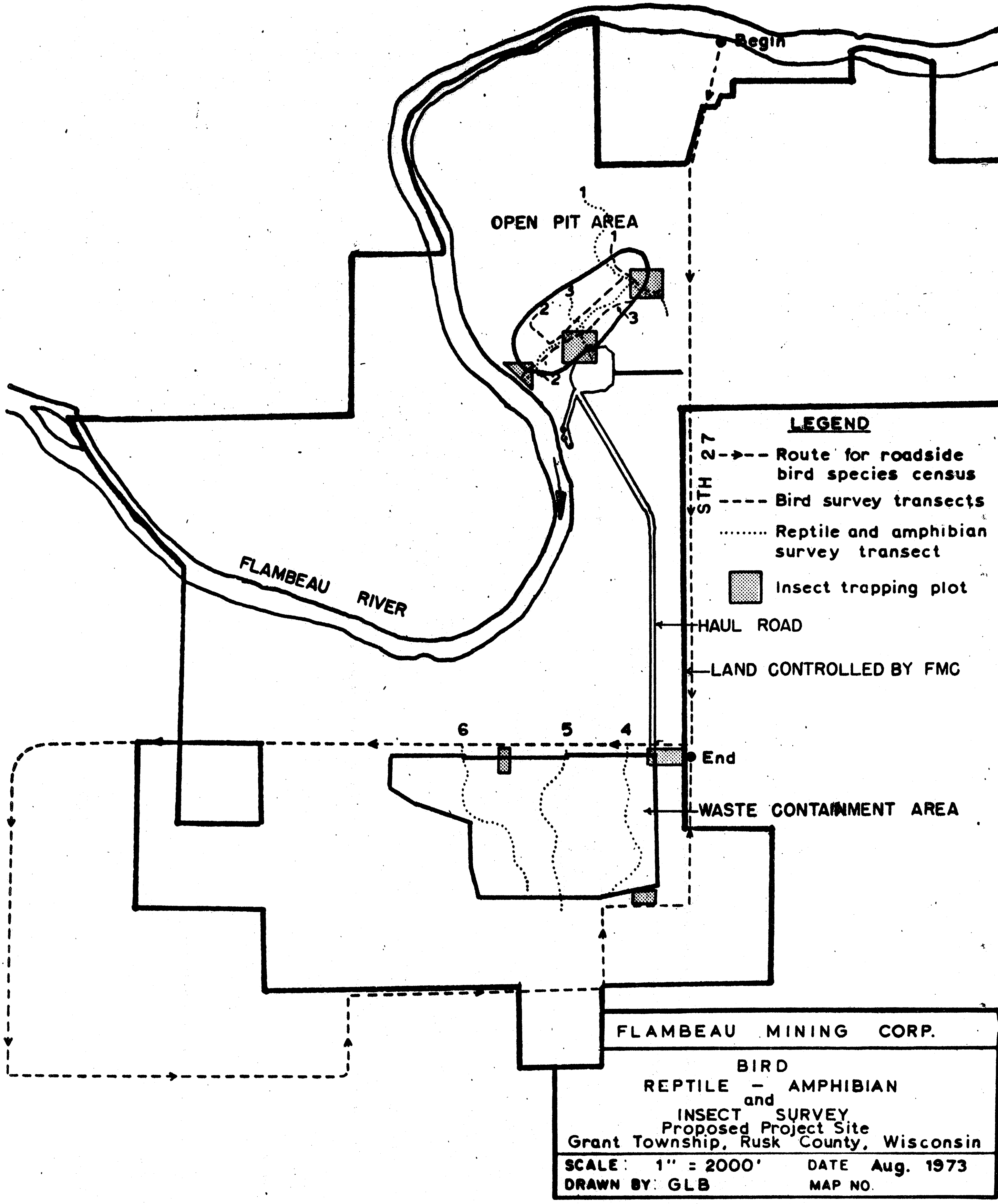
An extremely cursory spring 1973 qualitative survey of amphibians and reptiles on the mine site was conducted by the company. The three transects made in the area of the proposed pit, and the proposed waste containment area, are shown on Figure 22. No record of where each species was seen was made. Although no populations estimates were made, the following species were found in 100 hours of field work by the company's consultants.

Reptilia	
Common snapping turtle (Chelydra serpentian)	Uncommon
Painted turtle (Chrysemys picta)	Very common
Eastern garter snake (Thamnophis sirtalis)	Common
Amphibia	
Tiger salamander (Ambystoma tigrinium)	Common
Blue-spotted salamander (Ambystoma laterale)	Probably common
Red-backed salamander (Plethedon cinereus)	Fairly common
American toad (Bufo terrestris)	Very common
Spring peeper (Hyla crucifex)	Very common
Grey tree frog (Hyla versicolor)	Common
Pickeral frog (Rana palustris)	Uncommon
Mink frog (Rana septentrionalis)	Common

A hypothetical species list of reptiles and amphibians that may be found in this area is presented in Appendix F.

Insects

The number of insect species is greater than any other group of animals. Because insects occupy every level of ecosystems, they are important components of the fauna, serving to link many other species to the plant communities. Insects were collected and observed in representative habitats because most insects are bound to a particular habitat by food preferences or other requirements. Collections were made near or in small pond, marsh, grassland, pasture, old field, upland hardwood, small creek, wet banks, brush and roadside habitats. Collecting was done by sweep net, hand collecting, and sightings. No effort was made to take large numbers of insects. A few specimens were keyed to species, e.g., giant water bug (Belastoma sp.), dobson's fly (Coradalus cornutus) (Linn) and an unusual Lygaeid. Collecting was done once a week from late March until July. A total of twenty hours of collecting was done. The list appearing in the Appendix G includes individuals which were within the abilities of the company's consultant; the


Begin
OPEN PIT AREA
1
2
3
FLAMBEAU RIVER
STH 27
LEGEND
Route for roadside bird species census
Bird survey transects
Reptile and amphibian survey transect
Insect trapping plot
HAUL ROAD
LAND CONTROLLED BY FMC
6
5
4
End
WASTE CONTAINMENT AREA
FLAMBEAU MINING CORP.
BIRD
REPTILE - AMPHIBIAN
and
INSECT SURVEY
Proposed Project Site
Grant Township, Rusk County, Wisconsin
SCALE: 1" = 2000'
DATE Aug. 1973
DRAWN BY: GLB
MAP NO.

identification of order and species was not possible. No unusual insect families were collected, and insects seen were typical for the Ladysmith area. This observation is based on a number of past years spent in the field collecting, and comparisons with lists in publications.

Fish & Aquatic Life

Biological sampling of the plankton, benthos and fish populations of the Flambeau River and Meadowbrook Creek has been carried out by the Dames and Moore Consulting firm. The results of their study are summarized below.

Plankton

Phytoplankton and zooplankton were collected from midway in the water column at the following locations on May 2, 1973:

Station Number	Location	Depth*(meters)
1	0.30 miles west of State Highway 27 bridge near the north bank, 1.6 miles upstream from proposed open pit	1.5
2	Near the west bank across from southwest edge of proposed open pit	1.3
3	Near east bank at mouth of Meadowbrook Creek, 0.45 miles downstream from Station 2	0.8
4	0.50 miles east of the Flambeau in Meadowbrook Creek, immediately west of State Highway 27	0.5
5	0.95 miles downstream from Station 2, on south bank near entrance of intermittent drainage ditch, approximately 0.30 miles north of proposed waste containment area	1.2
6	3.90 miles downstream from Station 2 near south-east bank (not shown on Figure IV.20)	1.5

*All depths were recorded in spring during a period of high flow.

Sixty-six species of phytoplankton were identified. Fifty species were diatoms. The diatoms not only dominated the species list, but also comprised over 50 percent of the cells in most of the samples. Species of the diatom genera Fragilaria, Melosira, Navicula and Nitzschia were common in all samples. None of the species commonly occurring in the samples is considered to be a tolerant or pollution-indicative organism.

Thirteen zooplankton taxa were identified including two copepods, two protozoans and seven rotifers. The rotifers were the dominant organisms in the samples taken.

Plankton quantities were relatively low at all locations. Plankton abundance and distribution were probably influenced by the weather conditions at the time of sampling. These included abnormally high water levels, low water temperature and low solar illumination.

Benthics

Benthic organisms were collected at the six locations previously described between April 26 and May 4, of 1973. Approximately 80 different species were identified. The chironomids, trichopterans and ephemeropterans were represented by 27, 11 and 10 different species, respectively. The chironomids dominated all the quantitative samples, comprising from 41.3 percent to 50.2 percent of the total benthos. Total density of organisms ranged from a low of 248 organisms/m^2 at Station 6 to 800 organisms/m^2 at Station 1.

Fish

Fish were sampled at ten locations in the Flambeau River using fyke nets and in Meadowbrook Creek with a 110-volt AC shocker. Fifteen species were collected. Seven species were taken in the Fyke nets and ten species by electrofishing. Minnows dominated the catch from Meadowbrook Creek. No one species was predominate in the collections from the Flambeau River. The total number of fish collected in the Flambeau River was very low. This was probably partially due to a low survey gear efficiency. However, it appears that the fish populations in the river near the proposed mine site are limited by a lack of instream cover, low plankton abundance and fluctuating water levels during spawning seasons.

An electrofishing survey of the Thornapple Flowage (impoundment on the Flambeau River below the mine site) was conducted by the Department in May of 1972. Eleven species were collected. Black bullheads were the most abundant species followed by walleyes. The abundance of bullheads has decreased substantially from the levels indicated in earlier surveys predating the 1969 removal of the Port Arthur Dam. It appears that the fish species composition and relative abundance in the river has changed noticably since the removal of the dam and that it may continue to do so over the next several years. A list of the fish species which have been collected in the Flambeau River during the Dames and Moore and various Department surveys is given in Appendix H.

Archeologic & Historic Sites

The Wisconsin State Historical Society has not recorded any archaeological activity sites in the entire Town of Grant. There are no historic sites in Rusk County listed in the National Register of Historic Places.

The company employed a qualified archeologist to conduct a search for evidence of prehistoric sites on the project site. A study of air photographs, interviews with local residents and collectors, foot traverses, in selected areas soil phosphate testing, searches for disturbed plant habitat indicators, and test pits were used in a search for activity sites. Special attention was given to likely locales such as the bluffs along the Flambeau River and the areas along Meadowbrook Creek. One flake of chert was found along the eroded north shoreline of the Flambeau in Section 17, but it did not show any evidence of either manufacture or utilization. Interviews with residents revealed two small, local collections reported to have come from lands within the project site, and one small collection from just west of the project site. These collections indicate some prehistoric aboriginal activity in the area.

Collectors Artifacts

Mrs. John Cadotte owns two specimens obtained from the north end of the project site. Both are made of Hixton Silicified Sandstone which originates at an aboriginal quarry site near Hixton, Wisconsin, some 100 miles to the south. A side-notched projectile point indicates a Late Archaic time period (2,000 BC - 1,000 BC). A bifacially-worked knife, suggests the presence of an activity area in this locale, but sod covering the field precluded a surface survey.

Most of the artifacts from the Drum collection were reported by Mr. A. Drum to have come from the areas he farmed around a now-filled ancient lake east of Highway "27". This area is now grown up in sod and did not permit a close examination of the surface. The overwhelming majority of artifacts in this collection are projectile points which indirectly indicate that a substantial amount of prehistoric hunting activity occurred around the shores of this small lake. Projectile point typology indicates the presence of Late Archaic (2,000 BC - 1,000 BC), Early Woodland (1,000 BC - 500 BC), Middle Woodland (500 BC - AD 500), and Late Woodland (AD 500 - AD 1,400) activity around this small lake. Several of the small points in the collection are made of locally available quartzite but the others are made of chert foreign to the project site area.

The Raasch collection was recovered from the Flambeau shoreline one-half mile west of the project site. It includes a large scraping plane, a lamellar flake and a stemmed point which are made of Hixton Silicified Sandstone. A Middle Woodland time period (500 BC - AD 500) is suggested by these artifacts.

The archaeological survey of the Flambeau project area determined that prehistoric cultural activities had indeed left traces in the form of artifacts from the project area. Physical survey of selected parts of the area failed to locate any of the specific locales of prehistoric human activity.

Public Park & Recreation Areas

There are increasing pressures on recreational resources in all of Wisconsin. Rusk County does not possess a well developed recreational base and much of the tourist trade bypasses the county for the lake areas to the northwest.

Federal & State Lands

The nearest federal recreation land is that block of the Chequamegon National Forest in Taylor County. Brunet Island State Park in Chippewa County is the closest state park. The Flambeau River which flows through the project site is designated as part of the Chippewa River Water Trail. The southern end of the Flambeau River State Forest is located in the northeast corner of Rusk County less than 20 road miles from Ladysmith. There are five state wildlife areas in Rusk County with a total of 2,297 acres. The 1,044-acre Silvernail Wildlife Area is located north of Ladysmith.

Local Land

The county and some local municipalities provide lands for outdoor recreation. Most of the locally administered land is county forest land. There is no public recreational land in the Town of Grant.

Flowages

Approximately eight river miles north of the proposed mine site is Lake Flambeau, formed by a hydroelectric dam built in 1951 which encompasses 2,000 acres. Approximately 17 road miles south of the site is a large hydroelectric dam built in 1948 which has created the Holcombe Flowage with 112 miles of shoreline extending up the Jump and Chippewa Rivers. These areas are developing with many year-round "summer" homes and some resort facilities.

The number of lodging rooms available in Rusk County in 1973 for tourists was 250 with a statewide total of 75,750. The largest of these facilities are classified as small motels with less than 30 rooms. The number of available rooms was 0.33 percent of the total in the state, which is essentially equal to the population percentage, indicating that the economy of the area is not greatly influenced by tourism.

Project Site

There is little recreational use associated specifically with the area of the project site, except that which occurs on the river course through the property, i.e., canoeing and fishing. In the uplands there is some hunting, trapping and berry picking.

Population

The human population of the proposed project area can be considered at four levels: (1) the residents of the project site; (2) the residents of Grant Township which wholly encloses the proposed operations; (3) the population of Rusk County; and (4) the population of Ladysmith, county seat of Rusk County, immediately adjacent to the site. Ladysmith is the only community in Rusk County classified as a city. All other communities are classified as towns and villages and have populations of less than 1,000.

Project Site

During late 1972, the residents of the project site were identified and heads of households were surveyed for basic demographic and income data. A total of 86 persons in 34 households were located. When compared to the populations of Rusk County and Wisconsin, the residents of the project site were on the average significantly older. More than half the residents are age 46 or older as shown by Table 15. The median age for the state during the 1970 census was 27.2 years, while for Rusk County it is 30.4, and for the project site it is 46 to 50.

TABLE 15
COMPARISON OF AGE DISTRIBUTIONS BY PERCENT OF SELECTED POPULATIONS, ESTIMATED AVERAGE INCOME AND POPULATION DENSITY

Age Category	Impacted* Area/Project Site	Rusk County**	Wisconsin**
0-20	26%	39%	40%
21-44	22%	24%	30%
45-65	36%	23%	20%
>65	16%	15%	10%
Average age	41.9 Yrs.	N.A.	N.A.
Median age	46-50 Yrs.	30.4 Yrs.	27.2 Yrs.
Estimated mean income/household	$7,678	$6,724	$10,068
Density of persons/sq. mile	21.1	15.6	80.8

* BCMC survey, winter 1972-73
** 1970 census data

The population of the state, Rusk County, Ladysmith, Grant Township and the project site can be summarized as follows:

	1970 Population	Percent Change Since 1960	Percent 65 Yrs. and Over
State of Wis.	4,417,713	+11.8	10.7
Rusk County	14,238	- 3.8	14.2
Ladysmith	3,674	+ 2.5	19.7
Grant Township	931	-11.3	15
Mining proj. site	86	N.A.	16

Rusk County

Rusk County had its largest population in 1940 and the population of the county has declined at a relatively steady rate since that time. Out-migration during the decade of the 1950's was 4,190; during the 1960's 1,561 persons moved elsewhere. Population trends are shown more completely in Table 16. The number of farms declined from 2,608 in 1935 to 980 in 1969. Total farm acreage also decreased during this same period from 261,528 acres to 212,623 acres and, as might be expected, the farm size significantly increased from 100 acres to 217 acres.

DNR projections estimate a decline of the Rusk County population of 1.78 percent by 1980 and nearly no change from 1980 to 1990.

Land Use

Project Site

The project site includes single family residential, commercial, industrial, institutional, agricultural, forestry, and open space uses. Structures on company land include 6 dairy farms, 5 general farms, 31 single family residences, a commercial building, a town hall, and assorted accessory structures. Some of the residences and accessory buildings are being removed or destroyed since they occupy lands needed for other uses associated with mining or have become economically or aesthetically burdensome. Many residences on the margins of the site continue to be occupied on a rental basis. A former dairy products hauling company building may serve as a temporary field office during the construction phase of the project. The Grant Town Hall continues to be used for some town government functions. A former Rusk County gravel pit is located in Section 9, but has been idle since the company purchased it. Some of the agricultural land has been pastured or cultivated recently while other fields, forest, and wetlands have lain essentially idle in recent years.

Zoning

In the absence of a county land use plan, current zoning district classifications indicate the county's intent for future land use. Proposed land use on the FMC holdings of 2,750 acres as determined by zoning is as follows: (Figure 23)

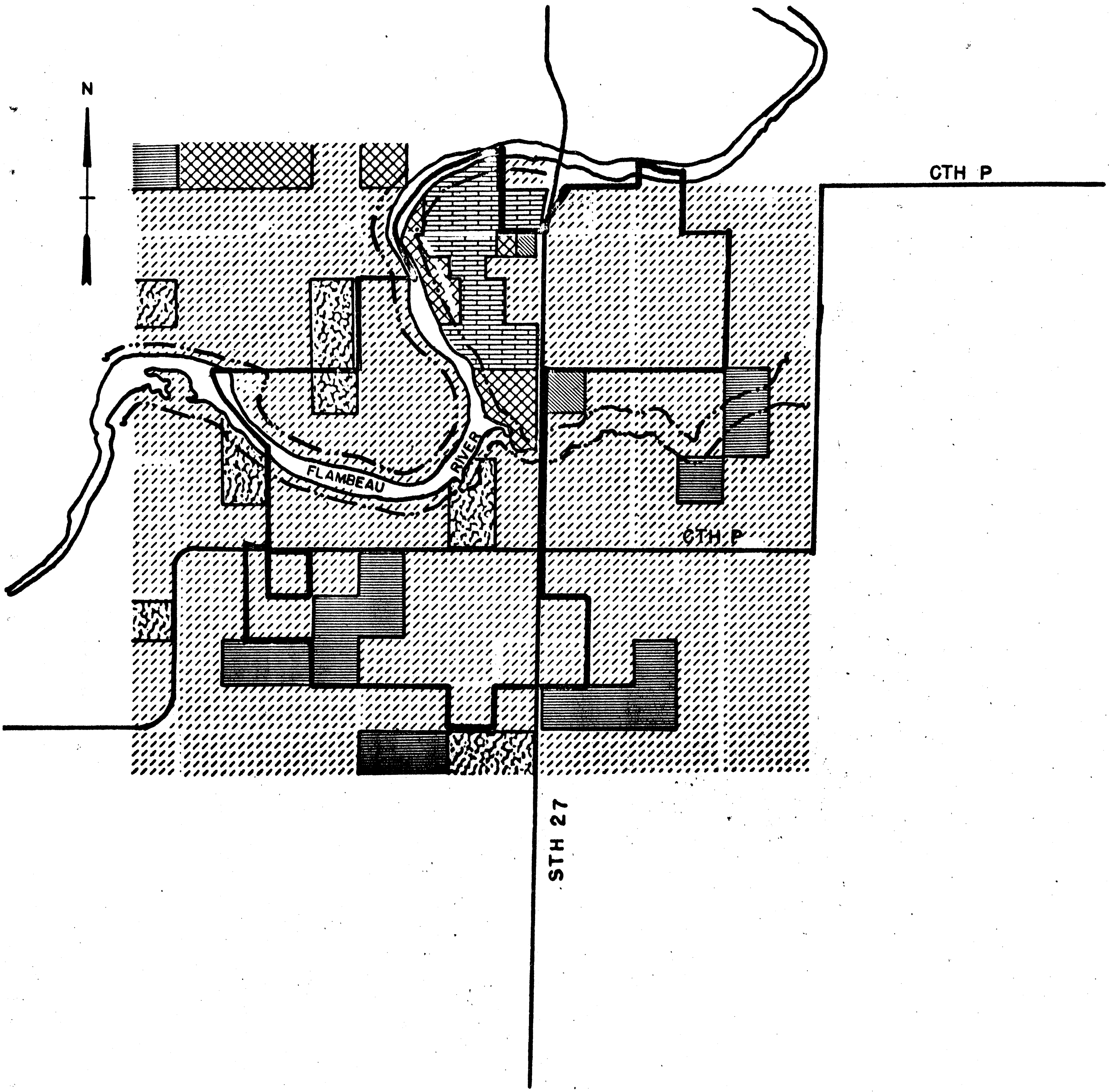
Zoning District	Acreage	Percent of Total
Agricultural	2,077	75.5
Industrial	221	8.0
Residential	171	6.2
Resource Conservation	160	5.8
Forestry	116	4.2
Commercial	5	0.2
	2,750	99.9

Current zoning is appropriate for most of the mining operation. It appears that portions of the East ½ of Section 9 would have to be changed from Agricultural to Industrial to accommodate the eastern end of the open pit. The NW¼NW¼ of Section 21 is zoned Resource Conservation which would not allow construction of the western portion of the proposed waste containment area.

Town of Grant

Of the 23,013 acres in Grant Township, 14,072 acres are zoned as agricultural, representing 61 percent of the total area. Approximately 10 percent is zoned as resource conservation, 8 percent for forestry, 5 percent for residences, 0.9 percent for industry and 0.8 percent for commercial ventures. This township has experienced intensive, yet marginal, agricultural land use. Following the pattern of the whole county, much land is in the process of reverting to forest. A relatively new impact on the township is the extension of commercialism along State Highway 27 south of Ladysmith.

FIGURE 23



LEGEND

Residential
Agricultural
Commercial
Industrial
Forestry
Resource Conservation
Shoreland Protection

FLAMBEAU MINING CORP.

LAND ZONING
NEAR PROJECT SITE
RUSK COUNTY, WISCONSIN

SCALE: 1" = 4000'
DATE July 1973
DRAWN BY: GLB
MAP NO.

TABLE 16

SUMMARY OF POPULATION TRENDS IN SEVERAL GOVERNMENTAL UNITS

Unit		1930	1940	1950	1960	1970	Avg. % Annual Change*	Absolute Change and Percentage**	
Wisconsin	Number	2,947,000	3,138,000	3,449,000	3,952,765	4,417,731			
	% Change	-	+6.48	+9.91	+14.61	+11.76	+1.07	+1,470,731	+49.91
Rusk County	Number	16,081	17,737	16,790	14,794	14,238			
	% Change	-	+10.3	-5.34	-11.9	-3.8	-0.26	-1,843	-11.5
Ladysmith	Number	3,493	3,671	3,924	3,584	3,674			
	% Change	-	+5.1	+6.9	-8.7	+2.5	+0.15	+181	+5.2
Grant Township	Number	1,014	1,049	983	1,049	931			
	% Change	-	+3.5	-6.3	+6.7	-11.3	-0.19	-83	-8.2
Project Site (2,603 A.)	Number	N.A.	N.A.	N.A.	N.A.	86			
	% Change	-	-	-	-	-	-	-	-

* Average Annual Change = average of change in ten-year segments.

** Absolute Change since 1930 as percent of 1930 population.

Grant Township agriculture consists primarily of dairy grazing, i.e., two cuttings of hay and some oats and corn. Tame hay and some clovers are used for pasture grazing. The following information from the office of the Rusk County Extension Agent gives a profile of Grant Township agriculture for 1972:

1.	Number of farms		103
2.	Farm population		382
3.	Cropland (acres)		4,782
	a.	Clover-timothy-hay (acres)	3,348
	b.	Oats for grain (acres)	866
	c.	All field corn (acres)	347
	d.	Alfalfa hay (acres)	12
	e.	Barley for grain (acres)	7
	f.	All other lands (acres)	202
4.	Livestock		
	a.	Milk cows	945
	b.	Beef cattle	633
	c.	Grain-fed cattle marketed	97
	d.	Stock sheep	28
	e.	Brood sows	7

Buildings, homesteads and farmsteads in Grant Township in 1967-1968 were inventoried as follows:

116	Occupied year-round residential structures
10	Seasonally-occupied structures
121	Farmsteads
26	Mobile homes
7	Vacant farmsteads
24	Vacant nonfarm residences

Rusk County

Woodlands

Rusk County includes an area of 590,275 acres of which 98.7 percent is unincorporated. Table 17 shows the percentage distribution of land use in each of the delineated categories. As illustrated by the table, woodlands constitute the largest land use in Rusk County (54 percent), with cropland (15 percent) next, followed by "other cleared or open land" (14 percent), then wooded wetlands (10 percent). The woodlands were largely stripped of white pine, hemlock and hardwoods prior to 1900. Forest management, since the mid-1930's, has enabled Rusk County to have 54 percent of its county in forest land now. At the present time, aspen is the major tree of all types present, amounting to nearly one-third of the total volume of the available forest reserve.

Agricultural Land

Cropland and pastures are used primarily to support dairying in Rusk County. Dairying was the primary function of 59 percent of the farms during 1967-68. General crop farming was reported to be the primary function of 24 percent of the farms. Beef cattle operations constituted 5 percent of the total. At the present time there are about half the number of farms present in Rusk County that there were during the peak years of the forties, but the remaining farms are larger in acreage than their predecessors. Out of the 174,000 acres of cleared land in either crop production or simply cleared and open but uncultivated, 84,000 or almost half is not being cultivated at the present time. No doubt many of these old fields are in the process of reverting to forest and used increasingly by wildlife.

Aesthetic Values

The Flambeau River remains an important aesthetic resource in spite of the recent lowering of its level by the removal of the Port Arthur Dam. The "new" land exposed has some charm even in its earliest stages of tree succession. West of State Highway 27, Meadowbrook Creek flows through a stand of mature conifers which possesses exceptional beauty. There are no areas possessing unique open space qualities present on the FMC holdings or the nearby lands.

Community Facilities

Medical

Health services are presently represented by a small 57-bed hospital. Plans for updating this service were approved on May 15, 1973, when the county board voted to authorize the sale of 3.25 million dollars of bonds to finance construction of a new 52-bed hospital to replace the existing facility. The new hospital is located on the north bank of the Flambeau

TABLE 17

APPROXIMATE* RUSK COUNTY LAND-USE ACREAGE
FOR SELECTED ACTIVITIES**

	Incorporated	Unincorporated	Rusk County
Totals: acres	7,925	582,350	590,275
percent of total	1.34%	98.66%	100%
Water	300 3.70%	10,800 1.85%	11,100 2.00%
Woodland	- -	319,200 54.81%	319,200 54.07%
Woodland, wetland))+ Open wetland)	- - -	51,550 10.66% 10,575	51,550 10.52% 10,575
Cleared or open land		190,230	190,230
Residential including farmsteads	350 4.48%	3,675 .63%	4,025 .68%
Commercial	50 2.92%	225 1.78%	275 1.79%
Industrial	50	50	125
Transportation, communications and utilities	-	175	175
Roads, railroad and transportation rights-of-way	-	9,925	9,925
Public and semi-public	125	150	275
Vacant	7,050 88.87%	500 .08%	7,550 .13%
Crop and open pasture	-	90,775 15.58%	90,775 15.37%
Other cleared or open land	-	84,750 14.55%	84,750 14.35%

* All figures rounded to nearest 25.

** From Northwest Wisconsin Regional Planning and Development Commission. "Land Use and Physical Features", January 1972, page 43.

River adjacent to Highway 27. Completion of the hospital is anticipated in early fall of 1975. Institutional care for the elderly is found in three facilities: the Glen Flora Nursing Home, the Ladysmith Nursing Home, and the Rusk County Nursing Home associated with present hospital facilities. Total bed capacity of these facilities is 170, and they have been approximately 93 percent occupied.

Schools

The Ladysmith School District encompasses an area of 207 square miles and includes the project site. Enrollment in 1974-75 was 1,507 students with a professional staff of 90. The total equalized assessed valuation for the district was $41,689,300 in 1974 or about $28,000 per pupil. Estimated school costs for 1974-75 were $2,262,768 or about $1,500 per pupil. The state estimated aid payments were $1,261,624 or about $850 per pupil. It can be seen that over half of the costs of school services are paid by state aid. The local full-value school tax rate in 1974 was estimated to be about $24 per thousand valuation. The 1973-74 potential borrowing power was $4,310,370 of which $2,075,000 (51.9%) was committed as long-term indebtedness.

The school facilities are generally new. The estimated capacity is 2,000 students. The recent rapid fall in the Rusk County birth rate (from about 375 live births per year in 1950 to 1965 to 244 live births per year since 1965) suggests that the school-aged population will begin to decline.

Water Supply

The Ladysmith water supply is from wells and is untreated. The supply capacity exceeds demand, but storage facilities are limited. Potable water in Grant Township is derived from private wells.

Law Enforcement

Law enforcement services are of average capacity for a community of this size. The presence of the county sheriff in Ladysmith provides some extra service in the environs.

Sewage Disposal

The sewage system of Ladysmith includes both primary and secondary treatment. It has a capacity of 645,000 gallons per day. Corrective measures have been ordered by the DNR including the installation of effluent disinfection facilities. Outside of Ladysmith, private on-site sewage disposal systems are used.

Transportation

The transportation network through the project site consists basically of State Highway 27, County Highway P, and township roads. State Highway 27 running north-south intersects the proposed mining property for 1¼ miles and is tangent to it for an additional 1½ miles; County Highway P runs east-west intersecting the property for 1½ miles. There is approximately ¼ mile of city street tangent to the property on the north and township roads are tangent for approximately 1¼ miles. The principal motor vehicle traffic is along State Highway 27 which is an all-weather two-lane highway in good condition.

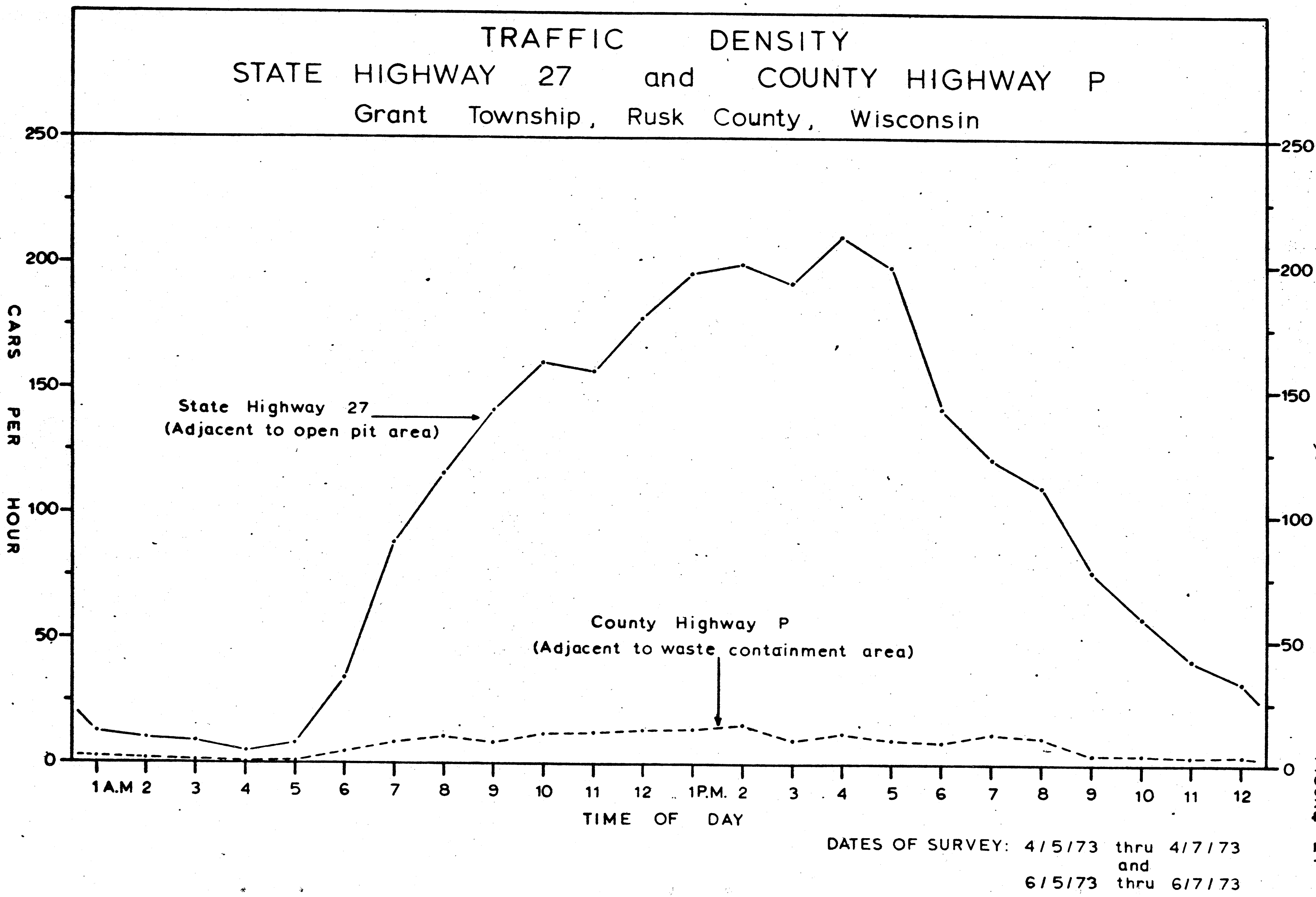
Traffic Flows

The Wisconsin Department of Transportation studied traffic flows in the area during 1973. The average daily traffic count on Highway 27 between Ladysmith and County Highway P was 2,090. The traffic count on Highway P was 150. The mining company conducted traffic counts in April and June 1973. The results of their survey are presented in Table 18 and Figure 24. The densities are normal for these types of highways and, except for late afternoon, no significant overloading was recorded.

TABLE 18
TRAFFIC DENSITIES ON STATE HIGHWAY 27 AND
COUNTY HIGHWAY P, GRANT TOWNSHIP, RUSK COUNTY

	State Highway 27	County Highway P
Highest hourly density/hour	306/4:00 PM	26/12:00 noon
Lowest hourly density/hour	2/4:00 AM	0/1:00-5:00 AM 9:00-11:00 PM
Average hourly density	105	7.33
Total vehicles in 96 hours	10,035	704

FIGURE 24


TRAFFIC DENSITY
STATE HIGHWAY 27 and COUNTY HIGHWAY P
Grant Township, Rusk County, Wisconsin
CARS PER HOUR
0
50
100
150
200
250
State Highway 27
(Adjacent to open pit area)
County Highway P
(Adjacent to waste containment area)
1 A.M 2 3 4 5 6 7 8 9 10 11 12 1P.M. 2 3 4 5 6 7 8 9 10 11 12
TIME OF DAY
DATES OF SURVEY: 4/5/73 thru 4/7/73
and
6/5/73 thru 6/7/73

Railroad

Tracks of the Soo Line Railroad run through the northeast corner of the project site. This is the principal rail connection between Chicago-Milwaukee and Superior-Duluth.

Pipeline

A 34-inch crude-oil pipeline, owned by Lakehead Pipe Line Company, Inc., crosses the project site diagonally in a northwesterly direction, buried approximately three feet below the surface. The 80-foot wide pipeline right-of-way crosses the Flambeau River approximately 1,340 feet southwest of the mouth of Meadowbrook Creek, continues across the project site, and crosses under State Highway 27 north of its intersection with County Highway P.

Utilities

Electrical and telephone utility services are distributed about the mine site as shown in Figure 25.

Economy

Wisconsin

The basic economy of the State of Wisconsin is furnished by its manufacturing activities, as shown in Table 19, and the percentage of income from manufacturing in the state is well above the national average. The percentage of state income provided by farming is also significantly higher than that for the nation. The percentage of income from service activities and government is somewhat lower than the national average, while other activities, including construction, transportation, utilities, wholesale and retail trade are comparable with the nation. Mining contributes approximately 0.2 percent of the total income to the state.

The overall economic growth of the state since 1960 has been somewhat less than the economic growth of the nation. During the past decade, farming income in Wisconsin has increased at a rate greater than the national average, but manufacturing which is the more important industry in Wisconsin, increased at a rate slower than the overall national average. The relative increase of the mining industry in Wisconsin was far less than in the nation, and in terms of constant dollars is actually declining. Agricultural employment is predicted to continue to decline as it has during the past decade. This does not necessarily mean that agricultural income will decline or even cease to grow since the size of individual farms and the use of mechanized farming methods have been increasing.

Rusk County Income

Average family income in the state was reported in 1969 to be $10,068, while the Rusk County family income was reported to be $6,724. A more recent survey conducted by BCMC in the project area during early 1973 showed family income in the impacted area to be somewhat higher than the Rusk County average, but still well below the state average. In the project area the average family income was reported to be $7,678, but ten families reported pensions as their sole income.

Personal income earned by the residents of Rusk County arose primarily from four sources - manufacturing, farming, wholesale and retail trades and government, as shown by Table 20. Manufacturing in Rusk County, although important to its economy, has not grown substantially. There was a decline in the value of manufactured goods from 1963 to 1967. In 1967 there were some 32 manufacturing establishments ranging in size from 1 to 200 employees. In 1972 there were 30 manufacturing establishments, one of which had 250 employees. In general, manufacturing is concentrated in Ladysmith where 14 of the 30 manufacturers are located, including five of the seven largest employers.

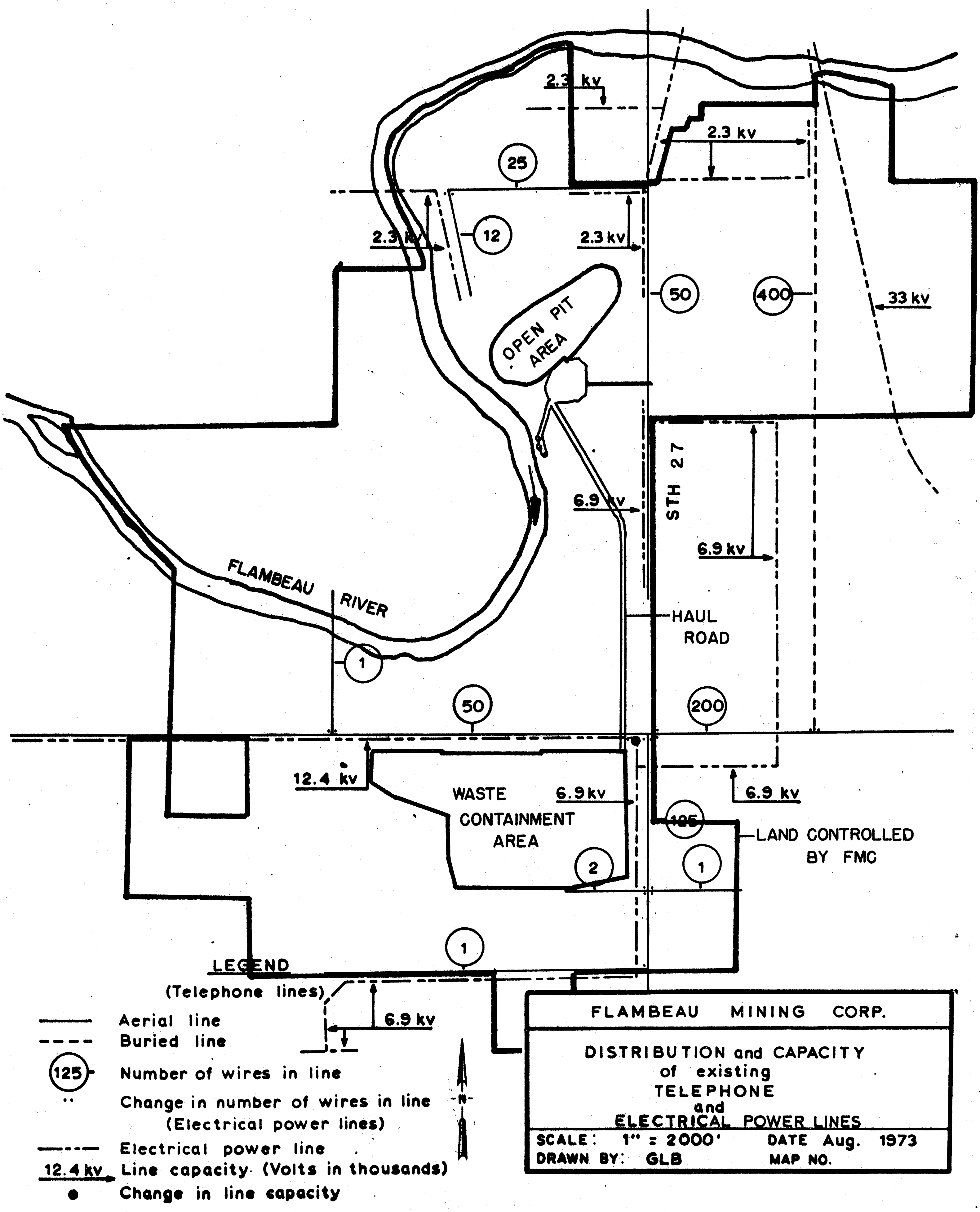

2.3 kv
2.3 kv
25
2.3 kv
12
2.3 kv
50
400
33 kv
OPEN PIT AREA
STH 27
6.9 kv
6.9 kv
FLAMBEAU RIVER
HAUL ROAD
1
50
200
12.4 kv
WASTE CONTAINMENT AREA
6.9 kv
6.9 kv
125
LAND CONTROLLED BY FMC
2
1
1
LEGEND
(Telephone lines)
Aerial line
Buried line
125 Number of wires in line
Change in number of wires in line
(Electrical power lines)
Electrical power line
12.4 kv Line capacity (Volts in thousands)
Change in line capacity
6.9 kv
N
FLAMBEAU MINING CORP.
DISTRIBUTION and CAPACITY of existing TELEPHONE and ELECTRICAL POWER LINES
SCALE: 1" = 2000'
DATE Aug. 1973
DRAWN BY: GLB
MAP NO.

TABLE 19

SOURCES OF INCOME TO WISCONSIN AND THE UNITED STATES IN 1960 AND 1970
(in millions of dollars)

	Wisconsin				United States				
	1960	1970	% of Income	% Increase	1960	1970	% of Income	% Increase	Differential*
Contract construction	$ 444	$ 769	5.9	73.1	$21,038	$38,627	6.2	83.6	-12.6
Services	735	1,692	13.0	130.2	41,666	96,343	15.6	131.2	- 0.8
Government	652	1,773	13.7	171.9	38,207	95,150	15.6	149.0	+15.4
Farm	434	640	4.9	47.4	14,951	19,116	3.1	27.8	+71.0
Mining	23	26	0.2	13.0	4,349	6,582	1.1	51.3	-75.0
Manufacturing	2,676	4,684	36.0	75.0	94,589	176,075	28.4	86.1	-12.9
Transportation, communications, and public utilities	464	761	5.9	64.0	24,875	44,943	7.3	80.6	-21.0
Wholesale and retail business	1,278	2,074	16.0	62.2	62,385	105,496	17.0	69.1	-10.0
Finance, insurance and real estate	266	528	4.2	98.4	16,247	33,210	5.4	104.4	- 5.7
Other	13	32	0.2	146.1	1,037	1,866	0.3	79.9	+82.9
	$6,985	$12,979		85.8	$319,344	$617,408		93.3	- 8.0

*Calculated by dividing the difference between Wisconsin's percent change and the U.S. percent change, by the U.S. percent change.

TABLE 20

PERSONAL INCOME, RUSK COUNTY, WISCONSIN (1972)

Source	Amount (millions)*
Farm earnings	$ 4.6
Government labor earnings	
Federal civil service	.6
Military	.2
State and local government	4.1
Manufacturing	5.5
Mining	.0 (less than $500,000)
Contract construction	.8
Transportation, communication & utilities	2.2
Wholesale and retail trade	4.3
Finance, insurance, real estate	.8
Services	3.0
Other	.2
Property rentals	4.6
Wisconsin transfer payments	7.8
TOTAL	$38.7

Per capita personal income $2,583.00

*Survey of Current Business, May 1974, Volume 54, No. 5, Part II.

Employment and income factors for the state and Rusk County at the time of the 1970 census are summarized in Table 21.

Employment

Although the State of Wisconsin during this period enjoyed high employment, and a high median income with relatively little poverty, Rusk County did not share in this general prosperity.

TABLE 21

EMPLOYMENT AND INCOME FACTORS FOR WISCONSIN AND RUSK COUNTY
1970

	State of Wisconsin	Rusk County
Total work force	1,932,800	4,529
Labor force, percent unemployed	4.0	6.4
Nonworker to worker ratio	1.45	1.91
Median family income	$10,068	$6,734
Adjusted gross income per capita*	$3,244	$1,995
Percent with income less than median family income	7.4	18.9
Percent with income in excess of $15,000	19.8	9.4

*Adjusted gross income is total income after business expense, but before deductions.

More than 40 percent of the Rusk County work force was engaged in either agricultural or manufacturing occupations while the remainder was dispersed in other activities. Unemployment was 6.4 percent of the total work force. The distribution of the labor force in Rusk County in 1970 by activity is shown in Table 22.

TABLE 22

DISTRIBUTION OF RUSK COUNTY LABOR FORCE IN 1970 BY ACTIVITY

Activity	No. of Workers	Percent of Total Workers
Agriculture, forestry and fisheries	857	18.9
Mining	4	0.1
Construction	207	4.6
Manufacturing	830	18.3
Railroads	67	1.5
Trucking and warehousing	81	1.8
Other transportation	32	0.7
Communications	41	0.9
Utilities and sanitary services	111	2.5
Wholesale trade	66	1.5
Food, bakery and dairy stores	99	2.2
Restaurants, cafes and bars	186	4.1
General merchandise retailing	75	1.7
Motor vehicle retailing and service stations	122	2.7
Other retail trade	260	5.7
Banking and credit agencies	74	1.6
Insurance, real estate and other finance	46	1.0
Business and repair services	86	1.9
Private households	40	0.9
Other personal services	112	2.5
Entertainment and recreational services	35	0.8
Hospitals	200	4.4
Health services except hospitals	88	1.9
Elementary, secondary schools and colleges (Gov't.)	283	6.0
Elementary, secondary schools and colleges (private)	166	3.7
Other education	9	0.2
Welfare, religious and nonprofit organizations	90	2.0
Legal, engineering and miscellaneous services	53	1.2
Public administration	209	4.6
Total employed, 16 years and over	4,529	100.0

More recent data coming from the first eight months of 1972 shows a total work force in the county of 5,104 but with unemployment increasing to 9 percent. Increased employment since 1970 has predominantly been in agriculture which averaged 1,159 the first eight months of 1972, as contrasted to 857 for the year of 1970. Unemployment is very seasonal and is highly influenced by the fluctuating demand for agriculture workers. This can be readily seen in the following data for the first eight months of 1972.

	Rusk County Agricultural Employment	Percent Unemployed of Total Work Force
January	1,000	10.7
February	1,040	10.3
March	1,090	10.6
April	1,160	10.1
May	1,260	8.0
June	1,220	8.6
July	1,240	7.9
August	1,260	5.5

The increase of 260 jobs in agriculture from January to August is about 5 percent of the total available work force.

Manufacturing

The manufacturing sector, according to census reports, had an employment of 830 in Rusk County in 1970 while the State of Wisconsin survey of 1972 indicated a total manufacturing employment of only 690 in Rusk County. The eight largest manufacturers are shown in Table 23.

TABLE 23
RUSK COUNTY MAJOR MANUFACTURERS

City	Manufacturer's Name	Product	No. Employed
Ladysmith	Conwed Corp.	Finished cabinets	35
Ladysmith	Great Lakes Millwork Corp.	Millwork, doors, etc.	91
Ladysmith	Peavey Paper Mills	Paper products	100
Ladysmith	Fiberstrong, Inc.	Molded fiberglass	55
Ladysmith	Balko, Inc.	Boat trailers	24
Ladysmith	Kenneth Mills	Handcraft kits	161
Hawkins	Northern Sash & Door Co.	Millwork, windows	250
Glen Flora	R & W Novelty	Novelty items	20

All other manufacturers had less than 20 employees. As can be seen, the employment by manufacturers is concentrated in Ladysmith and Hawkins. Employment in neither the county nor Ladysmith is dependent upon the fortunes of any single manufacturer. It is apparently somewhat dependent upon the demand for forest products.

Taxation

Town Assessment

The 1973 total general property tax status of the Town of Grant, City of Ladysmith, and Rusk County is presented in Table 24. The Town of Grant had a local assessment of $7,114,670 or 120 percent of full equalized assessed valuation. This abnormality of the local assessment reflects, in part, inflated prices paid by the mining company for land within the project site. It may also reflect prices paid by land speculators looking for recreational land in northern Wisconsin.

Revenues Collected

State Aids

Estimated state revenues collected are presented in Table 25. The state makes various types of aid payments to local units of government. The 1973 state payments to the Town of Grant were $304,325, or 103.90 percent of the amount collected. The City of Ladysmith and Rusk County also received more state aid than state revenue which was collected. Considering the state as a whole, 62.47 percent of state revenues collected were returned as state aids. The Rusk County communities benefit disproportionately from state aid payments.

TABLE 24

PROPERTY TAXATION - 1973

Municipality	Full Value 1973	General Property Taxes State	County	Local	School	Totals	Full Value Property Tax Rate State	County	Local	School	Total
Town of Grant	$ 5,923,700	$ 1,184	$ 26,415	$ 673	$ 136,366	$ 164,640	.0002	.00445	.00011	.02302	.02779
City of Ladysmith	22,726,300	4,545	178,071	91,735	532,576	806,928	.0002	.00783	.00403	.02343	.03550
Rusk County	$112,003,500	$22,383	$804,295	$173,447	$2,145,909	$3,146,080	.0002	.00718	.00154	.01915	.02808

TABLE 25

ESTIMATED STATE REVENUE COLLECTIONS 1973

	Town of Grant	Ladysmith	Rusk County
Population 1973	933	3,666	14,626
Adjusted Gross Income Per Capita	$2,498	$2,803	$2,413
State General Fund:			
Individual Income Tax	$91,218	$408,365	$1,310,203
Corporation Income Tax	13,778	103,097	274,896
Sales and Use Tax	77,072	317,421	1,191,889
Excise Taxes	24,527	96,372	384,490
Utility Taxes	12,910	78,580	238,251
All Other Taxes	8,972	37,570	149,175
Highway Fund:			
Motor Vehicle Taxes/Fees	61,446	192,443	728,917
Conservation Fund:			
Various Fees	2,980	11,708	46,709
Total State Revenues	$292,903	$1,245,556	$4,324,530

DESCRIPTION OF THE PROPOSED ACTION

Summary

The essentials of the mining operation being considered are as follows:

-Mining method:	Open pit followed possibly by an underground operation.
-Deposit description:	A steeply-inclined massive-semimassive sulfide deposit, averaging 50 feet wide, 2,400 feet long, bottoming at 800 feet below surface.
-Open pit size:	Area of opening at surface: 55 acres. Depth: 285 feet. Pit wall slope angle: 35 degrees. (Economic and rock structural conditions could affect the area, depth and shape of the open pit.)
-Open pit location:	1.6 miles south of the junction of U.S. Highway 8 and State Highway 27 on State Highway 27, thence west 0.3 miles on a private gravel road to the geographic center of the open pit; west edge is 300 feet east of the Flambeau River; east edge is 400 feet west of State Highway 27.
-Concentrating processes:	Crushing, grinding, flotation and dewatering.
-Average Production rate:	
Ore:	1,000 tons per day (tpd) taken from open pit
Waste rock:	4,120 tons per day (tpd) taken from open pit and trucked to waste containment area.
-Ore becomes:	
Concentrate (average daily production):	160 tpd (average) shipped out of state for smelting.
Tailings:	
Amount:	840 dry tpd (average) piped as a slurry to waste containment area. Note: 11 years would generate 2,617,000 tons (dry weight) of tailings.
Composition:	Approximate proportions would be 50 percent to 70 percent quartz, mica and clays, and 30 percent to 50 percent iron sulfide (pyrite).
-Copper recovery from ore:	86 to 89 percent depending on ore type.
-Waste containment area:	
Size of area:	186 acres including dike.
Location:	Adjacent to and south of County Highway P west of State Highway 27.
Dike dimensions:	56 feet high, 80 feet wide at top, 363 feet wide at bottom.

-Land use: The mining company has acquired 2,750 acres, used as follows:

	Acres
Mining	
Open pit copper mine	55
Gravel from Rusk County pit	10
Gravel from new pit (contingent)	30
Plant	3
Haulage facilities	
Haul road & pipeline	16
Rail siding & spurline	13
Waste containment area including dikes	186
Soil stockpile	36
Total Industrial	349
Visual and noise screens	2401
TOTAL	2750 acres

-Life of operation: Open pit - 11 years; followed possibly by underground mining for additional 11 years.

-Work force:
Construction phase: Average: 102 employees; peak: 220 employees.

Production phase: 28 salaried employees; 50 hourly rated employees.

-Approximate annual payroll - production: $ 1,020,000

-Total capital investment: $15,000,000

Construction Phase

The first step in the construction period is the establishment of an access road from State Highway 27 to the plant site. This would be a standard 22-foot graded roadway with three feet of shoulder on each side, and would be tree lined.

The major work performed during the construction period would include:

1. the removal of overburden and waste rock (called "prestripping") to expose three to four months' ore supply;

2. the use of the overburden and waste rock for the construction of the haul road and the first lift of the waste containment area dikes; and

3. the construction of the concentrator, ancillary facilities and explosive magazines.

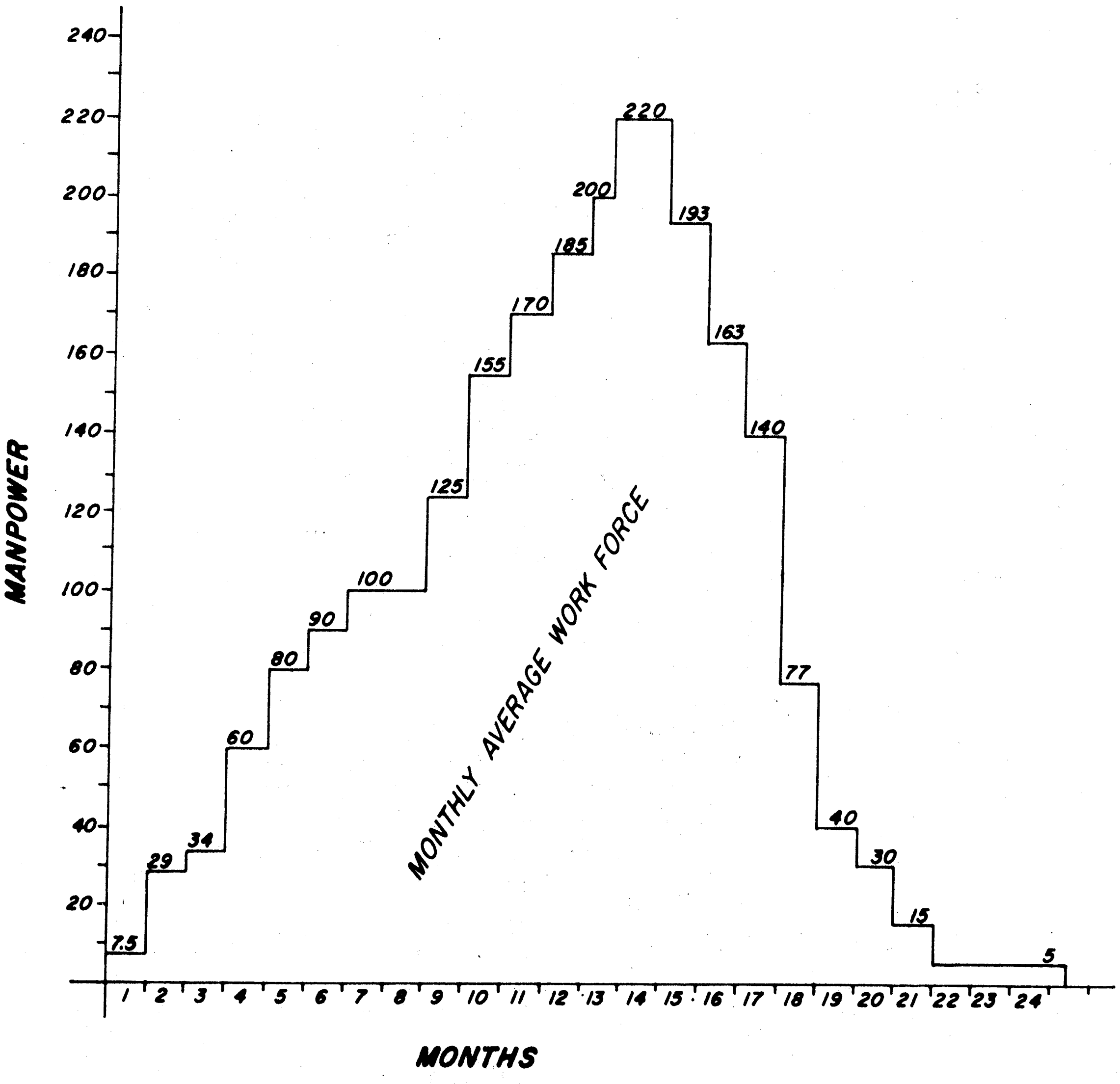
The construction period is expected to last 1½ years after the beginning of the mine prestripping. During the construction period, an average of 121 persons would be employed, peaking at 220 in the fourteenth month of construction (Figures 26 and 27). Local subcontractors and local labor would be used as far as possible. It is anticipated that the skills not available locally would be obtainable from the larger cities such as Minneapolis. This type of work force is normally housed in trailers near the site but probably not on company land.

Mine Area

In sequence, the construction in the mine area would be:

1. Felling and grubbing trees and shrubs over the pit area. Some of the timber would be chipped for use as mulch over bare soil on the outside of the waste containment dikes, road banks, etc., to assist in promoting revegetation. The balance would either be sold, burned or otherwise lawfully disposed of.

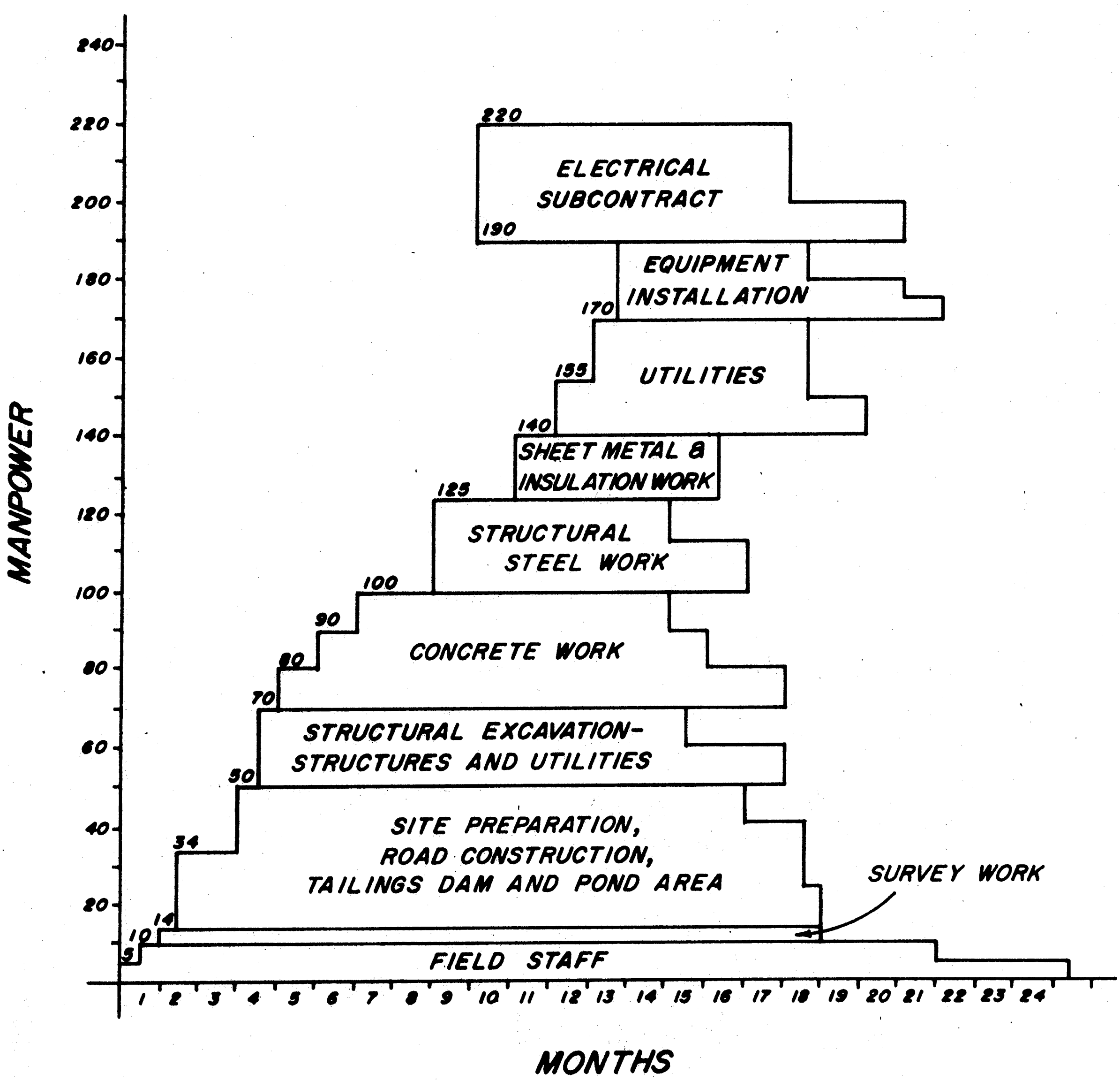
FIGURE 26



KENNECOTT COPPER CORPORATION	FLAMBEAU MINING CORP.	MICROFILM	MMD JOB
	PLANT & FACILITIES-CONSTR.		506
	LABOR FORCE	MMD DRAWING	REV.
METAL MINING DIVISION ENGINEERING DEPARTMENT SALT LAKE CITY, UTAH		BCM82-00-112	
		DIV. DRAWING NO.	

MAY, 1974

FIGURE 27



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FLAMBEAU MINING CORP.
PLANT & FACILITIES
CONSTRUCTION
LABOR FORCE

MICROFILM | MMD JOB 506
MMD DRAWING BCM82-00-113 | REV.
DIV. DRAWING NO.

MAY, 1974

2. Establish security measures to control access to the pit area to prevent unauthorized entry and as a safety measure.

3. Removal and temporary stockpiling of the topsoil and silty glacial subsoils obtained from within the pit area. When the haul road is completed this material would be transferred to another stockpile area located within the SW¼ of Section 16.

4. Construction and approval of the explosives magazines.

5. The removal of overburden and waste rock either by drilling and blasting followed by loading into 50-ton off-highway haulage trucks, or by ripping with a crawler dozer and scraping. Either method could be used depending on the nature of the material. Excavation would commence in the northeast portion of the area to be prestripped so that silt-laden waters would flow into the excavation and not into the river.

   Prestripping

   Continuous on-site testing of the materials excavated would be carried out by the mine geologist who would direct the material either to the haul road or to various stockpiles, and after completion of the haul road, to the waste containment area.

6. A drainage ditch would be constructed in the top of the clay-saprolite layer at the 1,085 elevation level within the pit to collect groundwater inflow and surface water runoff. The ditch would be graded at -2 percent toward sumps at the southwest end of the pit. One pump capable of pumping the average sump inflow to the gravel pit and for sundry usage would be installed together with a similar capacity pump as standby. During storm conditions, excess water beyond the installed pumping capacity would flow into the pit bottom and would be pumped from the pit bottom sump to the waste containment area. Before sufficient dike has been constructed in the waste containment area, such excess water would be disposed of in the gravel pit.

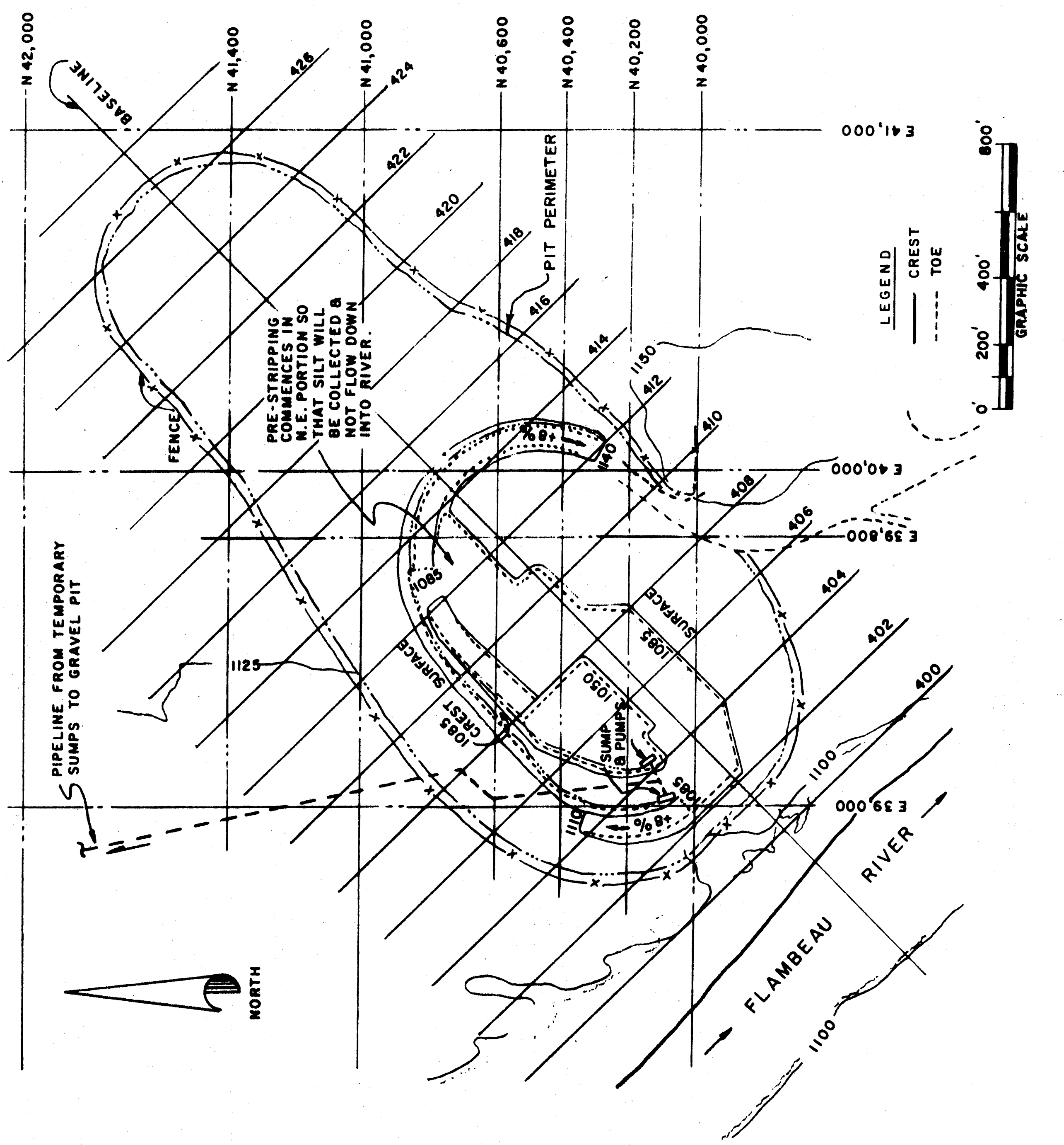
7. Spillways would be provided as required to divert surface water runoff to the 1,085 level drainage berms.

8. A visitor's observation post would be constructed as soon as practicable.

The work in the mine area consists mainly of removing sufficient overburden and waste rock to expose 75,000 to 100,000 tons of ore, i.e., sufficient for three to four months' milling (Figure 28). The overburden materials would be used for the construction of the plant site, roadways, haul road, and waste containment area dikes. Appendix I shows the waste material production schedule on an annual basis. Appendix J shows the disposition of waste materials during the preproduction, production, and post-production periods. The estimates of material quantities available are based on the soil samples and geologic data obtained from soil test work.

The steeply-dipping Precambrian rocks which contain the orebody are overlain by 30 to 60 feet of flat-lying sandstone and glacial deposits. Ancient weathering of the upper portion of the Precambrian bedrock has converted it to clay-rich saprolite. This material has a very low permeability and would be used to construct an impervious core in the waste containment area dikes. Overlying the saprolite is a poorly-cemented Cambrian sandstone, varying in thickness from zero to thirty feet. If it is found that the sandstone can be adequately compacted, it would be placed in the downstream section of the waste containment dike or in fill sections of the roadway. Otherwise, it would be disposed of inside the waste containment area. Overlying the Precambrian bedrock and Cambrian sandstone are unconsolidated granular glacial deposits of variable composition ranging in thickness from 15 to 60 feet. The coarser glacial materials would be used as a subbase for the haul roads and traffic areas in the plant site and for dike construction. Some of the finer glacial materials would be used as fill for the subgrade of the haul road. The rest would be stockpiled, covered with vegetation, and used as a soil cover for the final rehabilitation of the waste containment area. Top soils would be stockpiled and covered with vegetation until used in stabilization and final rehabilitation (see Figure 29).

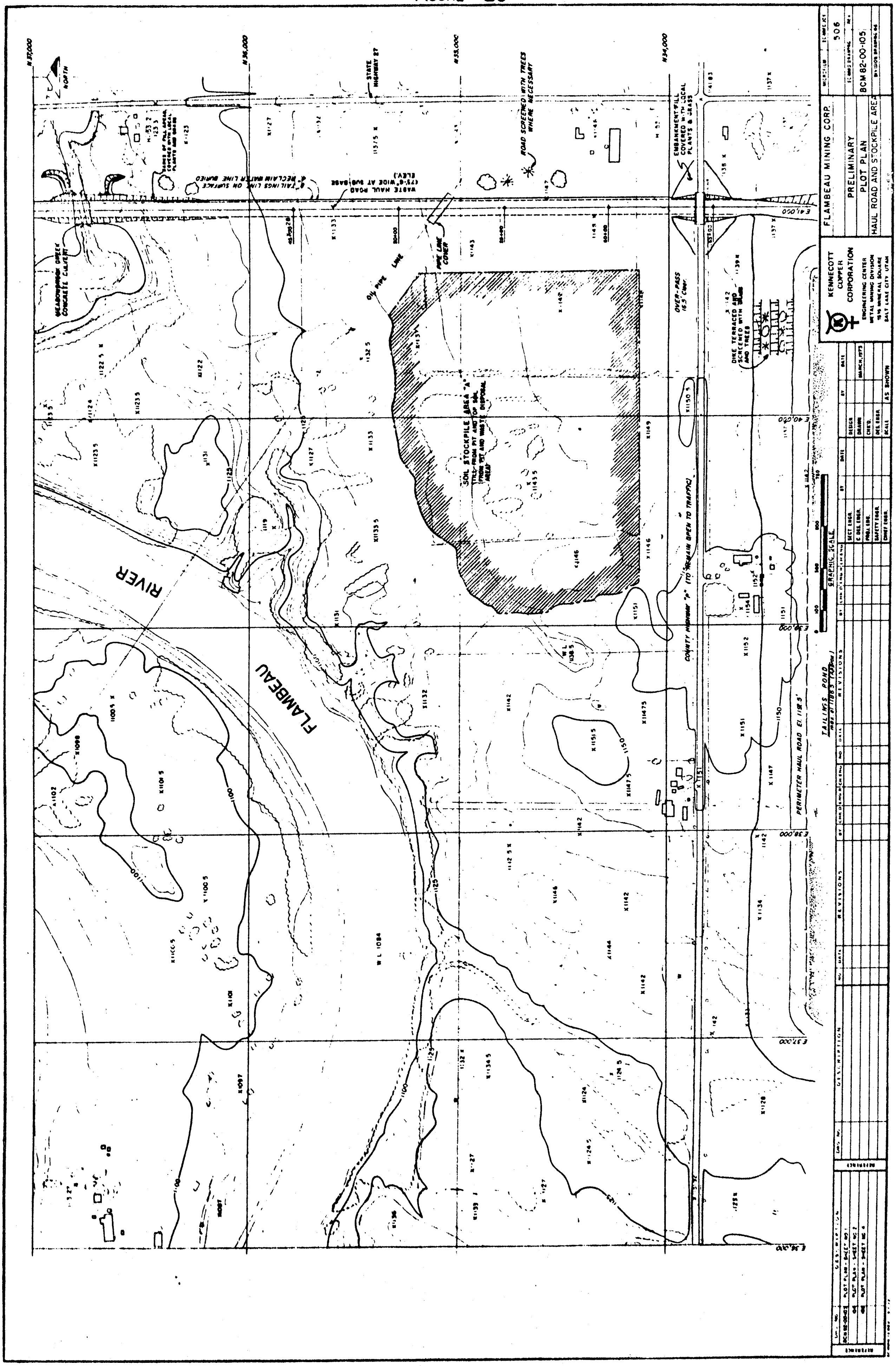
FIGURE 28



KENNECOTT COPPER CORPORATION METAL MINING DIVISION ENGINEERING DEPARTMENT SALT LAKE CITY, UTAH	FLAMBEAU MINING CORP. MINING PLAN END OF PRE-MINE STRIPPING	MICROFILM / MMD JOB 506 MMD DRAWING BCM82-00-114 / REV. DIV. DRAWING NO.

MAY, 1974

FIGURE 29


FLAMBEAU MINING CORP.
PRELIMINARY
PLOT PLAN
HAUL ROAD AND STOCKPILE AREA
BCM 82-00-105
MAY, 1974
KENNECOTT COPPER CORPORATION
GRAPHIC SCALE
AS SHOWN
FLAMBEAU
RIVER
SOIL STOCKPILE AREA "A"
TAILINGS POND
PERIMETER HAUL ROAD
OVER-PASS
STATE HIGHWAY 27
NORTH

Diamond drill hole data indicates that the blast holes below the overburden would be dry. Accordingly, it is anticipated that for most of the blasting a mixture of ammonium nitrate prills and fuel oil (AN-FO) would be used as the blasting agent. Although ammonium nitrate is not considered an explosive until it is mixed with fuel oil (this mixing takes place at the blast hole site immediately prior to loading the hole), it is proposed to store it in the magazine area (Figure 30). A 30-ton capacity storage bin - roughly one month's supply would be provided.

Explosive Magazines

Two other magazines would be constructed. One would be designed to store a total of five tons of explosives, including primacord, some dynamite for secondary blasting and some mixed AN-FO in plastic bags for use in the occasional wet hole. The other magazine would be similar and used for the storage of boosters and caps. The American Table of Distances for storage of explosives requires that barricaded magazines storing five tons of explosives must be a distance of 865 feet from inhabited buildings, 345 feet from passenger railways and 260 feet from public highways. In addition, the separation of magazines must be 78 feet. The magazines would be 875 feet from the nearest inhabited building along the west edge of State Highway 27, 1,020 feet from State Highway 27, still further from the railway, and 100 feet apart.

The magazines would be surrounded by a wall of earth of sufficient thickness and height to meet applicable safety standards. This earth would be obtained from the till of the open pit. By law, the mounds of earth would be kept clear of vegetation. Erosion prevention measures such as the use of crushed rock or asphalt covering would be taken to prevent siltation.

Plant Site

The plant would be located on the southerly side of the pit on a hill surrounded by the 1,150-foot contour. The site is roughly 65 feet above the river. Within the plant site area would be the concentrator, including crushing, grinding and flotation sections, the warehouse, offices, workshop and changehouse, and other minor buildings. The preliminary design of the plant has not yet been determined. Based on the soil conditions found in the preliminary borings made near the plant site area, the proposed plant could be supported on a normal footing or mat-type foundation with soil bearing pressure in the range of 4,000 to 7,000 pounds per square foot. Additional borings and detailed soil investigations would be necesssary once the concentrator and other buildings have been designed.

Concentrator

The concentrator buildings, shops, warehouse and offices would be painted to blend with the surroundings, and the plant site landscaped and planted with trees.

The company's design criteria for the concentrator include:

1. An adequate dust collection system for the dry crusher circuit so that the dust created at the crushers and transfer points is removed and not allowed to pollute the atmosphere in or outside of the building.

2. Provision for the installation of a heating system for use in the winter plus adequate insulation. The products of combustion from this heating would be vented to atmosphere.

3. Sprays for dust suppression at the concentrate stockpile.

Waste Containment Area

The proposed waste containment area would cover 186 acres in Section 21 (Figure 31) and is designed to store 2,617,000 tons of tailings from an open pit operation, 2,886,000 tons of tailings plus 740,000 tons of washing plant silt from a possible subsequent underground operation, and 4,009,000 cubic yards of surplus waste material from the open pit. Assuming no pyrite sales, the average dimensions of the dike walls would be 56 feet high, 80 feet wide at the top, and 363 feet wide at the base.

The company's design criteria established for the waste containment area were:

1. To provide dikes and a reservoir that would be as impermeable as possible so that seepage losses during the life of the operation and thereafter would be minimal.

FIGURE 30

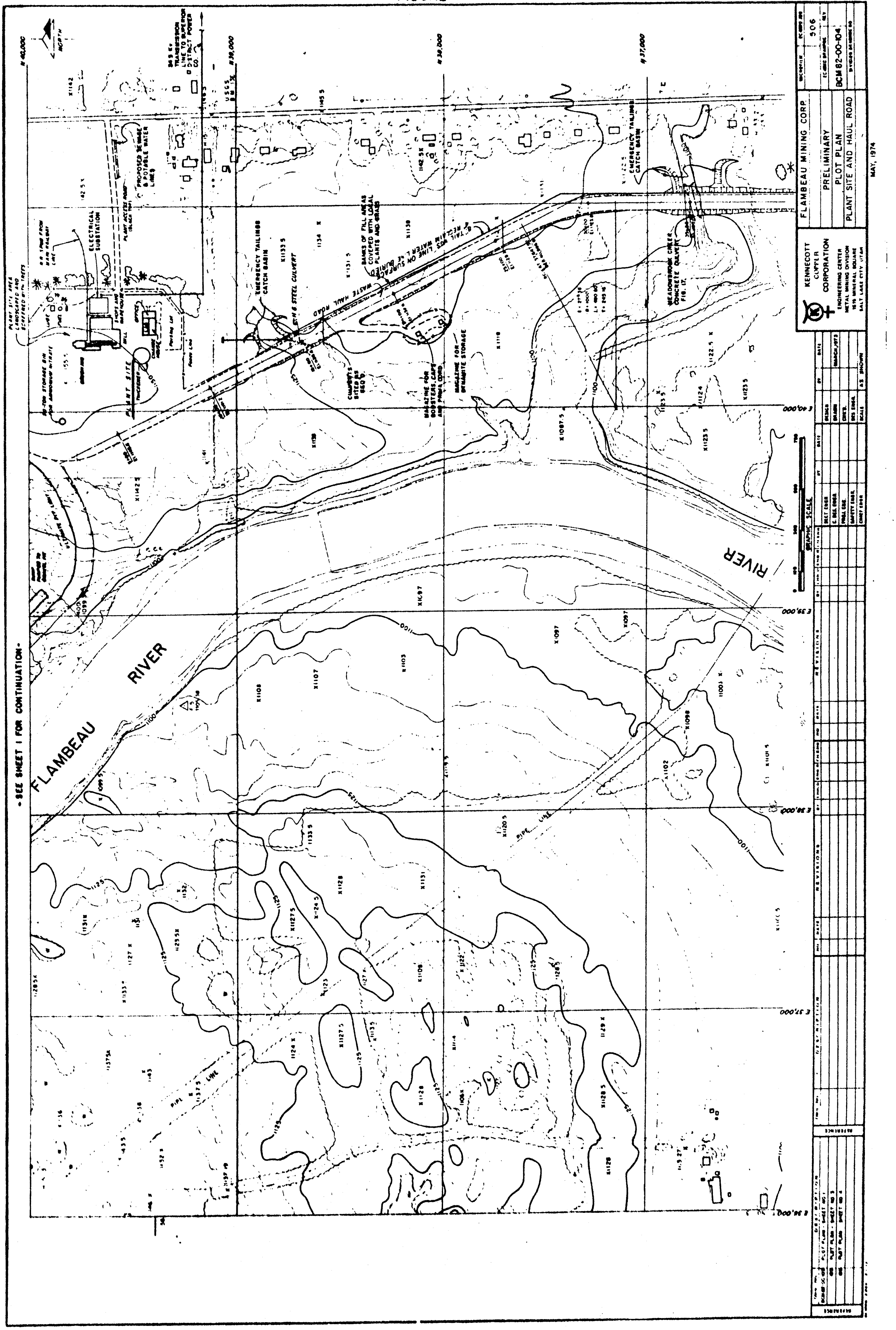
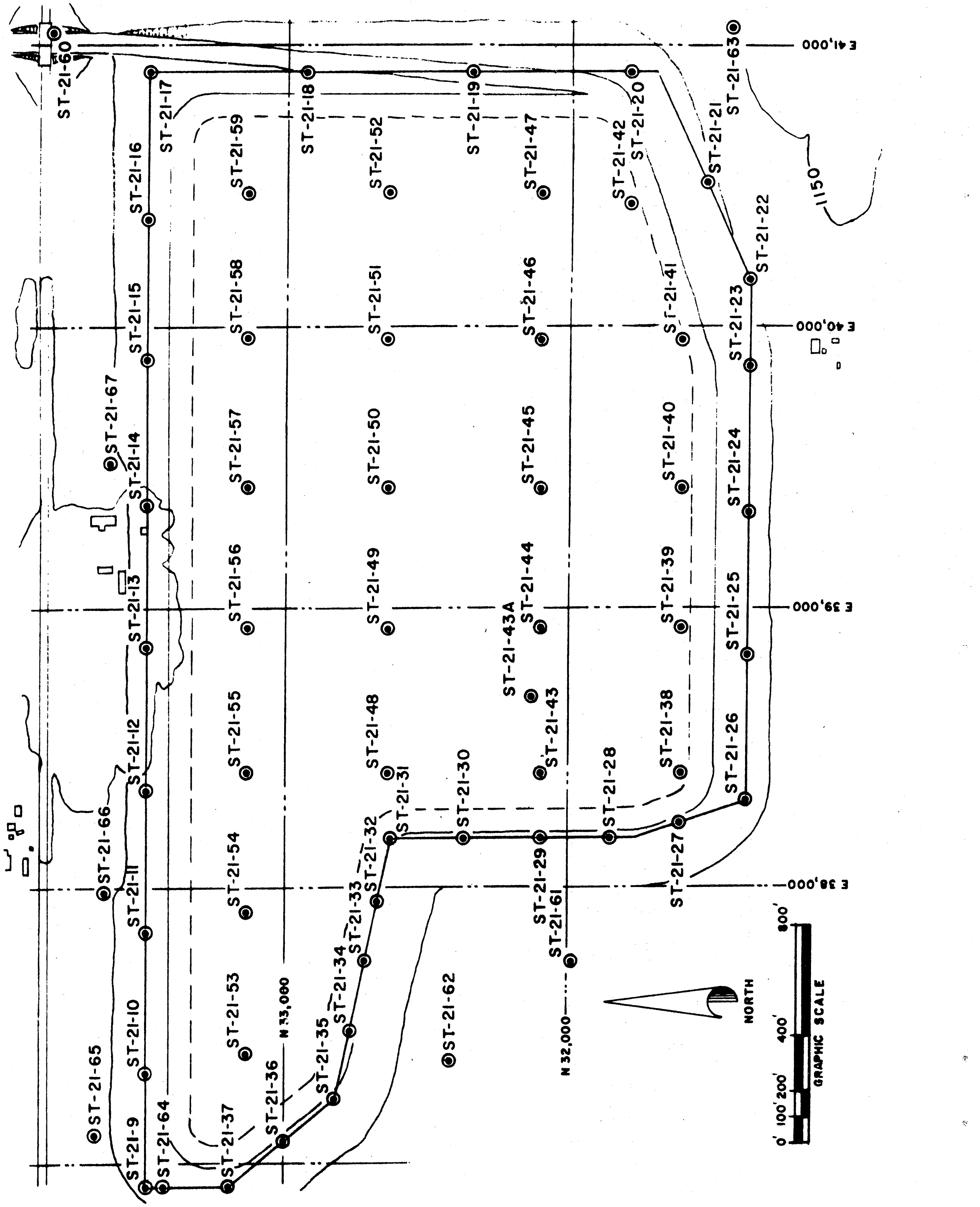

FLAMBEAU RIVER
RIVER
SEE SHEET 1 FOR CONTINUATION
FLAMBEAU MINING CORP.
PRELIMINARY
PLOT PLAN
PLANT SITE AND HAUL ROAD
BCM 82-00-104
KENNECOTT COPPER CORPORATION
MAY, 1974
WASTE HAUL ROAD
PLANT SITE
ELECTRICAL SUBSTATION
EMERGENCY TAILINGS CATCH BASIN
MAGAZINE FOR DYNAMITE STORAGE
GRAPHIC SCALE
PIPE LINE

FIGURE 31



KENNECOTT COPPER CORPORATION
METAL MINING DIVISION
ENGINEERING DEPARTMENT
SALT LAKE CITY, UTAH

FLAMBEAU MINING CORP.
SOIL TEST BORING
LOCATIONS
SOLID WASTE DISPOSAL AREA
SECTION 21 GRANT TOWNSHIP
RUSK CO., WISCONSIN

MICROFILM | MMD JOB 506
MMD DRAWING BCM82-00-109 | REV.
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2. To provide stable dikes with an adequate factor of safety.

3. To locate the waste containment area in an area where its presence would not be obvious. To further remove it from the public eye, a screen of trees and shrubs is proposed around the perimeter.

4. To terrace the outer walls of the dikes so that they can be planted with trees and other native flora as the dike increases in height during the life of the operation.

5. To site it in an area which was not a unique ecological habitat, since destruction of existing ecological relationships within the confines of a waste containment area is complete.

Dikes

The requirement of stable and relatively impermeable dikes dictated the use of solid waste dikes with a clay core, and ruled out the traditional method of building dikes from the coarse fraction of tailings. The dike material and the clay for the core can be obtained from the open pit operation.

Figure 32 shows a section of the designed waste containment area dike and the estimated permeability of the soil materials used in its construction. The core (Soil 2) is a highly impervious saprolite obtained from the open pit.

A computer study of the stability of the dike section using the designed 1:1 upstream slope and a 3.4:1 downstream slope indicated the following factors of safety (Figure 33).

2.39 along the assumed failure surface AB

3.46 along the assumed failure surface CD

3.63 along the assumed failure surface EF

Since a factor of 1.5 is normally considered safe, the proposed dike's stability is adequate, especially when considered in conjunction with the high strength of the foundation soils at depth. Since the dike would be built in stages with high soil compaction, there would be consolidation of the soils which would also contribute to dike stability.

In sequence, the construction in the waste containment area would be:

1. The foundation preparation for the dike section would consist of stripping off all topsoil in excess of six inches and all peat in the low areas under the dike. The foundation soils for the dike are sandy or clayey silts.

   In the area commencing between borings ST21-35 and ST21-36 to the north to ST21-9, and then to between ST21-14 and ST21-15 in the east, permeable sands were found underneath the impervious silts. To reduce leakage through the foundation of the wall in this area, a cutoff trench would be excavated 13 to 15 feet deep and roughly ten feet wide. A similar cutoff trench would be excavated to a depth of six to nine feet between ST21-28 and ST21-29. The material excavated from these trenches would be placed within the waste containment area. The trenches would be backfilled with saprolite, compacted to at least 95 percent of the maximum dry density as determined by the Standard Proctor Test.

2. The larger trees and bushes would be cut from the designated waste area and the timber stockpiled for cutting into chips for use as a mulch. No grubbing or tree stumps or vegetation would be done so as to preserve the natural density and continuity of the upper layers of silts and clays.

3. The existing drainage ditch, which runs east-west through the center of the waste containment area would be cleaned of stones, trees and debris, and filled with compacted saprolite. A replacement drainage ditch would be established around the south side of the dike.

FIGURE 32

*SEEPAGE ANALYSIS:

AVE. LOSS THROUGH ELEMENT	1 = 0.05958	$\frac{ft^3}{day}$ / ft dam
" " " "	2 = 0.02890	
" " " "	3 = 0.00007	
" " " "	4 = 0.00006	
" " " "	5 = 0.00805	
" " " "	9 = 0.00833	
	TOTAL = 0.10499	$\frac{ft^3}{day}$ / ft dam
	= 0.78	$\frac{gal}{day}$ / ft dam
	= 9087 gal/day	
	= 6.3 gal/min	

* Derived from finite element model assuming 10 foot wide cutoff trench & 57 foot high impounded water level.

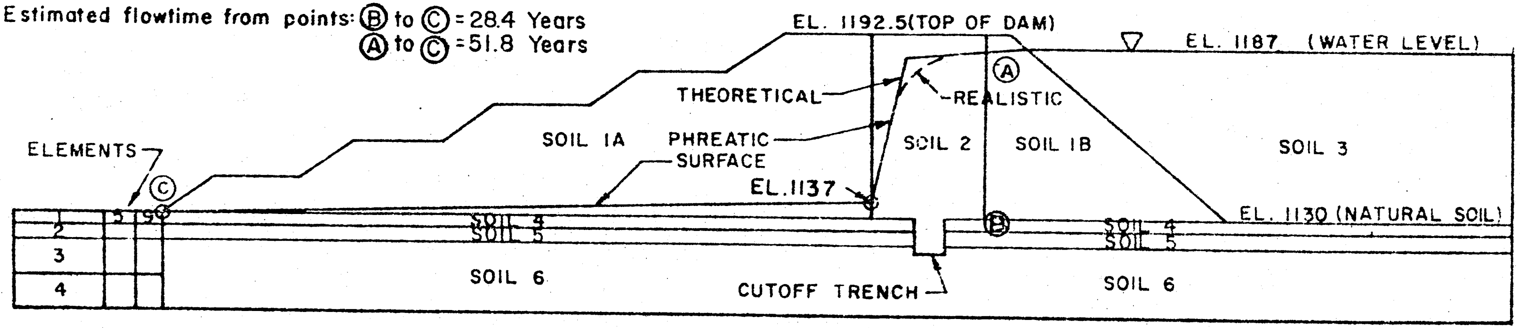
SOIL DATA

SOIL DATA	PERMEABILITY CM/SEC.
SOIL IA, SANDSTONE AND MINE ROCK w/o PYRITE	1×10^{-2}
" IB, WASTE MINE ROCK WITH PYRITE	1×10^{-2}
" 2, SAPROLITE (ML)	1.1×10^{-6}
" 3, TAILINGS	3.5×10^{-4}
" 4, SILT (ML)	1.0×10^{-6}
" 5, SAND MEDIUM DENSE (SM)	1.0×10^{-3}
" 6, SILTY SAND DENSE (SM)	1.0×10^{-6}

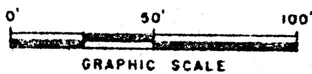
( ) Unified soil classification system

NOTE:

Estimated flowtime from points: B to C = 28.4 Years
A to C = 51.8 Years



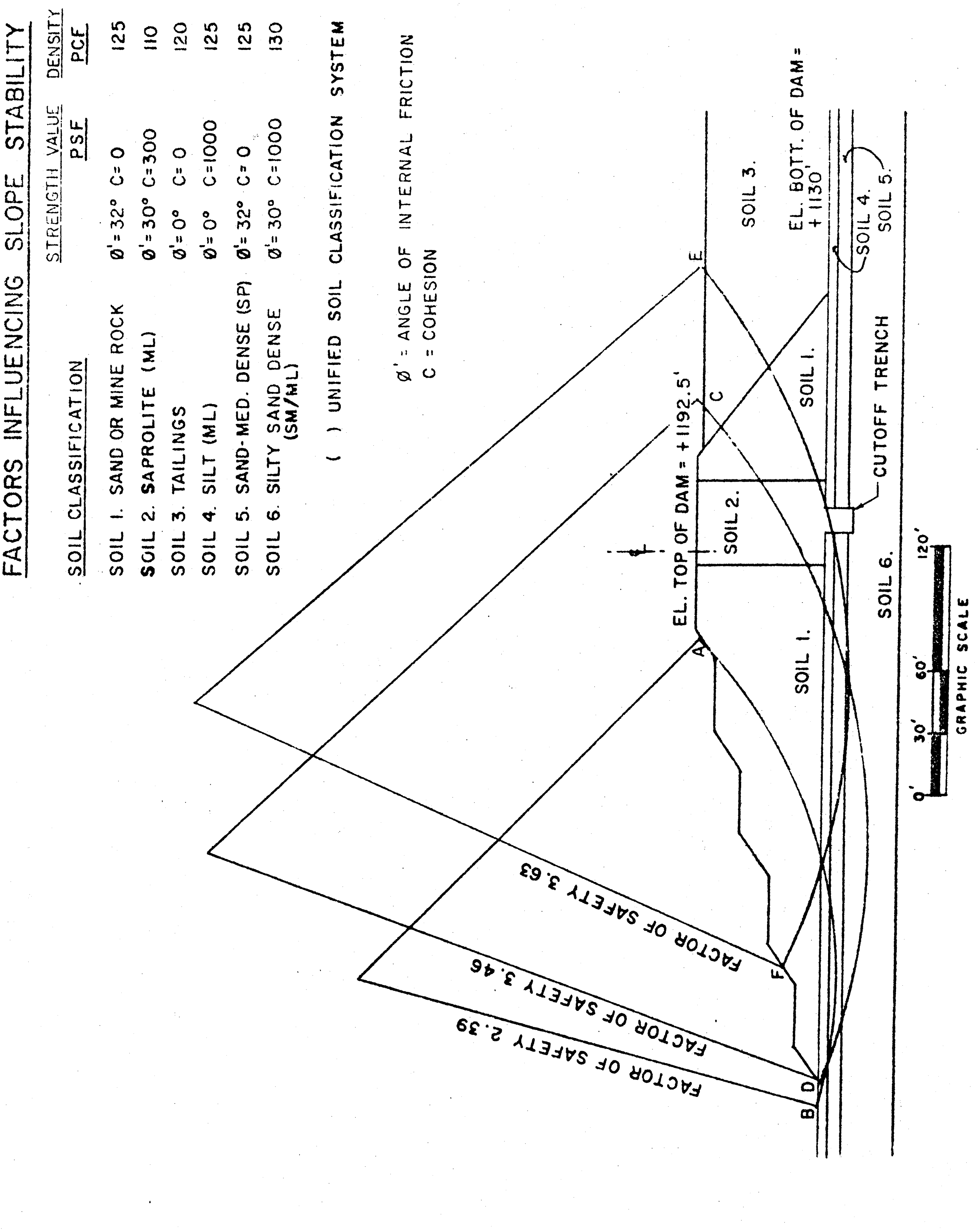
(DATA TAKEN FROM REPORT BY SOIL TESTING SERVICES OF WISCONSIN, INC., DATED SEPT. 27, 1973.)



KENNECOTT COPPER CORPORATION METAL MINING DIVISION ENGINEERING DEPARTMENT SALT LAKE CITY, UTAH	FLAMBEAU MINING CORP. SEEPAGE ANALYSIS PROPOSED WASTE CONTAINMENT AREA	MMD JOB 506 MMD DRAWING BCM82-00-210 DIV. DRAWING NO.

MAY, 1974

FIGURE 33



KENNECOTT COPPER CORPORATION METAL MINING DIVISION ENGINEERING DEPARTMENT SALT LAKE CITY, UTAH	FLAMBEAU MINING CORP. STABILITY ANALYSIS PROPOSED WASTE CONTAINMENT AREA	MICROFILM / MMD JOB 506 MMD DRAWING / REV. BCM82-00-116 DIV DRAWING NO.

MAY, 1974

4. There would be sufficient material from the prestripping of the open pit to construct all of the first lift of the waste containment dike to an elevation of 1,142.5 feet. The first lift of the dike would be 12½ feet high along the southern section and zero in the center portion of the northern section where it would conform to the existing ground contours. Referring to Figure 32, the core of the dike would be saprolite 40 feet wide. The inside would be sand or mine rock 90 to 100 feet wide at the base. The outside wall would be 240 feet wide at the base and would be made of sand or mine rock covered with glacial till material capable of supporting vegetation.

   Except for the outside facings of gravel and soil, all materials in the dike would be mechanically compacted with appropriate equipment in roughly 12 inch lifts. Compaction of the saprolite core would be carried to at least 95 percent of the maximum dry density of the material.

5. The decant tower would be roughly in the center of the area. Its outflow pipe to the water reclaim pipeline would be laid on the original ground surface.

6. To keep the tailings wet so that dust formation would be minimized, and to provide additional protection for the dikes, a ring feed would be installed on top of the first lift of the dike. A pipe carrying the tailings would be sited on top of the dikes around the waste containment area. The pulp would be delivered to the waste containment area via spigots spaced roughly 50 feet apart. With this method, the coarse fraction of the tailings settles rapidly and creates a slope from the dike to the center of the waste containment area. Thus, there would be little water against the dikes and a large pool of water in the center of the waste containment area. In addition to preventing dust formation, this technique allows time for the settling of the metal hydroxides and degradation of the reagents used in the concentrator. During freezing weather, the pulp would have to be delivered to the waste containment area through a single pipe because a ring feed system would freeze.

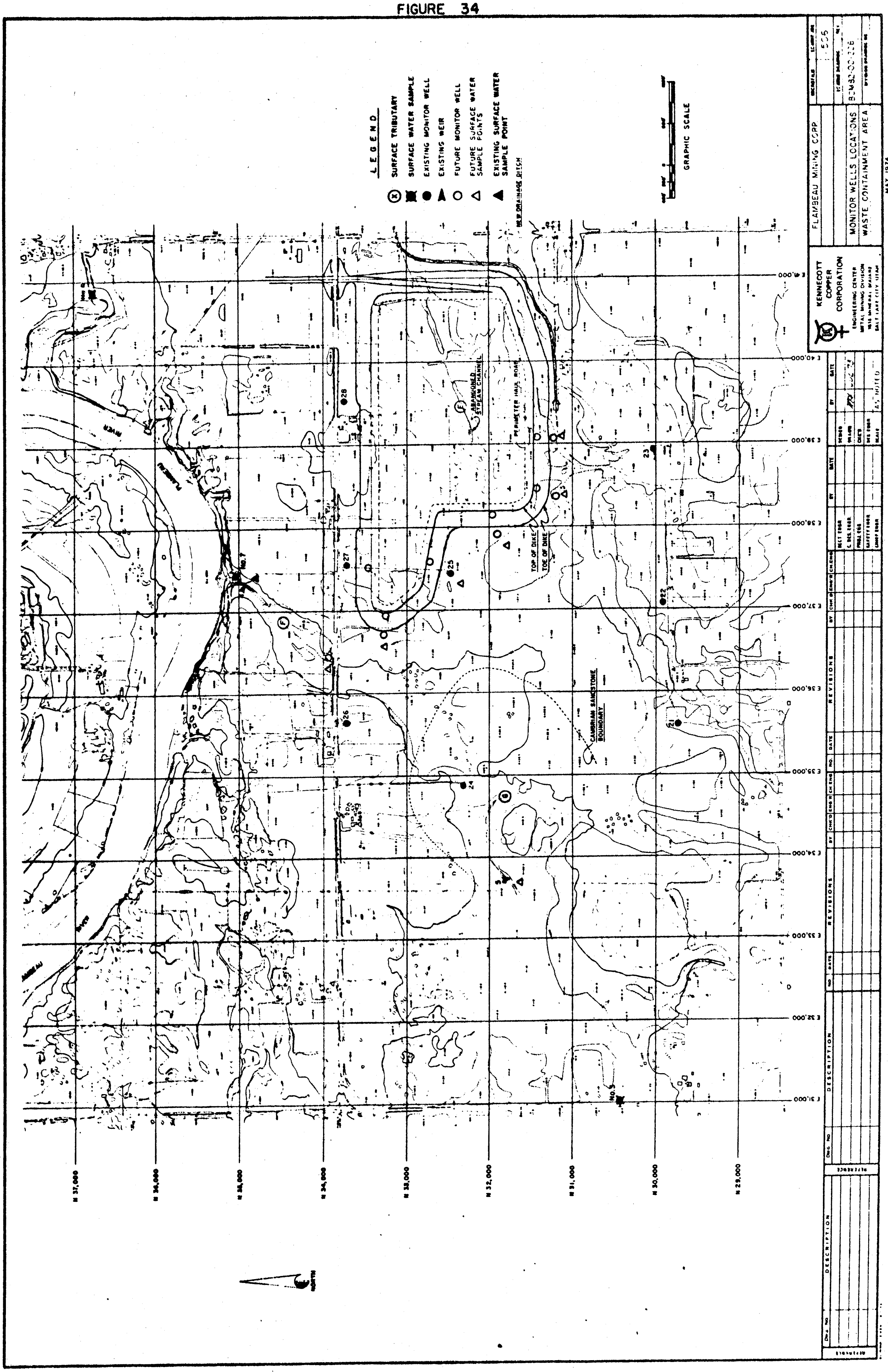
7. Eight monitor wells to detect seepage have been installed and an additional eleven monitor wells and seven surface water sample sites are planned to provide warning of any deterioration of groundwater quality (Figure 34).

Haul Road

The haul road design criteria were that the road was to be an all-season road for 90-ton gross load trucks with minimum maintenance throughout the year and with no paved surface. The location of the haul road is shown in Figures 29 and 30. The haul road would be constructed over subgrade soils that are susceptible to severe frost action, i.e., silty fine sands, silts and clayey silts with a groundwater table in some areas at three to five-foot depth. Because of these conditions, cuts would be minimized with most of the roadway being built on fill. The final design of the haul road is based on limiting frost penetration into the subgrade. This requires a total subbase thickness of 54 inches of nonfrost susceptible sands. To obtain the specifications required for the different layers of subbase material from prestripping material, it may be necessary to use a temporary washing and screening plant.

The prestripping material would be required in a certain sequence for road building, i.e., silty fine sand for subgrade and fill for the haul road, followed by clean sand for the lower subbase, and then gravelly sand for the middle subbase. This would necessitate a certain amount of stockpiling within the pit limits to provide a buffer between the mining of the material and its usage on the road. The silty fine sand found near the surface within the open pit would be used as fill. Over the subgrade there would be a lower subbase consisting of 24 inches of selected clean coarse sand, i.e., containing less than 12 percent passing a No. 200 sieve. The next subbase would be 18 inches of gravelly sand. The surface 12 inches of crushed gravel would be purchased. Treatment of the road surface, probably water sprayed from a truck, would minimize dust formation.

FIGURE 34


LEGEND
SURFACE TRIBUTARY
SURFACE WATER SAMPLE
EXISTING MONITOR WELL
EXISTING WEIR
FUTURE MONITOR WELL
FUTURE SURFACE WATER SAMPLE POINTS
EXISTING SURFACE WATER SAMPLE POINT
GRAPHIC SCALE
PERIMETER HAUL ROAD
ABANDONED STREAM CHANNEL
TOP OF DIKE
TOE OF DIKE
CAMBRIAN SANDSTONE BOUNDARY
FLAMBEAU MINING CORP
MONITOR WELLS LOCATIONS
WASTE CONTAINMENT AREA
KENNECOTT COPPER CORPORATION
MAY, 1974

Compaction of all subbase and base course materials would be at least 98 percent of the maximum dry density. In areas where fill sections are greater than 54 inches, the fill would be compacted to at least 95 percent of the maximum dry density.

Safety considerations dictate a 55-foot road width for all-weather, two-way traffic in connection with off-highway haul trucks having a gross load of 90 tons. An additional five feet in width is required for a ditch to contain tailings in the event of a pipe break. The tailings pipeline and reclaim water pipeline would be in the ditch. The road would be crowned to promote adequate surface runoff. With the shoulders, the total width required at the subgrade would be 73 feet, 6 inches (Appendix K).

Culverts

A culvert would be required to enable crossing over an intermittent stream between the process plant and Meadowbrook Creek. This would be a 48-inch corrugated steel pipe or a concrete culvert. A larger box culvert would be required for the crossing of Meadowbrook Creek, and this would be constructed of reinforced concrete (Figure 35). During the construction of the culverts, the streams would be diverted through gravel-lined channels.

County "P" Overpass

The design of the bridge crossing County Highway 'P' is subject to approval by the Rusk County Highway Department. The intent is to elevate County 'P' over the haul road at their intersection 500 feet west of State Highway '27'. Figure 36 shows a design based on the Hatfield Bridge in Jackson County.

As soon as portions of the haul road are complete, the banks would be covered with a layer of till mulched with wood chips or straw, fertilized and planted with native vegetation. Dust formation due to loading and hauling would be suppressed by the use of water sprayed from a water truck.

Tailings Pipe

The tailings and reclaim water pipelines would be laid along the east shoulder of the haul road, i.e., away from the river. Provision would be made at the intermittent stream and at Meadowbrook Creek for catchment basins to temporarily store tailings in the event of a tailings pipeline break. The basins are designed to hold 2 million gallons or the equivalent of 56 hours of tailings flow. Tailings held in these basins would be pumped back into the pipeline upon resumption of operations. Possible pipeline materials include 8 inch, 100 psi rating, Driscopipe 7600 Industrial Polyethylene pipe.

Railroad Spur

A railroad spur, approximately 5,400 feet long, would be constructed from the Soo mainline west into the plant area. The spur would cross a gravel township road and State Highway "27" at right angles. Appropriate highway safety indicators would be erected at each crossing in accordance with the rules of the Wisconsin Division of Highways.

Route selection was made for the shortest distance between the mainline and the plant with minimal cut and fill. Where cut and fill is necessary the banks would be mulched and reseeded with native vegetation. Culverts would be installed to reduce blockage of drainageways and to eliminate ponding on the uphill side of the spur line.

Sewage Disposal

A sewage disposal system would be constructed to handle a peak load of 100 gpm required for a short period of time (15 minutes) at the end of each shift. This system would probably be an onsite sewage disposal facility (septic tank and drainfield). Plant site soil characteristics would determine the final design and location of the sanitary system. Design of any disposal system would have to be in accordance with local and state codes. After the system is installed, the site would be revegetated.

Electricity

Electric power takeoff would be from the existing Lake Superior District Power Company 33KV line which follows the railway line. A 100-foot right-of-way, 50 feet each side of the line, would be required. Lobbing of tree branches may be required, as well as removal of some trees.

Industrial Water

A system of collection ditches and sumps would be constructed within the open pit area to collect groundwater inflow and precipitation into the pit. During pit construction, silt-rich waters from the pit would be collected by this system and pumped to settling ponds in the abandoned

FIGURE 35

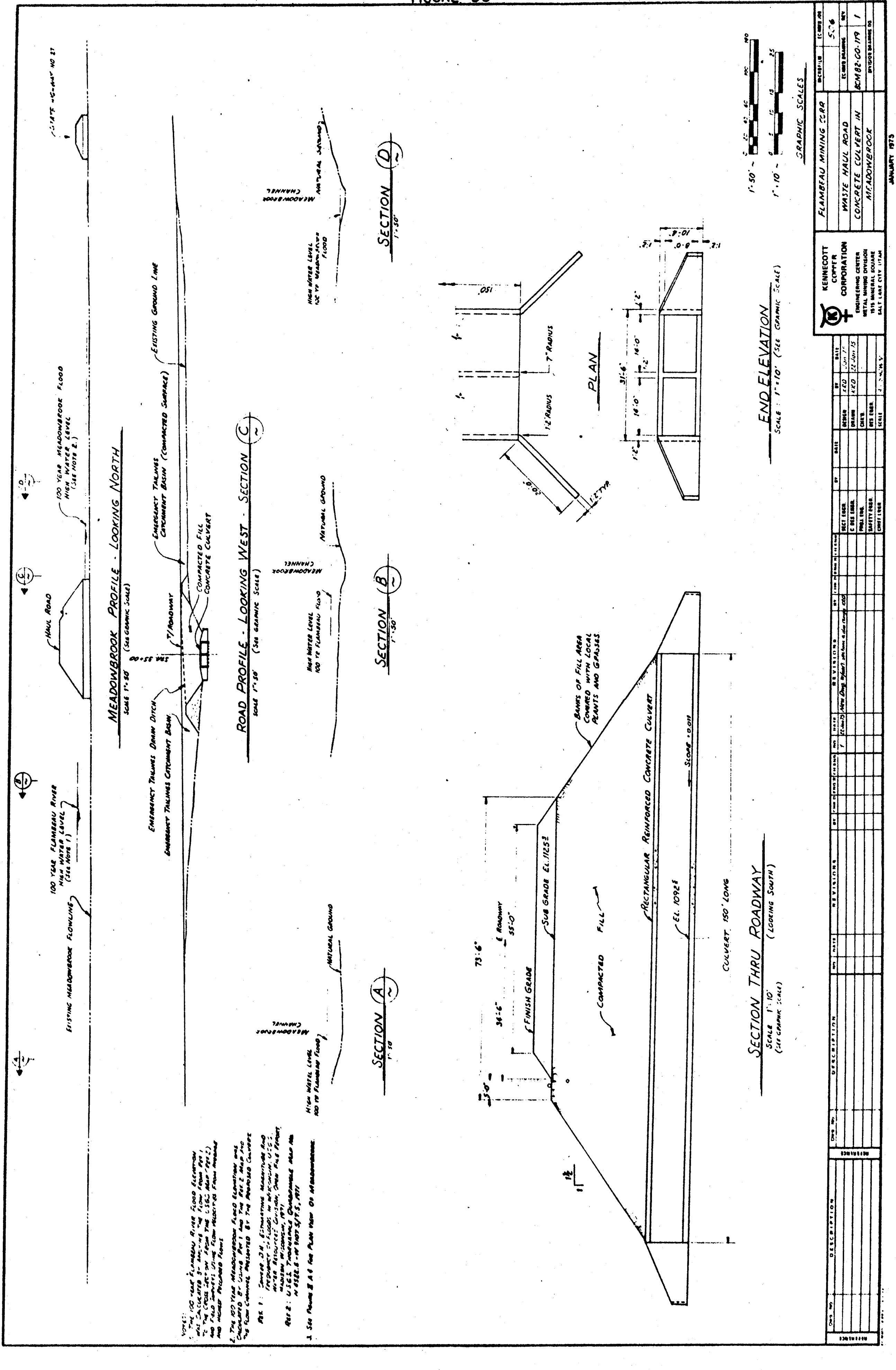
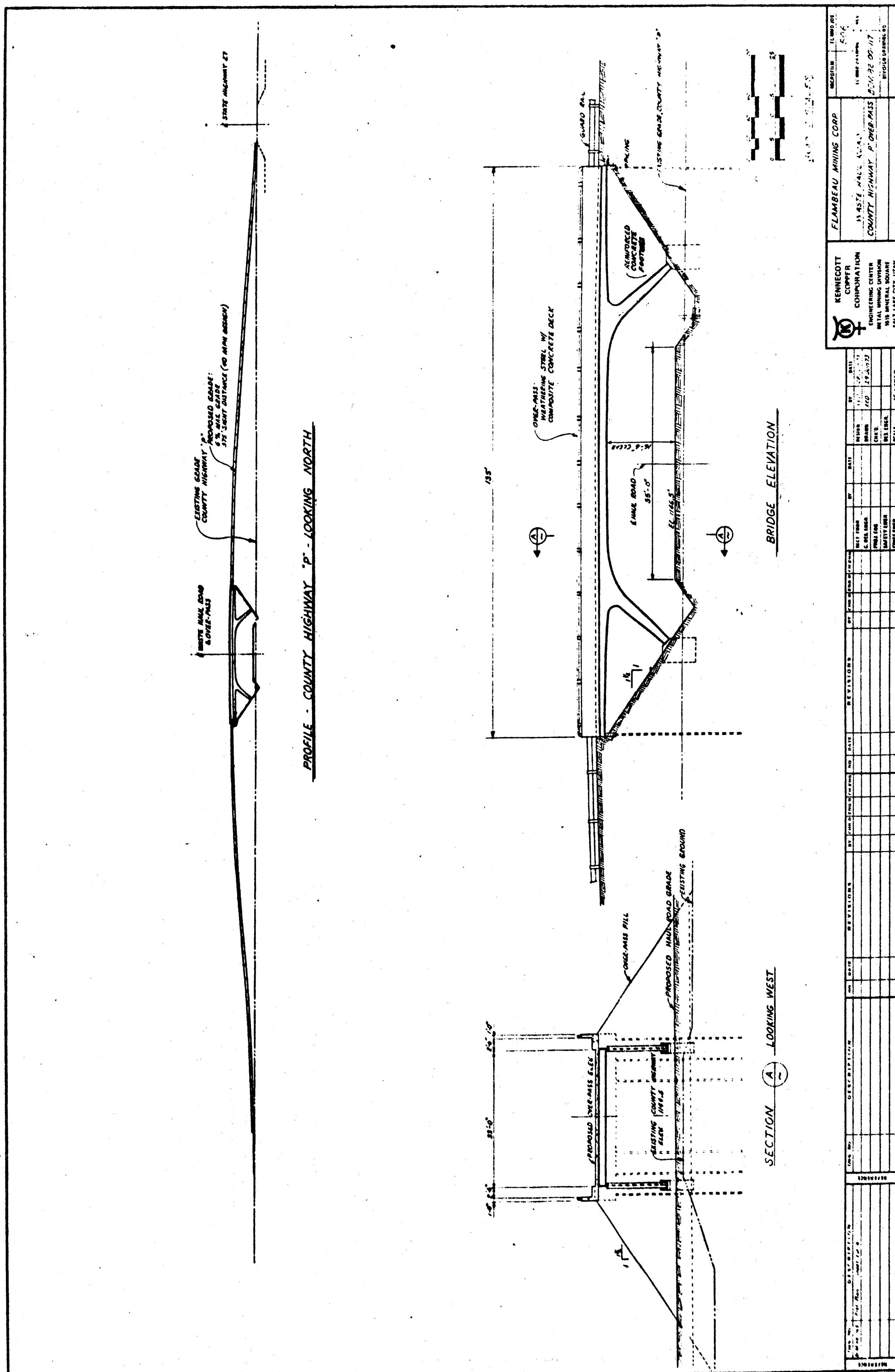

MEADOWBROOK PROFILE · LOOKING NORTH
SCALE 1"=50' (SEE GRAPHIC SCALE)
ROAD PROFILE · LOOKING WEST · SECTION C
SCALE 1"=50' (SEE GRAPHIC SCALE)
SECTION A
SECTION B
SECTION C
SECTION D
HAUL ROAD
STATE HIGHWAY NO 27
EXISTING GROUND LINE
EXISTING MEADOWBROOK FLOWLINE
100 YEAR FLAMBEAU RIVER HIGH WATER LEVEL (SEE NOTE 1)
100 YEAR MEADOWBROOK FLOOD HIGH WATER LEVEL (SEE NOTE 2)
EMERGENCY TAILINGS DRAIN DITCH
EMERGENCY TAILINGS CATCHMENT BASIN
EMERGENCY TAILINGS CATCHMENT BASIN (COMPACTED SURFACE)
COMPACTED FILL
CONCRETE CULVERT
MEADOWBROOK CHANNEL
NATURAL GROUND
PLAN
7' RADIUS
12' RADIUS
END ELEVATION
SCALE 1"=10' (SEE GRAPHIC SCALE)
14'-0"
31'-6"
SECTION THRU ROADWAY
(LOOKING SOUTH)
SCALE 1"=10' (SEE GRAPHIC SCALE)
FINISH GRADE
SUB GRADE EL. 1125±
COMPACTED FILL
RECTANGULAR REINFORCED CONCRETE CULVERT
EL. 1092±
CULVERT 150' LONG
SLOPE = 0.011
BANKS OF FILL AREA COVERED WITH LOCAL PLANTS AND GRASSES
73'-6"
38'-6"
55'-0"
GRAPHIC SCALES
1"=50'
1"=10'
KENNECOTT COPPER CORPORATION
ENGINEERING CENTER
METAL MINING DIVISION
SALT LAKE CITY, UTAH
FLAMBEAU MINING CORP
WASTE HAUL ROAD
CONCRETE CULVERT IN
MEADOWBROOK
JANUARY 1975
BCM 82-CO-119

FIGURE 36


PROFILE - COUNTY HIGHWAY 'P' - LOOKING NORTH
STATE HIGHWAY 27
WASTE HAUL ROAD & OVER-PASS
EXISTING GRADE COUNTY HIGHWAY 'P'
PROPOSED GRADE: 6% MAX. GRADE 575' SIGHT DISTANCE (40 MPH DESIGN)
BRIDGE ELEVATION
GUARD RAIL
PILING
EXISTING GRADE, COUNTY HIGHWAY 'P'
REINFORCED CONCRETE FOOTING
OVER-PASS: WEATHERING STEEL W/ COMPOSITE CONCRETE DECK
135'
16'-6" CLEAR
WASTE HAUL ROAD
35'-0"
EL 1166.5'
SECTION A LOOKING WEST
OVER-PASS FILL
PROPOSED HAUL ROAD GRADE
EXISTING GROUND
PROPOSED OVER-PASS ELEV.
EXISTING COUNTY HIGHWAY ELEV. 1169.5
35'-0"
KENNECOTT COPPER CORPORATION
ENGINEERING CENTER
METAL MINING DIVISION
1515 MINERAL SQUARE
SALT LAKE CITY UTAH
FLAMBEAU MINING CORP.
WASTE HAUL ROAD
COUNTY HIGHWAY 'P' OVER-PASS
MAY, 1974
AS NOTED

gravel pit nearby and allowed to seep into the groundwater. After completion of construction, approximately 223 gpm would be diverted from this system via pipe to the waste containment area for industrial make-up waters. It is anticipated that all of the industrial water requirements could be obtained from groundwater inflow into the pit plus precipitation into the pit and waste containment area. Should it be found that an outside source of water is required, a supply would be obtained from high capacity wells constructed in the vicinity of the gravel pit.

During the startup and shutdown phases of the operation it would be necessary to use water from the Flambeau River to supplement existing flows. A detailed water budget for the entire operation is given in Appendix L.

Potable Water

A domestic low capacity well would be constructed on the project site for potable water consumption in the changehouse, offices, laboratory, etc. Construction of a water storage tank near the process plant would ensure sufficient pressure and capacity. The potable water supply required is estimated to be 2 gpm.

Mining Phase

Open Pit Mine

The envisioned open pit mining method is conventional for an operation of this size (Figure 37). Technical details, i.e., bench height, berm width, hole size, spacing, and explosive charges, could change in practice as additional information on the nature of the rock is developed. An overall slope angle of 35 degrees would be maintained unless rock mechanic studies indicate a change. Bench height would be 35 feet. To break the required tonnage of ore and waste on a five-day mining, seven-day milling work basis, forty 6-3/4-inch blast holes per week would be required. These would be drilled by a mobile rotary blast hole drill. The cuttings from the hole being drilled would be flushed out by compressed air.

Blasting

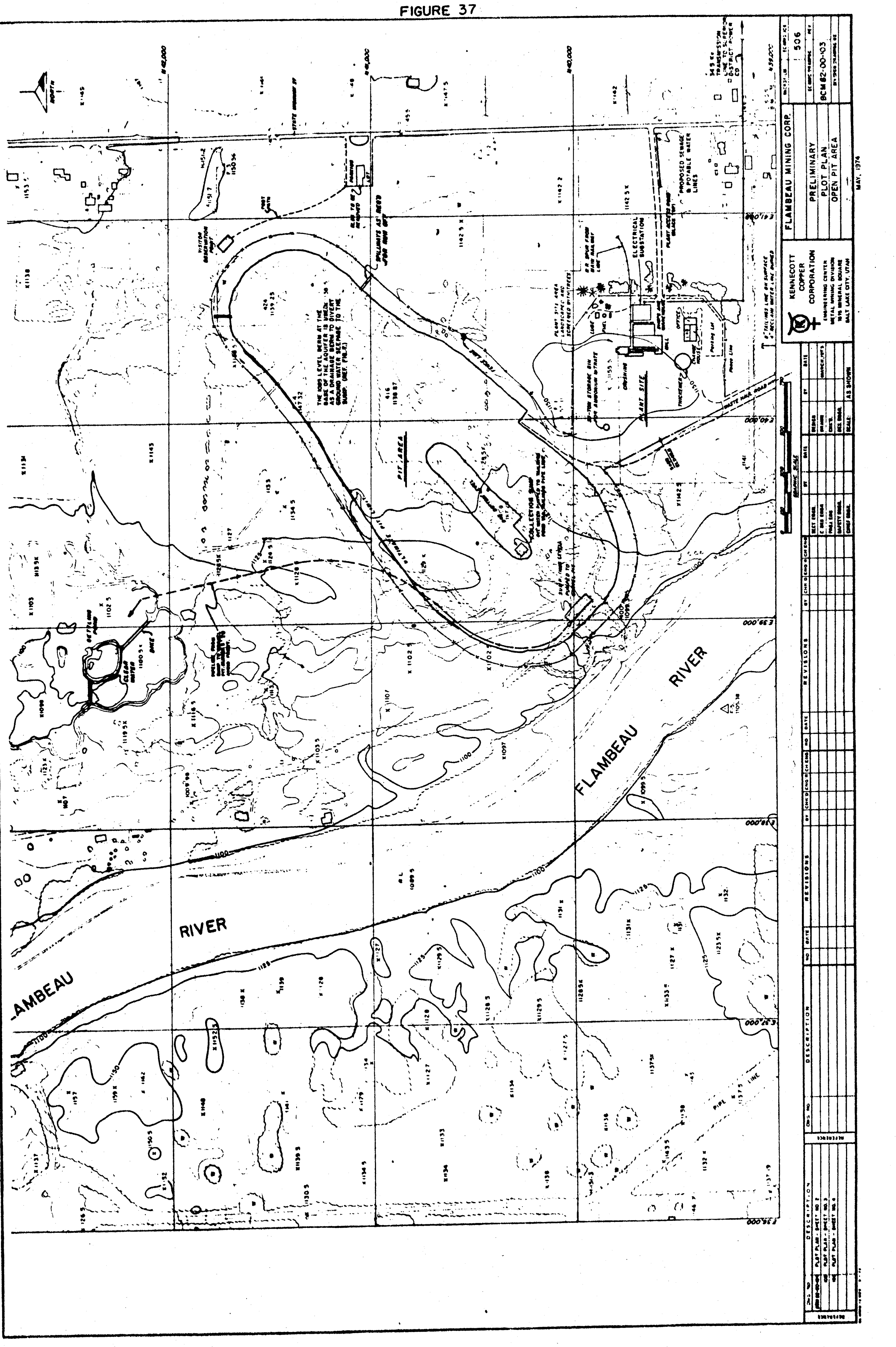
Ammonium nitrate for blasting would be loaded into a bulk transport truck of 1½-ton capacity provided with a unit for adding and mixing the required amount of fuel oil immediately prior to pumping the mixture into the hole. In the event of a wet hole, a plastic bag liner would be used to contain the ammonium nitratefuel oil explosive or else a moistureproof explosive would be used. Each hole would be loaded with roughly 300 pounds of explosives which would fill onehalf of the hole. The rest of the hole would be filled with fine rock arising from the drilling operation. To minimize the noise impact, ground vibration, and air impact, millisecond delays would be used such that the holes are exploded in sequence. The amount of explosive used is estimated as six tons per five-day week. In summer months, blasting would normally take place once per week. In the winter under freezing conditions, more frequent small blasts would be used to avoid freezing of broken open pit material.

Traffic Stoppage

Because of the proximity of the open pit to State Highway 27 and the possible danger from an occasional flying rock, it would be necessary to stop traffic for a period of roughly five minutes during the blast. Permission for this action must be obtained from the Wisconsin Department of Transportation. Based on experience at other open pit operations, the noise level from such a blast is predicted to be below the legal limits at the nearest inhabited building which would be the crusher building of the concentrator 1,000 feet from the center of the open pit and 520 feet from the pit limits. Based on the considerable amount of test work reported by the Bureau of Mines and explosives manufacturers, the ground vibration level at the crusher building from the detonation of a 300-pound charge per hole is estimated to be 1.7 in./sec., which is less than the safe vibration level of two inches per second. On the same basis, the air blast at the crusher building is estimated to be less than the safe level of one pound per square inch. Blasting would produce fugitive dust and noxious fumes, including nitrous oxides. The fumes are normally rapidly dissipated in the atmosphere. There is no known practical method for capturing the fumes.

The waste rock would be loaded into 50-ton haulage trucks for transport to the waste containment area where it would be used for building dikes. The ore would also be loaded into 50-ton haulage trucks for delivery to the primary jaw crusher. During dry periods, the haulage roads would be sprinkled by a water truck to suppress dust.

FIGURE 37


FLAMBEAU RIVER
RIVER
FLAMBEAU MINING CORP.
PRELIMINARY
PLOT PLAN
OPEN PIT AREA
KENNECOTT
COPPER
CORPORATION
MAY, 1974
PIT AREA
PLANT SITE
ELECTRICAL SUBSTATION
AS SHOWN

The noise produced by a moving 50-ton truck is estimated as between 86 and 88 dBA. The Caterpillar Tractor Company has established the noise levels of its type 773 50-ton off-highway truck equipped with Caterpillar's 600 hp engine as follows:

Stationary test	Distance (in front of truck) Noise level	50 feet 87.5 dBA
Moving test	In second range, direct drive at 1,900 rpm	Left side 86.5 dBA

There are no legal limits for off-highway truck noise, but this is lower than the EPA standards for highway motor carriers over five tons.

Underground Mining

The feasibility of extending the life of the mine by converting to an underground operation at the end of the open pit life would be reevaluated after several years of open pit operation. Should steeper than planned pit slopes be feasible, the economical depth of the open pit would be greater, thus reducing the amount of ore remaining for underground mining. In this event, the proposed vertical shafts could be uneconomical compared with providing access to the remaining ore from the open pit bottom. Should the open pit bottom at 285 feet below the surface as presently anticipated, access to the underground orebody would be by means of a two-compartment, production shaft sunk to a depth of 830 feet in the footwall of the orebody. This shaft would ultimately be equipped with a combined man-cage and haulage skip in one compartment, and a ladderway, utilities, and a counter-weight in the other. Shaft stations would be cut at about 200-foot intervals below the pit bottom, and cross cuts would be developed from these to the ore. A main station with pumping and ore-handling facilities would be constructed on the 400-foot level which would serve as the main haulage level for the mine. Stoping would commence on the 400-foot level.

To bring the underground mine to the production stage, the following items would also be required:

1. Excavation of a vertical ventilation shaft, about 50 square feet in cross section, that would intersect the ventilation raises; and the installation of a 50,000 cubic foot per minute fan.

2. Construction of ventilation and service raises in ore between levels at the extremities of the orebody. These would serve as upcast airways and would be equipped with pipes to handle the fill to be emplaced in the worked out stopes.

3. Construction of an ore pass and parallel service raise in the ore between the levels at the end of the production shaft cross cuts.

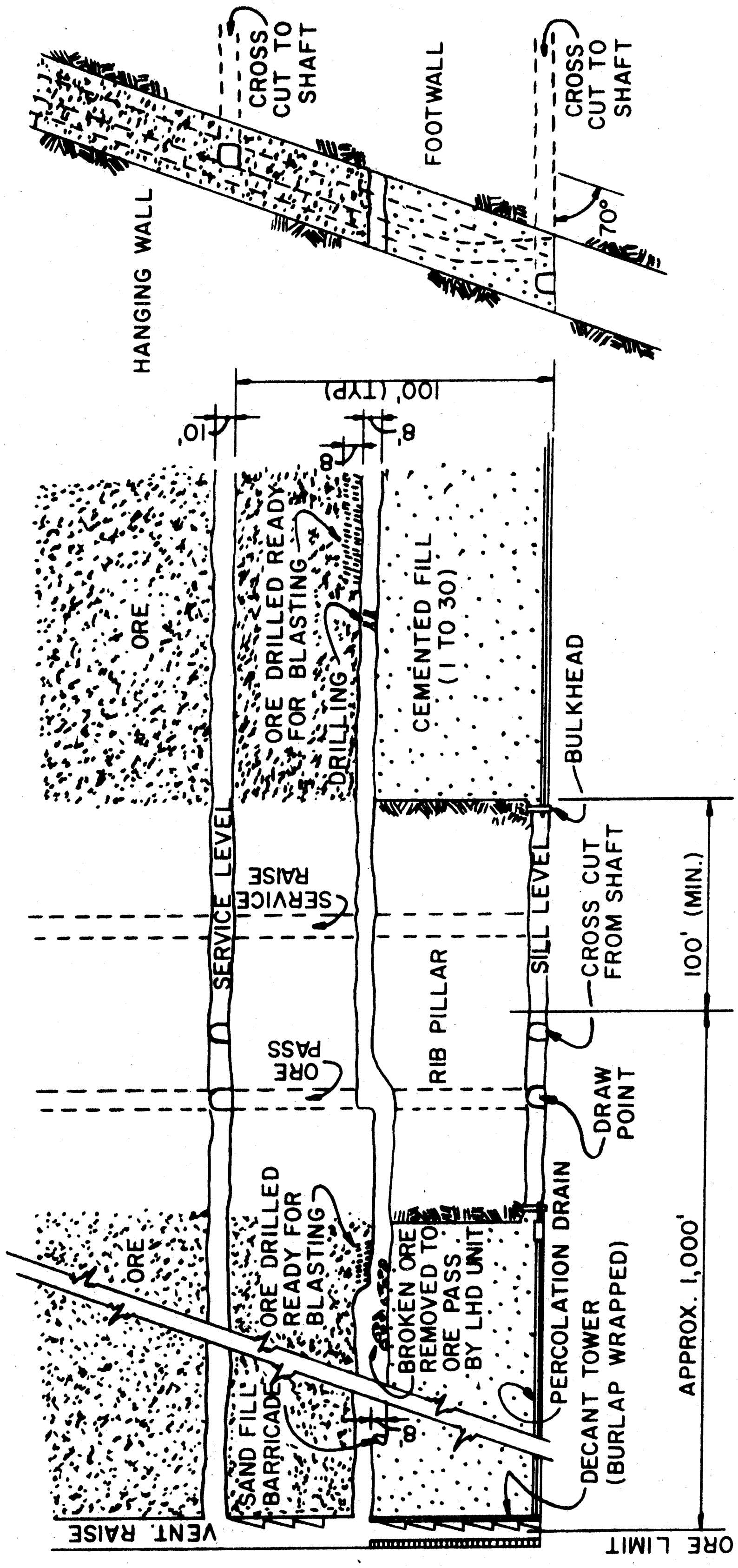
4. Installation of slusher trenches on the 400-foot level and loading pockets with spillage-handling arrangements below that level.

5. The erection of a gravel-washing plant to produce backfill.

Because of the absolute need for minimizing surface subsidence and the incompetence of the hanging wall, cut-and-fill would be used as the stoping method (Figure 38). The orebody is continuous on strike and has a comparatively short strike length of ± 1,200 feet on either side of the shaft system. Accordingly, it would be possible to consider the whole orebody below the pit as one stope.

The coarse fraction from the tailings contains up to 50 percent pyrite and would be unsuitable for fill due to fire hazards. Therefore, gravel for the fill would come from a new 30-acre pit south of the former Rusk County gravel pit located near the mine. This material would be crushed or screened to ½-inch and mixed with cement to provide a 1 to 30 cement to gravel ratio. The discard from the screening plant, amounting to 740,000 tons, would be pumped to the waste containment area. As mining progresses, the cement-rich fill would be pumped from the surface into the mined-out stopes at 70 percent solids to prevent excessive subsidence of the surrounding ground. Water draining from the fill would be pumped to the surface and into the tailings pipeline. Surface diamond drill holes have indicated that the underground mine would have comparatively

FIGURE 38



KENNECOTT COPPER CORPORATION METAL MINING DIVISION ENGINEERING DEPARTMENT SALT LAKE CITY, UTAH	FLAMBEAU MINING CORP. MECHANIZED CUT & FILL STOPING DETAILS	MICROFILM	MMD JOB 506
		MMD DRAWING BCM82-00-121	REV.
		DIV. DRAWING NO.	

MAY, 1974

minor water problems. Water from the fill operation would amount to roughly 30 gpm. Provisions would be made for a 200 gpm continuous pumping system and a 100 gpm standby system.

The underground work schedule would be three shifts per day, five days per week, with a mine production rate of 1,400 tons per day. The total number of employees on the property during this phase is estimated to be 143. The underground mining operation would prolong the overall life of the venture by about eleven years.

Concentrator

The main process at the plant site is concentrating. The flow of material in the concentrator is shown in Figure 39. In the case of the open pit operation, ore would be delivered to the concentrator by 50-ton rear-dump trucks during the day shift five days per week. In the case of underground mining, ore would be brought by truck from the headframe ore pocket to the concentrator.

Crusher

A stockpile would be established adjacent to the concentrator so that the crusher could be fed by a front-end loader over the weekend when the mine would not be operating. The ore would be dumped into a 60-ton live capacity pocket from which it would be drawn by an apron feeder and delivered to a jaw crusher.

The crusher product would drop onto a belt conveyor which discharges to a vibrating screen with a 3/4-inch slotted lower deck. Screen undersize would drop to a belt conveyor. Screen oversize would be fed to a cone crusher set at ½-inch which discharges to the same conveyor as the screen undersize. The combined 3/4-inch product would be conveyed to an 800-ton live capacity fine ore bin which would be located inside the concentrator building to minimize the problem of frozen ore in winter.

Fine ore would be drawn from the bin by a variable-speed slot belt feeder and would be fed to an eight-foot diameter by twelve-foot long rod mill for grinding. The process of crushing through to feeding the fine ore to the rod mill is dry and consequently, dust-forming. Dust would be removed by means of hoods under suction (Figure 40).

Two separate dust collecting systems are anticipated. One would operate on the crushing system through to the fine bin and would function only when the crusher system is in operation - normally one shift per day. The other system would operate on a feed from the fine ore bin to the rod mill - three shifts per day, seven days per week.

Grinding

Based on a yearly average production rate, 492 gpm of industrial water would be added to the fine ore feed to the rod mill. Roughly 419 gpm or 85 percent of this amount would be recycled water. The coarsely-ground ore slurry from the rod mill would be discharged to a sump from which it would be pumped to a bank of cyclone classifiers. The finely-ground slurry fraction from the classifier overflow would go to the flotation circuit. The coarsely-ground slurry fraction from the classifier underflow would be fed to a ball mill for further grinding. The ball mill discharge would be recirculated to the sump serving the cyclones. To the rod mill and the ball mill feed, a total of 5,000 pounds per day of slaked lime would be added to give an alkaline (ph 11) pulp in the flotation circuit.

Flotation

The ore slurry at 25 percent solids would be delivered to a bank of mechanical rougher flotation cells. At this point, approximately 150 pounds per day of promotor (typically Aerofloat 238) and 120 pounds per day of a frother (typically 25 percent cresylic acid, 75 percent methyl amyl alcohol) would be added. By aeration and the addition of these chemical reagents, the copper sulfide mineral grains are physically separated from the ore pulp in a froth. The copper sulfide-rich froth, called rougher concentrate, would be continually removed from the top of the flotation cells. The impoverished pulp from the rougher cells constitutes the plant tailings and would be pumped to the waste containment area. The rougher concentrate would be cleaned in a bank of cleaner cells and recleaner cells to produce the final mill concentrate and a cleaner tailings which would be returned to the head of the rougher flotation cells for recycling.

FIGURE 39

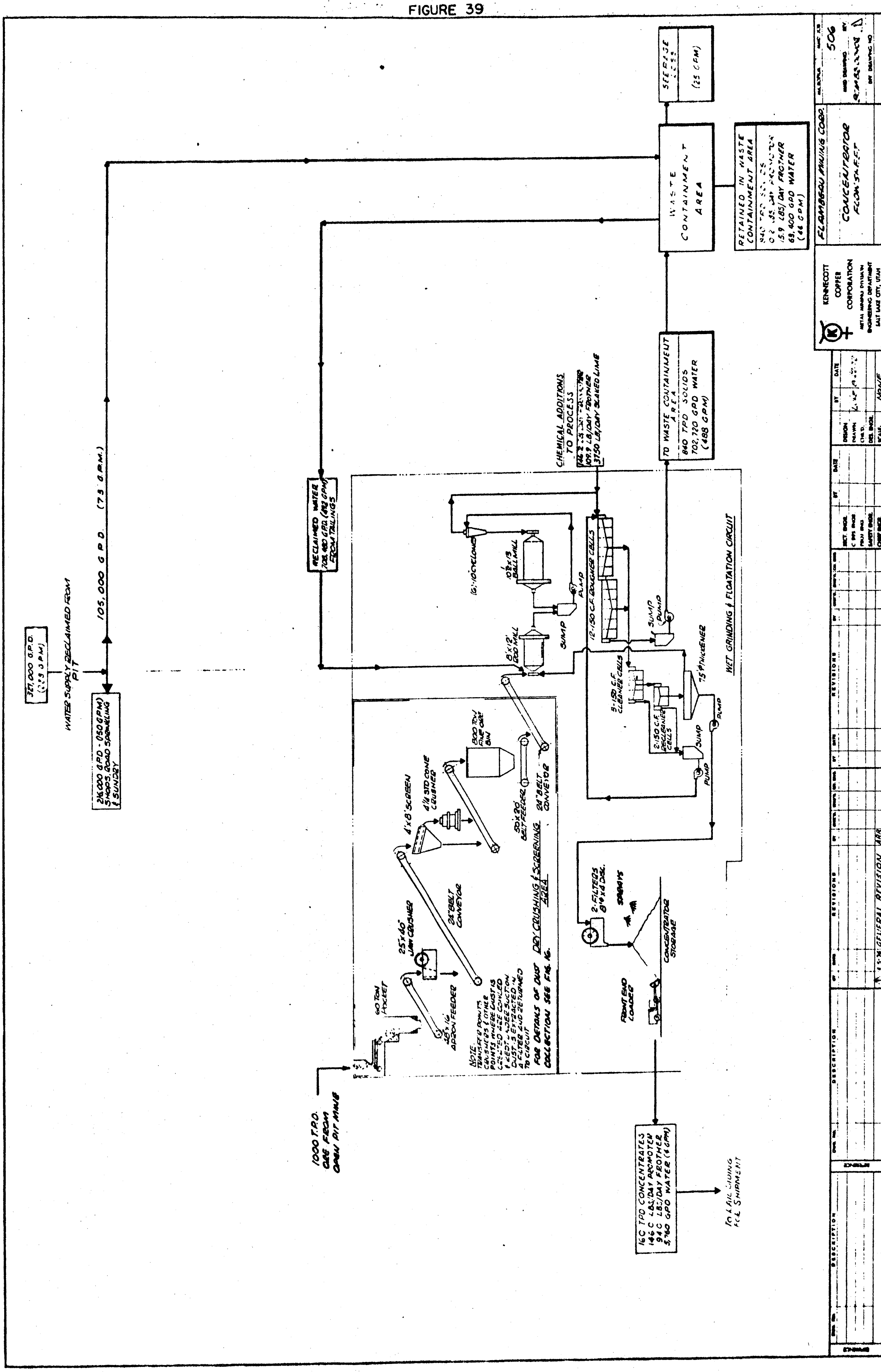
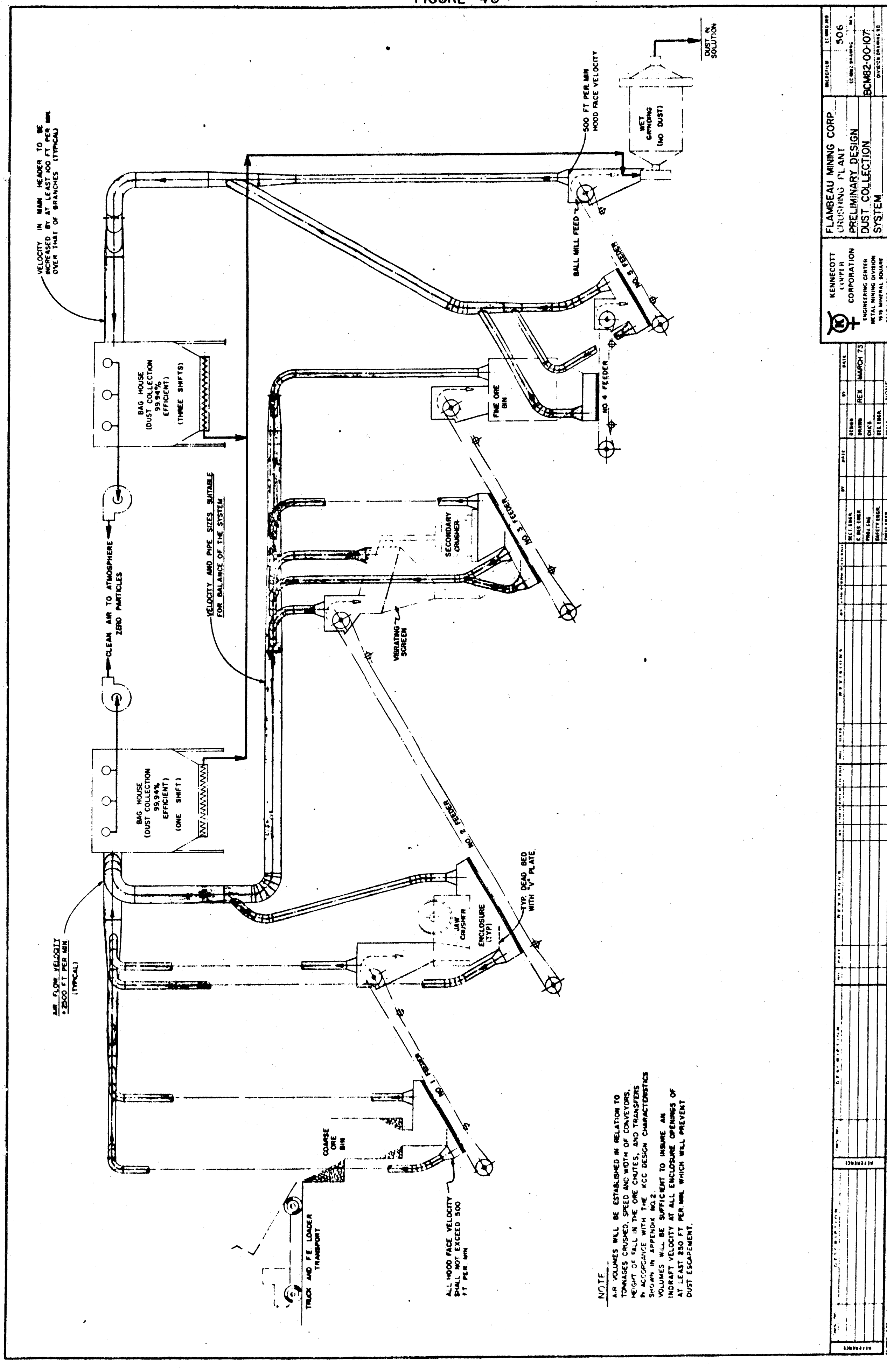

FLAMBEAU MINING CORP.
CONCENTRATOR FLOWSHEET
KENNECOTT COPPER CORPORATION
METAL MINING DIVISION
ENGINEERING DEPARTMENT
SALT LAKE CITY, UTAH
MAY, 1974
SEEPAGE LOSS
(25 GPM)
WASTE CONTAINMENT AREA
RETAINED IN WASTE CONTAINMENT AREA
15.9 LBS/DAY FROTHER
63,400 GPD WATER
(44 GPM)
TO WASTE CONTAINMENT AREA
840 TPD SOLIDS
702,720 GPD WATER
(488 GPM)
CHEMICAL ADDITIONS TO PROCESS
109.9 LB/DAY FROTHER
3750 LB/DAY SLAKED LIME
RECLAIMED WATER
708,480 GPD (492 GPM)
FROM TAILINGS
105,000 G.P.D. (73 G.P.M.)
WATER SUPPLY RECLAIMED FROM PIT
216,000 GPD - 150 GPM
SHOPS, ROAD SPRINKLING & SUNDRY
WET GRINDING & FLOATATION CIRCUIT
12-150 C.F. ROUGHER CELLS
BALL MILL
ROD MILL
SUMP
PUMP
75' Ø THICKENER
9-150 C.F. CLEANER CELLS
2-150 C.F. RECLEANER CELLS
2-FILTERS
SPRAYS
CONCENTRATOR STORAGE
FRONT END LOADER
DRY CRUSHING & SCREENING AREA
800 TON FINE ORE BIN
24" BELT CONVEYOR
BELT FEEDER
4'x8' SCREEN
4 1/4 STD CONE CRUSHER
25"x40" JAW CRUSHER
APRON FEEDER
60 TON POCKET
NOTE: TRANSFER POINTS, CRUSHERS & OTHER POINTS WHERE DUST IS CREATED ARE CONTROLLED & KEPT UNDER SUCTION. DUST IS EXTRACTED IN A FILTER AND RETURNED TO CIRCUIT
FOR DETAILS OF DUST COLLECTION SEE FIG. 16.
1000 T.P.D. ORE FROM OPEN PIT MINE
TO RAIL SIDING FOR SHIPMENT

FIGURE 40


VELOCITY IN MAIN HEADER TO BE INCREASED BY AT LEAST 100 FT PER MIN OVER THAT OF BRANCHES (TYPICAL)
500 FT PER MIN HOOD FACE VELOCITY
DUST IN SOLUTION
WET GRINDING (NO DUST)
BALL MILL FEED
NO 5 FEEDER
NO 4 FEEDER
FINE ORE BIN
BAG HOUSE (DUST COLLECTION 99.94% EFFICIENT) (THREE SHIFTS)
CLEAN AIR TO ATMOSPHERE ZERO PARTICLES
VELOCITY AND PIPE SIZES SUITABLE FOR BALANCE OF THE SYSTEM
SECONDARY CRUSHER
NO 3 FEEDER
VIBRATING SCREEN
BAG HOUSE (DUST COLLECTION 99.94% EFFICIENT) (ONE SHIFT)
NO. 2 FEEDER
TYP. DEAD BED WITH "V" PLATE
JAW CRUSHER
ENCLOSURE (TYP)
AIR FLOW VELOCITY +2500 FT PER MIN (TYPICAL)
NO 1 FEEDER
COARSE ORE BIN
TRUCK AND F.E. LOADER TRANSPORT
ALL HOOD FACE VELOCITY SHALL NOT EXCEED 500 FT PER MIN
NOTE
AIR VOLUMES WILL BE ESTABLISHED IN RELATION TO TONNAGES CRUSHED, SPEED AND WIDTH OF CONVEYORS, HEIGHT OF FALL IN THE ORE CHUTES, AND TRANSFERS IN ACCORDANCE WITH THE KCC DESIGN CHARACTERISTICS SHOWN IN APPENDIX NO.2.
VOLUMES WILL BE SUFFICIENT TO INSURE AN INDRAFT VELOCITY AT ALL ENCLOSURE OPENINGS OF AT LEAST 250 FT PER MIN, WHICH WILL PREVENT DUST ESCAPEMENT.
KENNECOTT COPPER CORPORATION
ENGINEERING CENTER
METAL MINING DIVISION
1515 MINERAL SQUARE
SALT LAKE CITY, UTAH
FLAMBEAU MINING CORP.
CRUSHING PLANT
PRELIMINARY DESIGN
DUST COLLECTION SYSTEM
506
BCM82-00-107
DESIGN
DRAWN REX MARCH 73
SCALE NONE
MAY, 1974

Dewatering

The final concentrate would be piped to a thickener and then pumped to two vacuum filters set on a mezzanine floor for dewatering. Filter cake would drop through the floor onto a ground level floor storage area from which it would be moved by conveyor or a front-end loader into the concentrate haulage railcars on an inplant siding.

Apart from the crushing section where provision is made for dust collection, there is a slight possibility of dust being made at any built-up concentrate stockpile. Normally the concentrate contains 12 to 16 percent water, but if it stands for a lengthy period, the surface of the pile could dry out. In this event, a water spray would be used to suppress dust.

Noise

The noise level from the concentrator and, in particular, close to the crushing section (which normally operates on day shift only, five days per week) is estimated to be below legal limits. This is based on noise levels at other Kennecott operations. For example, the noise level three feet away from the open door of the Bonneville, Utah, concentrator, which can crush and grind 35,000 tod of run-of-mine ore from the Bingham Pit, is 74.0 dBA and 85.0 dBC with the crusher section running, compared with 62.5 dBA and 72.0 dBC with the crusher idle. (The dBA scale most resembles the response of the human ear; the dBC records impact peaks with no levelling effect.)

Waste Disposal

Dikes

The dikes of the waste containment area would continue to be built up in 12½-foot lifts with a vertical 40-foot wide saprolite (clay) core in the center. Each layer would be mechanically compacted to 95 percent of the maximum dry density. Each lift would be stepped back on the outside wall, a horizontal distance of 30 feet from the edge of the lift below. As portions of each lift are completed, they would be covered on the berm and slope with a six-inch layer of the silty sand from the till, mixed with suitable mulch and fertilizer, and planted. Indigenous trees would be established in soil-filled holes on the berms.

Slurry Chemistry

The tailings slurry would contain the following concentrations of typical reagents used in the concentrator:

Reagent	Parts Per Million (ppm)
Promoter - Aerofloat 238	0.45
Frother - cresylic acid	14.00
Frother - methyl amyl alcohol	16.00

The toxicity of the promoter and the methyl amyl alcohol frother in the strengths above is minor. Concentrations of 100 to 200 ppm over periods of three to five days would be required to kill fish such as trout and salmon. Furthermore, the promoter biodegrades and the concentration is reduced to 0.1 ppm after fifteen days. The methyl amyl alcohol frother biodegrades to a concentration of 0.5 ppm in sixteen days. The cresylic acid frother in the above concentration is toxic to fish life. Cresylic acid, however, in the presence of organisms found in tailings solutions, completely breaks down into harmless constituents in less than eight days - much less than its retention time. The high alkalinity of the solution inhibits the oxidation of pyrite during mine operation. Computer studies based on the measured permeabilities of the soils in the floor of the waste containment area and the constituents of the dikes show that it would take much more time for any leakage to traverse from the inside to the outside of the waste containment area than is required for reagent degradation. The quantity of leakage from the waste containment area is estimated at less than 25 gpm. Sampling and analysis of the groundwater would be carried out on a continuous basis until seepage chemistry and treatment measures can be established in practice.

Waste Rock

The 50-ton trucks would be carrying waste to the waste containment area normally on day shift, but there may be occasions when a second and even a third shift may have to be used. Water trucks would be used to prevent dust formation in dry weather and also to water the vegetation on the slopes of fill areas until it is well established.

Tailings

The tailings from the concentrator would be pumped as a slurry containing 25 percent solids to the waste containment area via an eight-inch pipeline paralleling the haul road on the east or up-slope side. One of the design criteria is adequate provision for containing spillage in the event of a pipe break. In the event of a loss of head due to a pipe break, the pumps would automatically trip out, but pulp already in the pipeline would flow by gravity into the ditch. It would flow to catchment basins for emergency tailings storage.

Shipping

Concentrate loading of railcars would take place inside the concentrator building, thus permitting controlled housekeeping and minimizing dispersion of sulfides by accidental spills or blowing dust. Adequate storage area for railcars would be available at the plant. Railcars would be loaded by conveyor belt or a front-end loader.

Energy Use

Electricity

The principal energy used in the project would be electricity. It is estimated that during the productive life of the open pit mine-mill operation the weekly power usage would be 219,240 kilowatt-hours, and that the maximum 15-minute demand would be 2,600 kilovolt-amperes. The load factor and power factor are estimated to be 0.75 and 0.87 respectively. An additional 367,553 kilowatt-hours per month would be required for an underground operation, and the estimated 15-minute demand would be increased by 1,800 kilovolt-amperes.

Petroleum Products

Diesel fuel use is estimated at 15,625 gallons per month and gasoline use is projected to average 590 gallons per month.

The various buildings would require heating in the winter and, although the engineering for the concentrator and other ancillary facilities has not yet been completed, a preliminary estimate of the heat requirement is:

	Floor Area Square Feet	BTU's Per Hour
Truck shop	2,700	540,000
Warehouse	1,350	135,000
Offices	1,350	135,000
Concentrator	5,500	550,000
TOTAL	10,900	1,360,000

The building heating systems would be capable of firing either No. 2 fuel oil or alternately coal in anticipation of future fuel shortages of either oil or coal. Centrally-located steam boilers would produce low-pressure steam for use by individual unit heaters within the buildings. No. 2 fuel oil is a standard, domestic heating oil with a typical 0.3 percent sulfur content. This oil has a heat content of 140,000 BTU per gallon, of which 80 percent can be converted to useful steam heat. During the winter months, it is estimated that an average of 175 to 290 gallons per day would be required. Bituminous coal has a heat content of from 12,500 to 13,000 BTU per pound, of which 80 percent can be converted to useful steam heat. It is estimated that an average of 1.6 tons per day would be required during winter months. Use of Illinois coal with a 1.7 percent sulfur content would produce 54.4 pounds of sulphur dioxide per day.

Industrial Water Supply

It is estimated that 223 gpm of water would be required for industrial purposes made up of 73 gpm as new makeup water for the concentrator and 150 gpm for workshops, road sprinkling and other sundry uses. It is anticipated that most or all of this water could be obtained from water inflow into the pit water collection ditches and sumps, plus precipitation into the pit and waste containment area. Additional outside water supply, if needed, would be obtained from high capacity wells constructed in the gravel pit area.

Potable Water Supply

A low capacity well would supply all the potable water needs of the plant. Potable water consumption in the changehouse, office, laboratory, etc., is estimated to be 2 gpm on a steady usage basis. It should be noted, however, that most of the water would be consumed at the end of each shift, probably in the last 15 minutes. Assuming that half the total work force, 39 people, are employed on the day shift, 1,500 gallons could be consumed in the last 15 minutes of the shift, hence the sewage disposal system would be sized to dispose of 100 gpm over this peak period.

Site Rehabilitation The rehabilitation of the mine area would be a continuous process commencing with exploration and continuing for some years after the mine has closed down.

Cost The costs of environmental control and rehabilitation are estimated at 9.3 percent of the production costs if the mine closes down at the end of the pit operation (11 years). If the open pit phase could be followed by an economic underground operation, the costs of environmental control and rehabilitation would be reduced to 5.6 percent of the production costs.

Tree Plantings Eight separate tree screens were planned for the 842 acres immediately adjacent to the mine pit, haul road, concentrator and magazine buildings, soil stockpiles and the waste containment area. Indigenous trees, selected and planted according to advice from local DNR foresters, have been planted in four of the areas: west of State Highway 27 and east of the process plant and mine area (Section 9); west of State Highway 27 and east of the haul road, for ¼ mile south of Meadowbrook Creek (Section 16); west of the process plant beside the Flambeau River (Section 9); and north of the proposed pit between the mining operation and Ladysmith. Data on soils, water supply (existing and expected), land use history and the projected uses of the land at the close of mining were all considered in the development of these screens so that the probability of success could be maximized. The screen plan developed around the mine pit has been produced using tree species that can survive the expected lowering of the water table around the pit, plus certain species known to be capable of tolerating modest root-wetting which probably would occur if the pit is rehabilitated as a lake. Local plant materials have been used, and many tree screens already planted include trees moved from the area of the mine pit. The site would also be used to test experimental plant materials in conjunction with the Soil Conservation Service.

Dike Walls Revegetation of roadsides and the dikes of the waste containment area is a priority item during the construction phase for the simple reason that to allow these to be unprotected would result in serious erosion and siltation problems for FMC. Revegetation schemes were developed for the fifteen-degree sloped lip of the mine pit, the settlement basin in the old gravel pit, the haul road, and the dikes of the waste containment area. Soils used as dressing materials would be tested and treated with conditioners as needed to ensure a well-developed seed bed. The ecological tolerances and uses of available plant materials have been considered in the context of expected conditions. For example, emerald crown vetch is a tenacious and excellent revegetator of slopes up to 40 degrees and will persist even on north-facing slopes in northern Wisconsin. However, crown vetch is less used by wildlife than birds-foot trefoil, but the trefoil will not persist on north-facing or shaded slopes. Accordingly, plans are to use the trefoil in sunny locations, and the crown vetch under more stressful conditions. Waterloving grasses (reed canary or garrison creeping foxtail) would be used in ditches, on the inside of settling basins, and on the inside of the waste containment area. Sodding could be employed wherever special problems are anticipated such as the haul road crossing of Meadowbrook Creek. These plans are aimed first to prevent erosional problems that would cost a great deal to correct, and secondly to provide an improved wildlife habitat and aesthetic value to these areas.

Land Use The principal metal mining activity would physically disturb a core area of 349 acres. All mining related activities would be confined within a total area of 842 acres. The remaining 1,908 acres are expected to be used as visual screens and a buffer zone around the mine-dominated core. The major portion of this land is in agricultural production, mostly as pasture, with lesser acreages in other uses. It is planned to continue most of these land uses and to apply the best available techniques for improving the economic yield from these lands. Some acreage would be converted to new uses. Lands leased to tenant farmers or selectively cut would be monitored by the company. Intensive yield forestry would be practiced on part of this acreage according to recommendations by the Department of Natural Resources.

Remove Buildings The buildings that have been installed during the mining operation would be removed and reused elsewhere or otherwise disposed of. The exposed surface soil would be recovered and any foundation excavations filled in with fresh soil from the soils stockpile area and these sites replanted either to grasses or trees.

Roads

The surface of the haul road, the magazine road and the parking areas not to be included in the final lake rehabilitation plans would be ripped and plowed or disced to prepare an adequate seed bed. The road would be allowed to revert naturally or may be planted as required to more quickly reacquire a natural character.

Railroad Spur

The disposal or rehabilitation of the railroad spur and power lines would be studied and appropriate courses of action taken at mine closing as recommended by the appropriate authorities in the light of the expected land uses for these properties. Generally, if not required for any other purpose, FMC would plan to dismantle and remove these facilities.

Waste Containment Area

The estimated 135 million gallons of water remaining in the waste containment area would be neutralized and the suspended solids would be removed.* Under present DNR legal interpretations, the only point of discharge which could be permitted is the Flambeau River. The surface of the waste containment area would be covered with at least 12 to 18 inches of low-permeable silty soils after the dewatering is complete. The area would be planted to local vegetation. The shape of the replanted waste containment area would be that of a large (about 130 acres) very shallow bowl sloping at ½ percent or less toward the center. The decant tower would be left in place with its connection to the old wastewater reclaim line which would have been laid in the original creek bed through the waste containment area. Runoff would thus run through the old decant tower and water reclaim lines to rejoin the natural flowage through the swamp on the east end of the waste containment area. This permanent drain system should reduce movement of water through the tailings after the mine is shut down.

Open Pit

The open pit would be filled with water to an approximate elevation of 1,092 feet above sea level to form an ellipsoidal-shaped lake of approximately 50 acres having a maximum depth of approximately 250 feet. It is the intent of FMC to create a lake having acceptable water quality. However, it is extremely difficult to predict water quality within the resulting body of water given the possibility of contamination from sulfide minerals which would remain in the rock walls of the pit. As now designed, the resulting lake is expected to be meromictic, or nonmixing; thus, it is expected that waters contaminated by contact with sulfide mineralization in the pit walls and bottom would be held in the monimolimnion, or bottom waters, and never become mixed with the upper water layers of the lake. The present pit rehabilitation plan provides that all practicable measures be taken to promote stable meromixis as the best means of ensuring acceptable water quality within the lake. The present plan would be expanded and refined as additional information is developed from field and laboratory investigations conducted during the operation of the mine.

Nonmixing Lake

Factors which would tend to promote the development and maintenance of meromixis in the pit lake are: (1) morphology of the lake basin - both depth and configuration of the basin surface; (2) small water surface area, sheltered from winds; and (3) potential for the development of chemical differences in water density. Limnological conditions within the resulting lake as tentatively predicted by Alfred J. Hopwood, Professor of Biology and Director of Environmental Studies, St. Cloud College, St. Cloud, Minnesota are as follows:

> The maximum depth of the mixolimnion should be about 50 feet. The upper limit of the monimolimnion should be no deeper than 135 feet from the surface. A thermocline-chemocline should develop between the 50 and 130-foot levels. The lower limit of the trophogenic zone would be no greater than 100 feet. Oxygen depletion is expected below the 130-foot level.

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*The disposal of the waste process water from the waste containment area and the mill circuit and the filling of the open pit would not occur for 11 to 22 years after mine construction would start. Regulatory requirements, environmental priorities, the technological situation and economic setting which would be in effect at that time cannot be predicted. A disposal plan which is acceptable at this writing may not be optimal in the future. Therefore, neither the company nor the Department is in a position to propose the final disposal method. The method presented here is not the company's proposal but is an alternative which would be legal at this time.

These conditions are depicted graphically in the schematic cross section of the pit lake shown in Figure 41.

Preparation of the lake basin would probably commence during the last few years of open pit mining. Waste rock which is relatively free of sulfides would be used to cover sulfide-rich rocks of the ore horizon remaining in the walls at the ends and bottom of the pit. The waste rock, with a low sulfide content, would probably be obtained from the northeastern portion of the pit and would be spread over segments of the orebody on which mining has been completed, instead of being hauled to the waste containment area. This would be done to reduce interaction between the lake waters and sulfide minerals remaining in the pit walls.

Additional measures such as the application of saprolite or other sealants, could be taken if they were found by research to be effective. Should future investigations show that the development of meromixis would be furthered by allowing the lake bottom waters to interact with the sulfide minerals, only the upper portions of the ore horizon exposed at the ends of the pit above the predicted upper limit of the monimolimnion would be sealed.

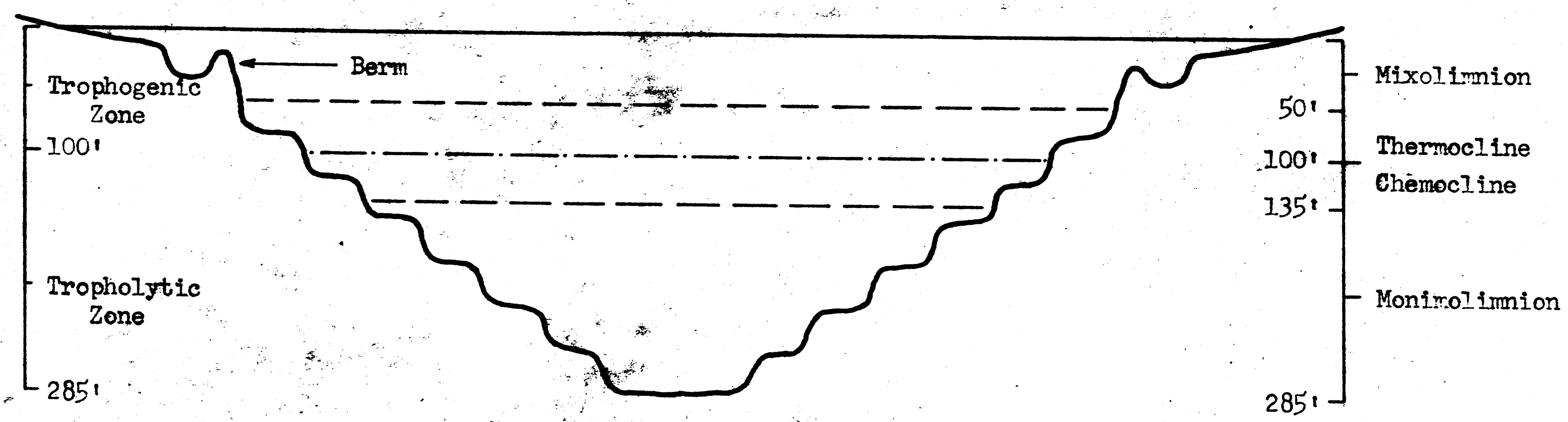
The pit walls below the lake surface would have an overall slope of about 35 degrees, consiting of 35-foot near-vertical steps and horizontal benches. The two upper benches would be approximately 35 feet wide; the lower benches would be somewhat narrower. The 1,085 level bench would be about 7 feet below the lake surface. The shoreline would be gently contoured so that a safe littoral zone would be created. The next lower bench, at the 1,050 level, would be approximately 42 feet below the lake surface, near the predicted base of the mixolimnion. The bench faces would be dressed down to remove loose rock to create a reasonably-smooth surface. To control water chemistry and wind-driven downward water currents, a berm approximately six feet high would be constructed of limestone and waste rock on the edge of the 1,050 level bench.

Above the lake surface, the pit walls would rise from 10 to 50 feet at an approximate slope of 15 degrees to the original ground surface. Stabilization of these slopes with vegetation, such as crown vetch and trefoil, would have been in progress before cessation of mining. Tree plantings to provide a wind screen around the circumference of the proposed pit have already been begun and would be completed prior to the commencement of mining. Tree species which can survive the expected lowering of the water table around the pit, and others known to be capable of tolerating modest root-wetting such as would probably occur after the pit is flooded, would be employed.

Prevailing winds in the Ladysmith area are from the west, southwest and northwest. Available records indicate that the average wind velocity in the windiest month (May) is 11 mph, and that the lowest monthly average wind velocity is 7.9 mph (August). A wind rose relative to the orientation of the pit lake is shown in Figure 42. The highest percentage of winds would blow across the short axis of the pit lake from the northwest or southeast, or obliquely from the south, north, east or west, and thus would reduce the wind piling effect on the lake. Winds from the southwest and northeast would sweep along the long axis of the lake for 25 percent of the time. This perspective of the lake would be protected by 50 feet of the pit wall above the water level on the northeast and by the mature tree canopy 50-60 feet high between the pit and the river on the southwest.

The presence of the 1,085 level bench some seven feet below the water surface, and the 1,050 level bench and berm some 42 feet below the surface would have a combined energy absorbing surface equal to approximately 172 percent of the entire lake surface. Therefore, wave action and wind piling would be diminished at or above the 42-foot depth, effectively promoting stability of any stratification phenomena in the lake. The downward thrust of water masses beyond the 1,050 level bench in a lakeward direction would force upon the next bench, and the mass would be restricted to a narrower horizontal space. The total effect of the stepped pit walls would be to retard downward movements forcing shoreward, and to redirect water masses upward toward the center of the lake as shown in Figure 43.

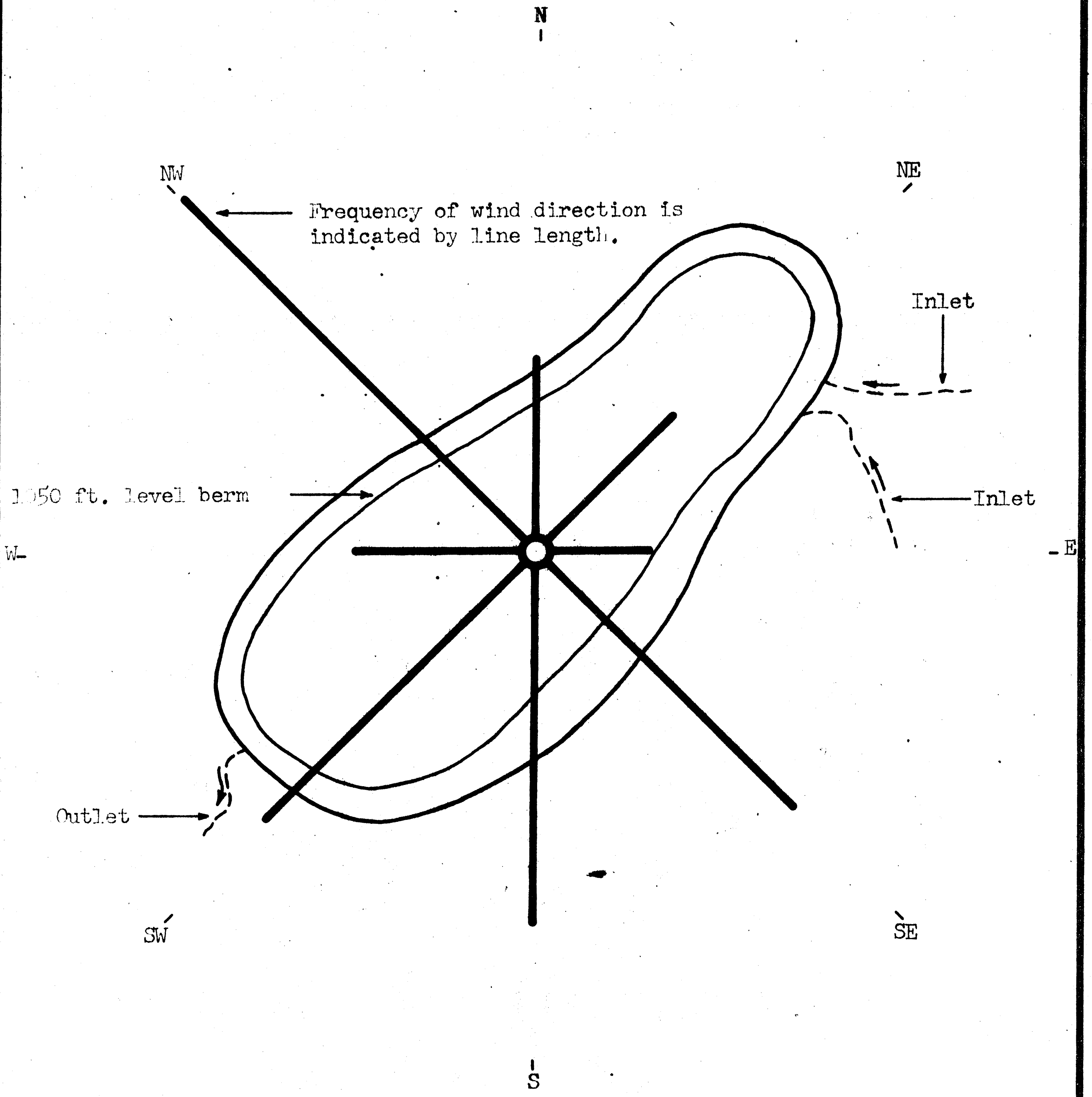
FIGURE 41



NOTE: The proposed miromictic pit lake in cross section showing the relative positions of the mixolimnion, thermocline-chemocline, monimolimnion, trophogenic zone and tropholytic zone.

FLAMBEAU MINING CORP.	
PROPOSED MEROMICTIC PIT LAKE IN CROSS SECTION	
SCALE: Not To Scale	**DATE** Apr. 1974
DRAWN BY: GLB	**MAP NO.**

FIGURE 42



NOTE: A view of the proposed pit lake showing the position, in plan, of the berm on the 1050 level bench. Relative frequencies of windy days from indicated directions are superimposed on the lake surface.

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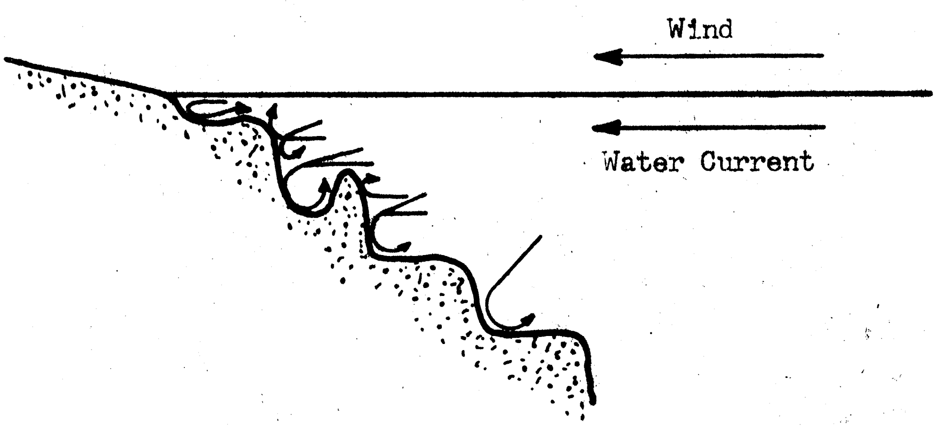
SUPERIMPOSED WIND ROSE
ON
PIT LAKE

SCALE: Not To Scale DATE Apr. 1974
DRAWN BY: GLB MAP NO.

FIGURE 43



NOTE: Diagram of eddies expected as horizontal currents strike the steps, berm and benches of the pit wall. If wind piling develops, the energy of downward currents should be dissipated and reflected by the benches.

FLAMBEAU MINING CORP.

EFFECT OF BERM
ON
WATER CURRENT

SCALE: Not To Scale DATE Apr 1974
DRAWN BY: GLS DWG. NO.

The pit would be flooded with water from the Flambeau River, and the normal inflows of groundwater and incident precipitation (see footnote, page 93). Approximately two billion gallons of water would be required to fill the pit to the 1,092 level. Approximately 1.5 billion gallons of this would be obtained by siphoning from the river at a rate of 5,950 gpm. At this rate of siphoning from the river, it would take 180 days to fill the pit if water from the other sources would be obtained at the following rates:

Pit Filling Sources	
River siphon	5,950 gpm
Groundwater inflow	1,620 gpm
Net precipitation	124 gpm

The effectiveness of various manipulations of the flooding schedule in promoting meromixis would be investigated further by the company. For example, it might be found advantageous to fill the pit to approximately the 1,042-foot elevation level in the fall and to add the final 50 feet of water depth from relatively warm river waters in the spring. This procedure would have the further advantage of providing an inoculum of the wide variety of phytoplankton organisms present in the spring waters of the Flambeau River.

The pit walls above the 1,015 level bench, which would contact the upper 77-foot stratum of lake water, are estimated to contain less than 1 percent by weight sulfide minerals and approximately 0.05 percent copper. From laboratory studies conducted by the Metal Mining Division Research Center, Salt Lake City, Kennecott Copper Corporation, it is concluded that:

1. EPA water quality standards can be met for all toxic metals except possibly for copper in the pit lake.

2. Copper concentrations in the pit lake water may reach a maximum of 0.04 to 0.07 mg/l after 15 to 30 years. EPA water quality limits of 0.02 mg/l would be exceeded after three years.

3. Periodic lime treatments equivalent to approximately ½ ton slaked lime per annum for the first ten years should be able to decrease the copper content of the lake water to within acceptable limits (<0.02 mg/l).

4. Limestone fragments added to the 1,050 level bench of the rehabilitated pit might serve instead of periodic lime additions.

5. It is probable that the copper concentration in solution would be limited to less than 0.02 mg/l by the precipitation of the basic copper carbonate, azurite.

6. Because the lake is likely to be meromictic, the lower stagnant layer of the lake water would become anaerobic and tend to scavenge toxic metals from the upper aerobic layer.

Inflow and Outflow

Surface waters flowing into the pit lake from the drainage basin on the north and east sides would be directed into two concrete spillways and could be treated by allowing it to flow through limestone rubble to increase the total alkalinity of the lake. Any overflow from the lake would be discharged to the Flambeau River through a concrete spillway lined with limestone fragments and located at the low point of the pit perimeter. From this point, the overflow would have a run of approximately 300 feet before reaching the river.

PROBABLE ADVERSE AND BENEFICIAL IMPACTS ON THE ENVIRONMENT

PHYSICAL-CHEMICAL ENVIRONMENT
Air Quality
Dust

The two principal sources of potential fugitive dust would be the crushing and grinding operations of the concentrator and the blasting operation in the pit. The threshold limit values for industrial air quality as established by the Mining Enforcement Safety Administration in 1974 are as follows:

1. Silica dust
   10 mg/m^3 ÷ the percent of respirable quartz +2
2. Total dust, respirable and nonrespirable:
   30 mg/m^3 ÷ the percent quartz +3

Dust collection equipment for the crushing section of the concentrator must meet these federal safety standards.

Blasting would take place approximately once a week during the summer and somewhat more frequently during the winter. Fugitive dust generated by blasting would dissipate into the atmosphere. There is no practical method for capturing this dust.

Sulfur Oxides

The other source of potential air quality contamination would be the heating system for the plant and associated buildings. If No. 2 fuel oil is burned, 7.5 to 12.4 pounds of sulfur dioxide (SO_2) would be emitted per day. If coal is used, 54.4 pounds per day SO_2 would be emitted.

Less significant sources of air pollution would include emissions from hauling trucks and dust generation along the haul road.

Contaminant Dispersal

These air contaminants would be dispersed by the wind into the surrounding area. The general prevailing wind directions are from northwest to southwest. Wind data from April through October indicate that south and southwest winds occur 35 percent of the time. Winds from these directions would disperse pollutants toward the Ladysmith area which is less than one mile to the northeast. The closest sensitive receptors are Mt. Senario College, the Rusk County Hospital and Nursing Home, and a low density residential area near Highway "27" just south of the Flambeau River. Winds from directions other than south and southwest would disperse pollutants over agricultural and forested areas primarily.

Noise

The noise impact of the FMC operation on the hospital-nursing home and college complexes was estimated by utilizing data from Kennecott's crushing operation at Bonneville, Utah, which has a production rate of 35,000 tons per day. The calculations of noise levels were based on a flat terrain void of vegetation or buildings, (See appendix M). The noise levels which would be expected at the hospital-nursing home and college complexes, assuming the only source of noise to be the FMC crushing operation, would be 22.0 dBA. If the heavy equipment in the open pit was the sole noise contributor, the levels at the sensitive areas would be about 37.5 dBA. These levels are well below the present normal background noise levels of 54 dBA near the hospital. The FMC operation should make no significant contribution to community noise levels. The adjacent sand and gravel operation is the primary source of noise at the present time and would continue to be the major contributor when the mine is operating.

Crushing Operation
Heavy Equipment

Blasting

Blasting in the pit would elevate noise levels somewhat. These would be short duration (impact noise) occurrences but could be unsettling to nearby residents.

Hydrology

Diversion of Waters

The planned mining operation would cause no detectable changes in the flow and water levels of the Flambeau River. The planned withdrawal of 10 million gallons of river water during a 14-day period at the beginning of operations would take place at a rate of 492 gpm, which is 1.1 cubic feet per second (cfs). This is insignificant when compared with the average river discharge of 1,776 cfs at the U.S.G.S. gauging station below the Thornapple power plant. The withdrawal of 1.5 billion gallons of river water during a 180-day period to fill the pit upon the cessation of mining would take place at a rate of 5,950 gpm, which is 13.3 cfs. This is 0.7 percent of the average river discharge at the Thornapple plant, and 1.8 percent of the 734 cfs calculated as the flow exceeded 95 percent of the time at Ladysmith.

Surface flow through intermittent tributary stream A will not be affected by the open pit as it originates in and discharges from a minute watershed to the northwest of the pit. Facilities such as the pipeline to the settlement basins in the gravel pit would not obstruct or contaminate the natural flow. Intermittent tributary stream B would be largely eliminated since its watershed is mostly within the perimeter of the planned open pit.

Tributary Eliminated

No alteration of the flow in tributary streams C and D would be created, except briefly during construction of the haul road as culverts are installed.

Tributary Stream E which crosses the proposed waste containment area would be diverted around the southeast section of the dike. Basically, the rerouting would substitute a channelized portion of this stream for a part that was channelized by previous owners. It has been determined by the DNR to be non-navigable. The rerouting of this stream would not influence water levels in the adjacent wetlands as all of the wetland basins in Sections 20 and 21 are interconnected. Flows in stream F would not be influenced by the waste containment facility. After the cessation of mining, the revegetated upper surface of the waste containment area would be sloped inward at a grade of 0.5 percent toward the decant tower. The tower would be left in place with its connection to the old wastewater reclaim line which was laid in the former channel of stream E. Runoff from the upper surface would thus pass down the old decant tower and through the reclaim line to join the natural flowage through the wetland on the east end of the waste containment area.

Stream G Watershed

Stream G would lose 160 acres from its watershed due to the construction of the waste containment facility. Some surface water flow would be generated by the facility, however. Computer simulations of seepage loss through and beneath the dike, under a 50-foot fluid mass head and with no allowance made for reductions in permeability due to the accumulation of slimes and chemical precipitates, indicate that 0.57 gallons per day per linear foot of dike would escape to the surface outside the toe of the dike after a period of approximately 28 years. Thus, the maximum total above-ground seepage around the full 11,650-foot perimeter of the waste containment area is estimated to be 4.6 gpm after the 28-year flow propagation time.

Groundwaters

Gradient Reversal

Excavation of the proposed open pit would have a pronounced local effect on the groundwater gradient and flowpaths adjacent to the pit. The present northwesterly flow of groundwaters across the mine area would be intercepted by the pit. Normal recharge of aquifers in the glacial outwash deposits immediately northwest of the pit would be altered, and the glacial tills to the southwest, south and southeast of the pit would be partly dewatered.

To predict groundwater flow conditions after pit excavation, the company used a finite element computer flow model. Groundwater flow into the pit as calculated from the model would be 1,620 gpm. Allowance was made in this calculation for inflow resulting from reversal of the existing hydraulic gradient on the northwest, or present down-gradient, side of the pit. The bedrock ridge described in an earlier section of this report would prevent the intrusion of river waters through the groundwater system into the pit from the southwest end of the pit. From permeabilities measured in the test wells, it is estimated that the glacial outwash materials present in the northwest sector of the pit perimeter would transmit an average of 50 gallons per square foot per day (0.0347 gpm). Thus, the highest amount of groundwater flow and intrusion of river water through the glacial outwash materials as shown in Figure 44 in the 1,000-foot segment of pit wall subject to such intrusion is estimated to be 347 gpm.

Cone of Depression

Figure 45 indicates the expected maximum and minimum extent of the cone of groundwater depression around the pit. Aquifer recharge outside the cone of depression northwest of the pit is expected to continue at the present rates. The low and very irregular permeability characteristics of the glaical tills and the heterogeneity of the till-outwash contact zone northwest of the pit would result in a decidedly asymmetric cone of depression. The lateral extent of the drawdown cone would be mostly controlled by the permeability characteristics of the glacial deposits and is estimated to vary from a minimum of 50 feet at the southwest end of the pit to a maximum of 500 feet in the heterogeneous soils northwest of the pit.

FIGURE 44

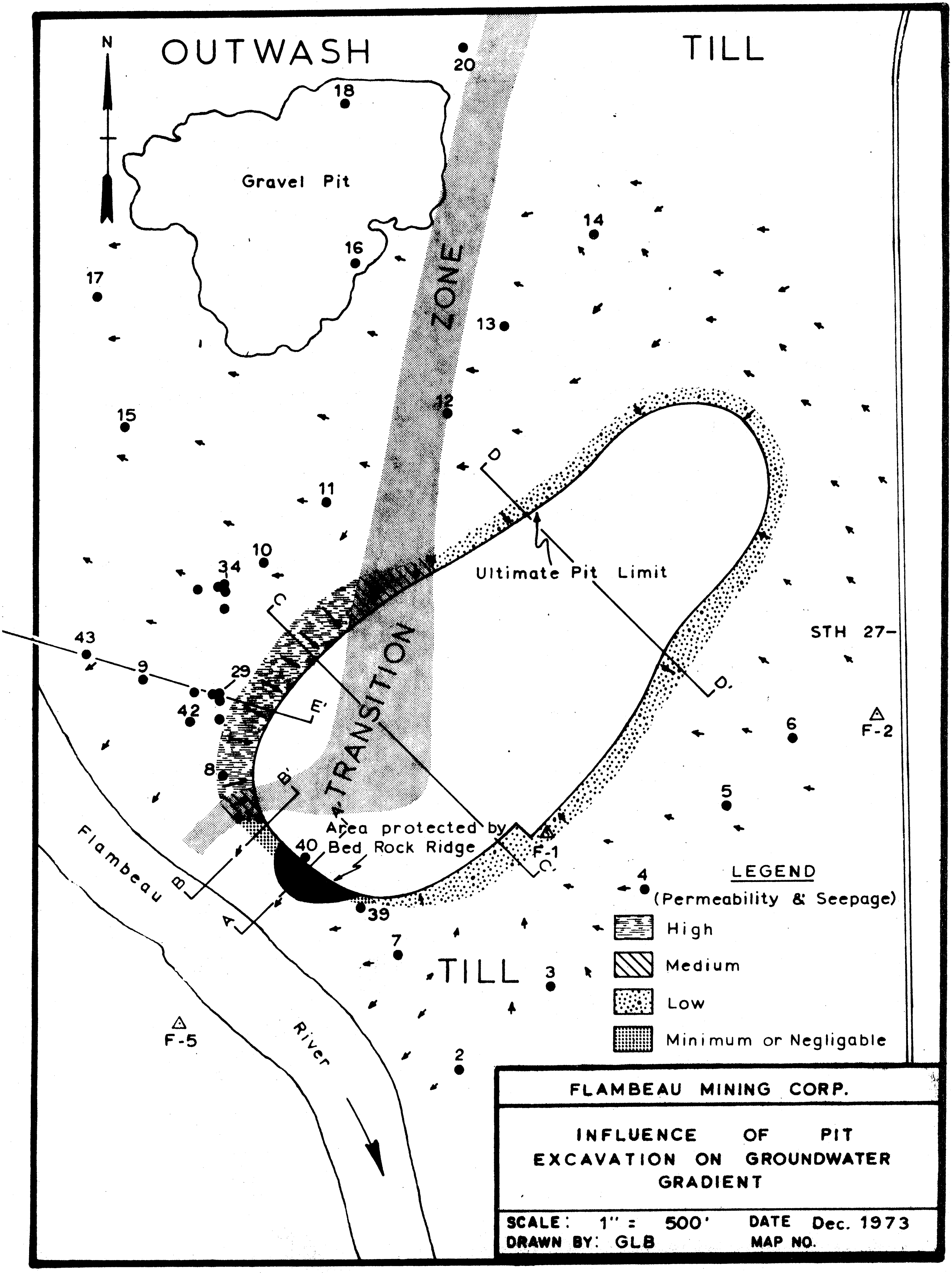
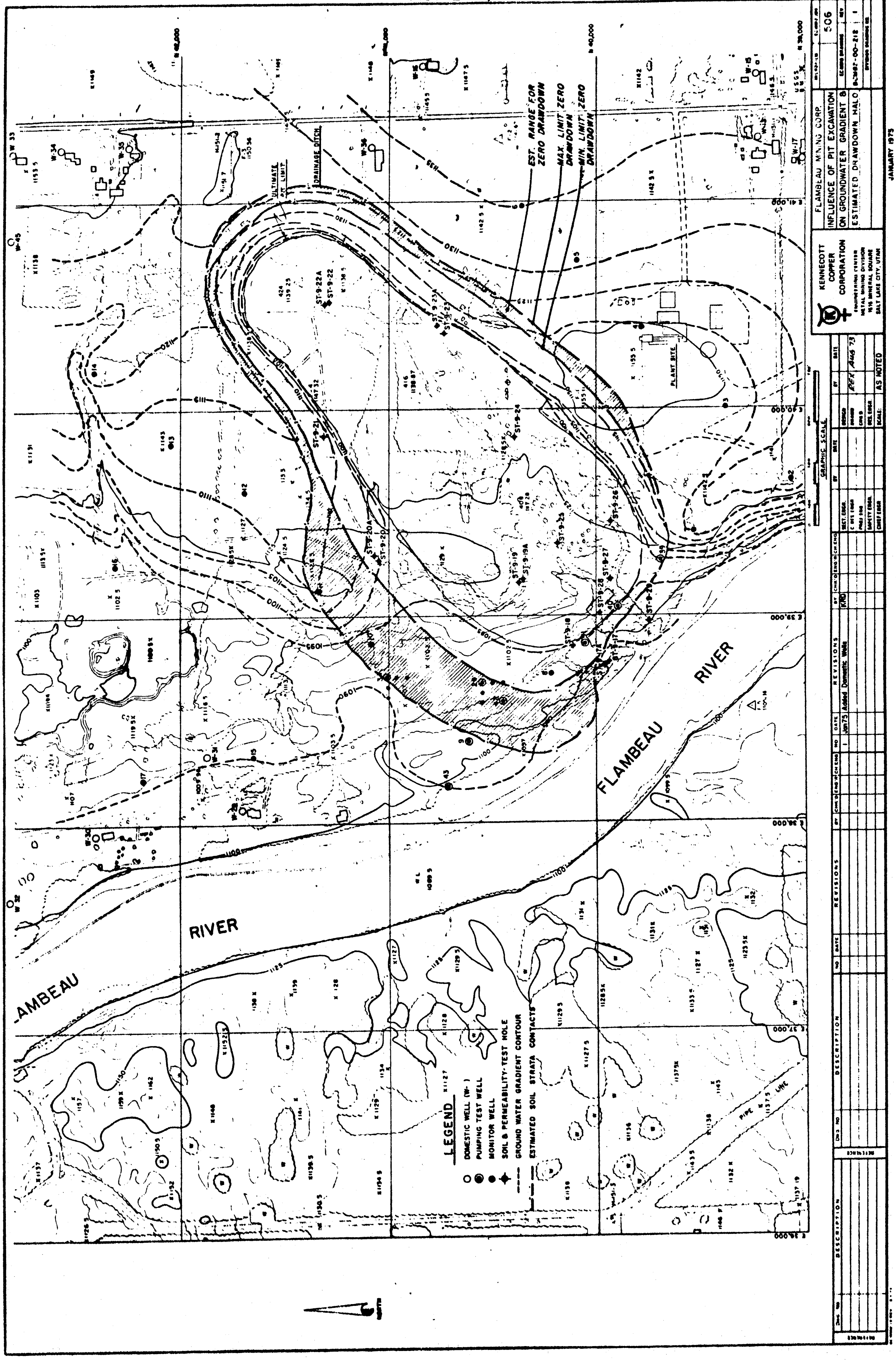

N
OUTWASH
TILL
Gravel Pit
ZONE
TRANSITION
Ultimate Pit Limit
STH 27
Area protected by
Bed Rock Ridge
Flambeau River
TILL
F-1
F-2
F-5
LEGEND
(Permeability & Seepage)
High
Medium
Low
Minimum or Negligable
FLAMBEAU MINING CORP.
INFLUENCE OF PIT
EXCAVATION ON GROUNDWATER
GRADIENT
SCALE: 1" = 500'
DATE Dec. 1973
DRAWN BY: GLB
MAP NO.

FIGURE 45


FLAMBEAU RIVER
RIVER
EST. RANGE FOR ZERO DRAWDOWN
MAX. LIMIT ZERO DRAWDOWN
MIN. LIMIT ZERO DRAWDOWN
ULTIMATE PIT LIMIT
DRAINAGE DITCH
PLANT SITE
PIPE LINE
LEGEND
DOMESTIC WELL (W-)
PUMPING TEST WELL
MONITOR WELL
SOIL & PERMEABILITY TEST HOLE
GROUND WATER GRADIENT CONTOUR
ESTIMATED SOIL STRATA CONTACTS
GRAPHIC SCALE
KENNECOTT COPPER CORPORATION
FLAMBEAU MINING CORP.
INFLUENCE OF PIT EXCAVATION ON GROUNDWATER GRADIENT & ESTIMATED DRAWDOWN HALO
JANUARY 1973
AS NOTED

Although the hydrological studies suggest that the glacial materials surrounding the mine pit could yield up to 1,620 gpm, based on their permeabilities and the existing groundwater conditions, the long-term yield of such a volume of groundwater is considered unlikely for several reasons. First, experience with other mine pits has shown a rapid initial inflow into a pit during excavation followed by great reduction in flows up to 80 to 90 percent of the initial flow. Secondly, in this case 82 percent of the water-bearing upper pit perimeter wall would consist of till within which aquifer continuity is very poor. Finally, if the till and outwash in the cone of depression would be dewatered, incident precipitation and regional groundwater flow recharge would have to come through adjacent soils, most of which have low to very low transmissivities. Thus the effects of evapotranspiration plus the above factors indicate a very slow infiltation through the soils into the mine pit. A more realistic long-term estimate of groundwater flow into the pit after flows have stabilized is 320 gpm, which is 20 percent of the calculated theoretical figure.

Possible Loss of Trees

Many of the trees within the drawdown cone northwest of the pit are species that prefer moist soils, i.e., black ash and hemlock. Soil moisture levels and tree survival would be monitored during the operation because these trees would be of value to FMC in the postmining development of the pit into a recreational lake. Some irrigation of these trees may be needed during the life of the operation.

No Effect on Wells

Because all property within the cone of groundwater drawdown around the pit would be owned by FMC, no private water wells would be affected. Excavation of the pit will, however, intercept the water supply to the two seeps located northwest of the pit with the result that flow from these seeps would be drastically reduced or would cease entirely. Preservation of the water-dependent vegetation at these sites would be maintained through irrigation as required.

Groundwater flow across the orebody toward the Flambeau should be almost entirely eliminated by excavation of the pit. Because there are significant quantities of dissolved mercury, zinc and lead present in the waters which have percolated over the orebody, the removal of this source of natural contaimination to the Flambeau River may have a positive effect.

Waste Containment Area

The diversion of stream E to the south, around the southeast corner of the waste containment facility, would have little effect on groundwater supply outside the facility. The rerouted flow of stream E when added to the area surrounding the southeast corner of the facility would be taken up by the adjacent wetlands into which the stream presently discharges.

Seepage Through Floor

Creation of the waste containment area and the imposition of the resulting fluid mass head on the underlying area would produce an increment of recharge to the groundwaters in the waste containment area. Permeabilities and expected vertical travel times through the soils underlying the area are given in Table 26. It should be noted that vertical travel time through the most permeable soil under a 25-foot head would be 45 days.

The rate of seepage through the entire dike, around its full perimeter, is estimated to be approximately 6 gpm under a 50-foot fluid mass head. Only 1 gpm of this flow would remain in the groundwater system, however, as approximately 5 gpm of that total flow would escape to the surface outside the toe of the dike. The rate of seepage through the 125-acre floor of the waste containment area is estimated to be 19 gpm under a fluid mass head of 50 feet - which would not be reached until the final year of underground mining. No allowance was made in the estimate for the sealing effect which could be produced by the accumulation of slimes and precipitates within the tailings. Thus the increment of recharge to the groundwater system f resulting from the creation of the waste containment area would be 20 gpm at maximum.

Long-term Impact

Seepage would continue at a reduced rate indefinitely after the cessation of the operation.

TABLE 26

PERMEABILITIES AND EXPECTED TRAVEL TIME OF TAILINGS WATER THROUGH REPRESENTATIVE BASE SOILS UNDER THE WASTE CONTAINMENT AREA

Sampling Station	Depth & Thickness of Soil Tested	Soil Type*	Averaged Permeabilities CM/Sec	Averaged Permeabilities Feet/Day	HEADS	Time in Days Required for Water to Pass Through Soil Stratum at Various Heads** 1'	6'	10'	25'	50'
27	6.0-7.0	SM	1.7×10^{-6}	4.81×10^{-3}		1559	260	156	62	31
33	2.0-3.5	ML	1.1×10^{-6}	3.11×10^{-3}		1125	187	113	45	23
38	0.0-8.0	OL-SM-ML	1.7×10^{-6}	4.81×10^{-3}		2391	398	239	96	48
53	2.0-5.0	ML-SM	6.6×10^{-8}	1.87×10^{-4}		21,390	3565	2139	856	428
40***	0.0-11.5	ML-SM	9.1×10^{-7}	2.57×10^{-3}		4475	746	447	179	89

* As per Unified Soil Classification System

** The analysis assumes that there will be no self-sealing in the waste containment area from slimes. (However, experience with existing tailings ponds suggests that slimes accumulation will act to seal the pond bottom so that leakage will be minimized.)

*** This soil would not be flooded until more than 6 feet of tailings and water have accumulated in the waste containment area.

Water Quality

Waste Contamination Area

Seepage from the waste containment area would constitute the major potential source of contamination of water. Seepage would be released in three ways: 1) through the dike to the surface at a rate of five gallons per minute (gpm); 2) under the dike to the groundwater at a rate of 1 gpm; and 3) through the bottom of the waste containment area at a rate of 19 gpm. These estimated seepage rates through the dike would occur after 28 years due to the relative impermeability of the clay core. Seepage would occur sooner through the bottom of the waste area.

Tailings Chemistry

Initially the tailings would be very alkaline due to the addition of lime in the concentrator circuit. However, this condition would be reversed by oxidation of the pyrite in the top layers of the tailings. The chemistry in the tailings basin would probably be as follows:

1) $2FeS_2 + 7\ O_2 + 2H_2O = 2Fe^{++} + 4SO_4^{=} + 4H^+$

2) $4Fe^{++} + O_2 + 4H^+ = 4Fe^{+++} + 2\ H_2O$

3) $Fe^{+++} + 3H_2O = Fe(OH)_3 + 3H^+$

4) $FeS_2 + 14Fe^{+++} + 8H_2O = 15\ Fe^{++} + 2SO_4^{=} + 16H^+$

The oxidation of the sulfide of the pyrite to sulfate (1) releases dissolved ferrous iron and hydrogenious (acidity) into the water. Subsequently, the dissolved ferrous iron undergoes oxygenation to ferric iron (2) which then hydrolyzes to form insoluable ferric hydroxide (3), and generates more acidity. Ferric iron can also be reduced by pyrite itself, as in (4), where sulfide is again oxidized and acidity is released along with additional ferrous iron which may re-enter the reaction cycle via equation (2). Therefore, once the process has been started by the oxidation of pyrite, little additional oxygen is required to sustain the acid generating reactions. The dissolution of 1 mole of iron pyrite leads ultimately to the release of 4 equivalents of acidity.

Some of the acidity could be neutralized by reaction with other minerals in the waste rock such as kaolinite:

$$\underset{\text{kaolinite}}{Al_2\ Si_2\ O_5\ (OH_4)} + 6H^+ + 3SO_4^{=} = Al_2\ (SO_4)_3 + \underset{\text{amorphous silicia}}{2SiO_2} + 5H_2O$$

and residual lime:

$$\underset{\text{lime}}{CaCO_3} + 2H^+ + SO_4^{=} = CaSO_4 + CO_2\uparrow + H_2O$$

Seepage Chemistry

The resulting solution which would escape from the waste containment facility would be a mixture of ferrous and magnesium sulfates and calcium sulfates, limited by the solubility of gypsum, with some free sulfuric acid and aluminum sulfate.

Rate of Acid Generation

The initial rate of acid generation within the waste containment facility would be primarily controlled by the diffusion of oxygen into the tailings. Due to weather fluctuations the oxygen flux would vary widely and would be expected to range from $2.0x10^{-11}$ to $1.0x10^{-8}$ g O_2 / cm^2/sec. during the spring, summer and fall seasons if the tailings surface were left untreated. This oxygen flux range corresponds to an acid generation rate of from 0.1 to 64 lb of sulfuric acid/acre/day. The most likely average oxygen flux of $1x10^{-10}$ g/cm^2sec. corresponds to an acid generation rate of 0.75 lb/acre/day, or a total of approximately 100 lb per day.

The company proposes treatment to prevent acid generation rather than to treat acidic seepage water through lime injection wells or treatment of surface seepage.

Acid Prevention Measures

The rate of acid generation could be reduced by treatment of the upper surface of the tailings upon the cessation of mining. The application of lime-based chemicals directly within the uppermost tailings layer by slurry would passivate the pyrite mineral surfaces and would also neutralize acid formed in the aerobic zone. The installation of a sealant, such as bentonitic clay on top of the tailings surface, would reduce the oxygen flux and thereby inhibit initial oxidation of the pyrite. The effectiveness of such measures, cannot be quantified at this time. Experimental studies of the actual tailings materials in situ would be required to develop the quantitative information needed to design an effective set of treatment procedures.

Monitor wells to detect seepage and obtain samples for analysis and study have been installed and additional wells are planned to provide warning of any deterioration of groundwater quality. Surface water would have to be sampled to monitor the quality of water reaching the peat area, stream G, and ultimately the Flambeau River.

Peat Filtration

Both groundwater and surface water flow to the southwest from the waste containment area. Seepage would encounter a large area of peat type soils. The peat is acidic as indicated by the presence of blueberry plants. Surface water samples in the peat area have had a pH of 5.5 to 6. If the seepage is acidic, neutralization would not take place as it flows through the peat area. However, the peat may tend to adsorb some trace metals which would have been freed by the acidic seepage.

Experimentation showed that peat is capable of adsorbing heavy metal ions and alcohol, cresols, and dithiophosphate. Peat does have a finite adsorbtive capacity which indicates that in time all available adsorbtive space would be occupied and a flow through of metal ions would occur. In addition, metal ions are known to compete for available adsorption space. This presents the possibility that ions which were initially held by the peat could be displaced by more competitive ions and would be moved down gradient to the next available space. Ultimately this process would lead to contamination of the entire peat area and flow-through of metal ions would occur and contaminate ground or surface waters. The time required for adsorbtive saturation cannot be estimated from available data.

Effect on Flambeau River Unknown

After flowing through about 1½ miles of peat, the seepage would become part of the flow of stream G which flows for about one mile before entering the Flambeau River. Because of the uncertainties of the chemistry and quantity of the seepage, impacts on the Flambeau River are difficult to predict, but in all likelihood the acids and heavy metal ions would be detrimental to surface and groundwaters and to vegetation.

The discharge of 135 million gallons of treated waste process water from the waste containment area to the Flambeau River is expected to be able to meet current water quality standards. Although there may be some degradation of water quality for a short time, this impact should not be significant.

Tributary Streams

Impacts on water quality in tributary stream A would be limited to a minor amount of siltation for a short time during the construction period while a pipeline crossing is installed. Intermittent tributary stream B would be largely eliminated since its watershed is mostly within the perimeter of the planned open pit. The remaining course of this stream between the pit perimeter and the river would not be disturbed. It would drain no waters from within the pit since these would be directed into the 1,085 level collection system.

Impacts on water quality in tributary streams C and D would also be limited to minor amounts of siltation during the construction of the waste haul road while culverts are installed. During the installation of the culverts, the streams would be diverted and temporary dams would be constructed to provide settling ponds for control of siltation. Upon the completion of construction, the dams would be removed and the collected silt would be added to the FMC soil stockpile.

Any unplanned leakage from the tailings or water reclaim pipelines would not enter streams C and D, or other surface waters. The pipelines would be laid along the east shoulder of the haul road, away from the river. The lines would be elevated on a slight arc over the crossings of streams C and D, and catchment basins would be provided on either side of both streams to contain any leaking from the pipelines.

Minor amounts of siltation would occur during the construction period while stream E is rechanneled around the southeast section of the waste containment area. Temporary settling ponds would be constructed to control this siltation. Some siltation would occur periodically throughout the life of the open pit operation as the waste containment dikes are constructed. This would be controlled by temporary settling basins and by vegetation of the lower, already completed, portions of the dikes. Any siltation escaping would quickly settle out in the sluggish waters of the adjacent wetland.

Geologic Features
Ore Body

A direct and irreversible impact of the mining operation would be the depletion of the known mineral resources contained within the project area.

All economically recoverable copper would be extracted from the orebody. Yet-to-be-determined characteristics of the deposit itself, and future technology and economics would determine the ultimate extraction. Because the halo mineralization bordering the orebody is so low in grade and limited in quantity, the possibility is small that future advances in technology and economics would ever permit later extraction of this material. The known usable copper resources of the project area would be totally exhausted by the mining operation.

Other commodities of potential worth contained in the ore deposit are gold, silver, zinc and pyrite. At least 60 percent of the gold and silver contained in the ore would be recovered in the processing of the copper concentrates. The feasibility of adding a flotation circuit in the mill to produce zinc-bearing sphalerite concentrate would be evaluated before mining reaches the deep-lying mineralization which contains potentially recoverable amounts of zinc. The pyrite-bearing tailings to be produced as an unavoidable by-product from the milling of the copper ore constitute a potential sulfur and iron resource which would not otherwise be available. Although a market for this material is being sought, none is known at this writing.

Gravel

Well sorted gravel of sufficient quality to be considered a mineral resource is present only in the glacial outwash deposits located west and north of the orebody. Only a small amount of this material would be removed in the excavation of the open pit. If underground mining of the lower portion of the orebody is undertaken, approximately 1.2 million cubic yards of gravel would be used as backfill in the stopes. This material would be obtained from the former Rusk County gravel pit located 2,000 feet north of the mine. As Rusk County contains ample gravel reserves, the extraction of this amount of usable gravel is of little consequence.

Stimulate Exploration

The presence of an active mining organization in Grant Township would create an intangible and potential impact by fostering mineral exploration and thereby increasing the likelihood that additional mineral resources might be discovered, either on the project site or elsewhere in the region. It has been established by exploration drilling and geophysical surveys that the project site contains no shallow mineralization other than the known orebody that could be mined by open pit methods. The proposed surface facilities would not render any presently-unknown orebodies unminable.

Topography

There would be four impacts on the landscape: two excavated pits, a low flat-topped hill and a road bed.

The open pit as proposed would occupy 55 acres and would be approximately 285 feet deep at its deepest point. This major geomorphological impact would exist during the final months of operating the open pit or for eleven more years should it be decided to continue with underground mining beneath the open pit. At the cessation of mining the open pit would be allowed to fill with water and the walls above the water level would be

Create Lake

contoured to slope approximately fifteen degrees toward the lakeshore. Thus, the final impact on the landscape would be an artificial lake covering approximately 45 acres set within a 10 to 50-foot deep basin.

The waste containment area would present a flat-topped hill occuping 186 acres. Depending upon contingencies related to the sale of pyrite tailings and the economic advisability of underground mining at the end of the open pit mining, the waste containment hill could be 30 to 60 feet high with a top surface of approximately 145 to 160 acres.

The remains of the haul road bed would persist as a low, ridge-like hill in some areas. Cuts, embankments and the right-of-way through wooded areas would be visible. The most significant geomorphological feature on the project site, the steep river banks located on the outside meander banks of the Flambeau, would not be physically disturbed by the mining operations.

Possible New Gravel Pit

Should it prove economically feasible to extend the mining operation a second eleven years via underground mining, there would be additional excavation within the now-abandoned Rusk County gravel pit and possible expansion of this pit by as much as 30 acres. The rehabilitated gravel pit would form a gently-sloped basin some 20 feet deep.

Some Soil Loss

Large quantities of soils would be moved, manipulated, stored and reused during the life of the proposed operation. Erosion would be controlled by fertilizing and vegetating exposed soils and slopes.

An unavoidable impact of the manipulation of soils would be the upset of flora and fauna residents on the soil surfaces and in the organism-modified humus layers. These organisms and soil profiles would be mostly lost. No provision for segregation of soils according to profiles is planned as the humus layer is generally quite thin. Company tests have indicated that subsoils (parent materials) can support the growth of seed mixtures if there is use of recommended fertilization and liming. Most of the soils to be moved and reused are acidic in nature. As they would be reused, the pH would be adjusted to 6.5 to 7.0 with lime. This will improve their capability for production of soil-stabilizing vegetation.

206 Acres Lost

Much soil would be covered through emplacement of buildings, construction of the haul road and construction of the waste containment area. Approximately 206 acres of soils would be permanently covered with these structures; about three acres would be covered under the plant site to be rehabilitated later when buildings are removed and roadways restored. Presently these soils support mostly pasture and old field, and lesser amounts of mixed forests.

The quantities of soils lost to erosion are difficult to predict. The majority of soils to be manipulated are dense silty sands and clays, and are highly impermeable and water retentive after saturation. Such soils are subject to rapid erosion.

BIOLOGICAL ENVIRONMENT

Vegetation Loss

An estimation of the acreage of vegetative types which would be altered or lost due to mine construction is given in Table 27. The bog, river basin, and wooded swamp communities would be unaffected by construction. Less than 10 percent of the mixed deciduous-coniferous lowland and the shrub swamp would be altered. The meadow and old field would experience an acreage reduction of 10 to 15 percent. If seepage from the waste containment area is acidic and contains heavy metal ions, some destruction of the bog, wooded swamp, meadow, and mixed deciduous-coniferous lowland forest communities down gradient of the waste containment area could occur. Major losses of producing agricultural fields and mixed deciduous-coniferous upland forest would result from construction. Reforestation and maintenance of the remaining producing agricultural land would partially mitigate these losses.

Wildlife

Mammals

The disruption of nearly 350 acres would displace and ultimately destroy many mouse-size mammals. This would eliminate the food supply of their predators, and it is reasonable to assume that the presence of such mammals as weasel, mink and fox within the project site would be reduced. Disturbance of areas of climax forest would eliminate much of the on-site habitat for squirrel-like mammals. These animals would be dislocated and ultimately destroyed. Similarly, competition for the reduced range would eliminate some larger mammals. Those animals remaining would be somewhat restricted in

Barriers

their movements by barriers such as the open pit, haul road, and waste containment area. The mine site and waste area would reduce opportunities for east-west movement. The haul road would be partially restrictive since animals would cross it, but there would be some road kill. Local migration routes may tend to be reoriented to a more north-south pattern.

Birds

The destruction or alteration of habitat would result in the loss of some birds. With one exception, neither the habitat types nor species present are unique to this area. Bald eagles, which are on the Wisconsin Endangered Species List, have been observed over the project site. Since eagles are primarily fish eaters and observations have been in late fall over land areas, it is assumed that the individuals are migrants. No eagle nesting areas are known to exist near the project site. Therefore, no significant effect on these birds would be anticipated.

Reptiles & Amphibians

The numbers of reptiles and amphibians would also be reduced due to habitat loss. The major area of concern is the possible leaching of soluble salts from the waste containment area and associated variations of the pH. The permeable-skinned amphibians such as fogs and salamanders would not be able to tolerate these habitat alterations. The more mobile impervious skinned reptiles such as turtles and snakes would be able to relocate if suitable habitat were available.

Fish & Aquatic Life

No signficant flow alteration or direct discharges are anticipated from the mine operation. The only possible source of river contamination would be seepage from the waste containment area. This seepage would flow through 1.6 miles of peat bog before reaching tributary stream G which enters the Flambeau River about two miles above the Thornapple Dam. Toxic effects on fish and aquatic life cannot be estimated, but seepage from the waste area may be detrimental to fish and aquatic life.

<u>SOCIO-ECONOMIC IMPACTS</u>

Historical & Archeological Sites

No significant historic or archeologic sites have been discovered at the project site. The State Historical Society has recommended that a qualified archeologist be on-site when surface areas are disturbed during construction to insure that no sites are damaged or disturbed.

Recreational Facilities

The increased population stimulated by employment opportunities at the mine would create a slight additional demand for recreational facilities. It is not anticipated that this demand would exceed the existing supply of facilities. The proposed mining venture would have minimal impact on recreation in the fringe areas of the project site. There is a minor amount of fishing and some trapping in the tag alder marsh and throughout the project site. There is some upland game bird and large game hunting. Although hunting and trapping would be discontinued, fishing would continue to be an allowed form of recreation along the project site.

Loss of Hunting & Trapping Opportunities

Employment & Population

A relatively small increase in population would be expected to result from employment furnished by the project. The estimated number of employees required for construction and operation are given in Table 28. Explanations of the method for preparing the estimates are presented in Appendix N.

TABLE 27

ESTIMATED ACREAGE OF CHANGED VEGETATION COMMUNITIES DUE TO CONSTRUCTION OF MINE

Mine Facility Description	A. Mixed Deciduous-Coniferous Lowland	B. Shrub Swamp	C. Mixed Deciduous-Coniferous Upland	D. Meadow	E. Old Field	F. Bog	G. River Basin	H. Wooded Swamp	I. Producing Agri-cultural Field	Acreage
Total acres with changed use	32	9	70	12.3	12.9	0	0	0	205.8	342
Open pit			41						14	55
Concentrator plant and operation buildings									3	3
Magazines and access road			4						1	5
Waste containment area	23	7		11					145	186
Soil (till) stockpile		2	1	1					32	36
Railroad siding and loading facilities	9			.3	.4				1.8	11.5
Haul road			7						9	16
Public observation point, parking lot and trail					1.5					1.5
Gravel pit (contingent on second phase shaft mine)			17		11					28

Peak Increase

Jobs Created

Table 28 indicates a maximum population increase to the county of about 351 during the peak of the construction period which falls to 127 during the subsequent years of operation. This peak would only prevail for two or three months, and during this period, the population of the county would still be slightly below the 1960 level. During this period, the local jobs available directly on the project would average 120 per month. Service jobs created as a result of this stimulus to the economy are estimated at an average of 34 per month during this construction activity. Following construction and during the subsequent 11 years of operation, the direct employment at the project is estimated at 78; 22 service jobs are also estimated as a result of the operation of the mine. Most of this increase, including the construction crew, would probably come from the State of Wisconsin, so the effect of the Flambeau project on the population of the state should be negligible. The population increase for several months during the construction period would be as high as 2.5 percent which would still not increase the population of the county for these few months to the 1960 level. During the operating period, the increase in population as a result of the project would be only 0.9 percent, and the population of the county as a result of the project would be well below the 1960 level.

Reduced Unemployment

The county presently has a fair existing employment base in agricultural and manufacturing activities. With the exception of the construction period, the project would not be the largest industrial employer in the county as four other manufacturing employers presently have more people on their payrolls than is intended for the Flambeau project. The overall quantitative effect on the percentage of unemployment would be difficult to determine. Some jobs on the Flambeau project would be filled by those presently employed in marginal jobs, and some of these marginal jobs would probably not be continued when vacated. Some now listed as agricultural labor may become employees of the mining operation and still continue their agricultural endeavors to some extent. The effect on employment in Ladysmith is more difficult to predict. Evidently the employment situation in Ladysmith proper is much better than that for the county at large because of the several large employers in the community. In any case, the addition of a substantial basic industry to a small county having a high unemployment percentage would result in an improvement of the unemployment problem.

When the mine closes, a substantial number of employees would be adversely affected. Some job skills, such as heavy equipment operation, construction trades, stenography, chemistry, and accounting, may enable the employees to find other employment in the area. The company also has a policy of attempting to place employees in other operating divisions or with other mining companies. A shortage of persons trained in mining skill makes it desirable for the company to retain skilled persons in the mining industry.

Some Unemployment at Mine Closing

Twenty-eight salaried employees would have been brought into the area at the beginning of mining and most would probably choose to leave the area at shutdown. However, some locally hired hourly wage earners may not be able to obtain jobs locally nor be willing to relocate and may become a burden to local units of government.

Housing

Mobile Homes

There is no surplus housing in Ladysmith. This situation would result in some workers commuting from outside the county. Others would probably be housed in mobile homes near Ladysmith. This would have a temporary land use impact, as parks would develop to accommodate this demand. Sewer and water service may have to be provided by the City of Ladysmith. Even if 75 percent of all operating employees moved to Ladysmith, the population would increase only 2.6 percent. No new community would have to be built.

Land Use

Disturbed Acreage

During the life of the mine, the following acreages would be disturbed:

	Acres
Mining	
Open pit	55
Gravel (Rusk County pit)	10
Gravel (new pit, contingent)	30
Plant	3
Haulage facilities	
Haul road and pipeline	16
Rail siding	13
Waste containment area	186
Soil stockpile	36
TOTAL	349

TABLE 28

ESTIMATED EMPLOYMENT INCREASE IN RUSK COUNTY AS A RESULT OF THE FLAMBEAU PROJECT

A	B	C	D	E	F	G	H
Elapsed Time After Start of Construction	Total Construction Crew Employees	Total Operating Crew Employees	Total Employees on Project Derived from Residents of County	Total Added Service Employees as Result of Project	Total Added Service Employees from Residents of County	Total New Employees From Out of County	Cumulative Population Increase of County as Result of Project
1 month	8	5	2	4	3	12	28
2	29	5	5	10	8	31	59
3	34	5	6	11	8	36	68
4	60	5	10	18	14	59	105
5	80	5	13	24	18	78	137
6	90	5	14	27	20	88	154
7	100	5	16	29	22	96	166
8	100	5	16	29	22	96	166
9	125	5	20	36	27	119	204
10	155	5	24	45	34	147	250
11	170	5	27	49	37	160	272
12	185	5	29	53	40	174	295
13	210	5	32	60	45	198	335
14	220	5	34	63	47	207	351
15	193	10	35	57	43	182	309
16	163	15	33	50	38	157	272
17	140	20	33	45	34	138	245
18	77	78	59	43	32	107	245
19	40	78	53	33	25	73	188
20	30	78	51	30	23	64	172
21	15	78	49	26	20	50	150
22	5	78	48	23	17	41	136
23	5	78	48	23	17	41	136
24 months	5	78	48	23	17	41	136
Average	93	27	29	34	25	100	176
3 years - 12 years	0	78	47	22	17	36	127

This 349 acres is approximately 13 percent of the company's total area. The remaining acreage would be managed on a multiple use basis as shown on Figure 46.

Zoning Changes

The projected zoning changes due to the development of the mining operation are shown in Table 29. Considering the Town of Grant as a whole, these changes are not significant. It should be noted that the FMC would hold nearly 89 percent of all land zoned industrial in the town.

A forty-acre tract, the NW¼, NW¼, Section 21, would have to be changed from Resource Conservation to Industrial to accommodate the waste containment area. The west half of that parcel is low lying land which would be unsuitable for industrial use and would remain as shrub swamp regardless of the zoning classification.

Ultimate Use Unknown

The land use plan upon the cessation of mining has not been fully developed. The open pit would become a lake for recreational use and the waste containment area would be revegetated. The ultimate use and ownership plans for the property are not known at this time.

Aesthetics

During the initial development of the open pit, construction of the haul road and buildings, there would be a negative visual impact. At present, the areas to be disturbed have no especially unique scenic qualities. The massive visual impact of construction would be controlled and ameliorated as far as possible through the vegetation management plan which aims to provide tree screening and the revegetating of roadsides, pit edge and other areas as rapidly as possible. Once construction is complete, a unique (to Wisconsin) vista in the form of the open pit mine would be generated, the reaction to which will depend on the aesthetic values of each visitor. At project close, the open pit is expected to be rehabilitated as a deep water recreational lake which may possess positive aesthetic attributes when developed according to the vegetation and shoreline management plans.

The development of the waste containment area would also intrude on the existing landscape. Initially during construction, there would be negative aesthetic impacts, and also later as the dikes are extended upwards in 12½ foot lifts. At project close, the waste containment area would have grown into a symmetrical flat-topped hill with stepped sides covered with grasses and shrubs.

The scenic value of the Flambeau River should not be compromised by this project. Plans to leave and augment existing tree corridors along the shoreland should actually enhance the scenic value of this segment of the river. Tree plantings within the shoreland protection zone of the Flambeau east bank have already been undertaken by the BCMC staff.

Municipal Facilities

There would not be a significant impact on local municipal facilities. The school system is adequate to handle the anticipated enrollment increase of 45 to 70 pupils. No use would be made of city sewerage, water, or solid waste facilities. Law enforcement, fire, and emergency medical facilities would be available.

Utilities

The telephone system has sufficient capacity to meet the limited needs of the mining company.

The total electrical power draw would be about 1.5 megawatts during regular operation and a maximum startup draw of 2.0 megawatts. The monthly electric power consumption is projected to be 1,064,000 kilowatt hours. Such levels could be provided without stress on the capacities of existing generating and distribution facilities.

The proposed 5,450 foot railroad spur with its 100-foot right-of-way would require alteration of about 12 acres. No unique habitat areas or topographic features would be affected. A township road and State Highway "27" would be crossed.

FIGURE 46

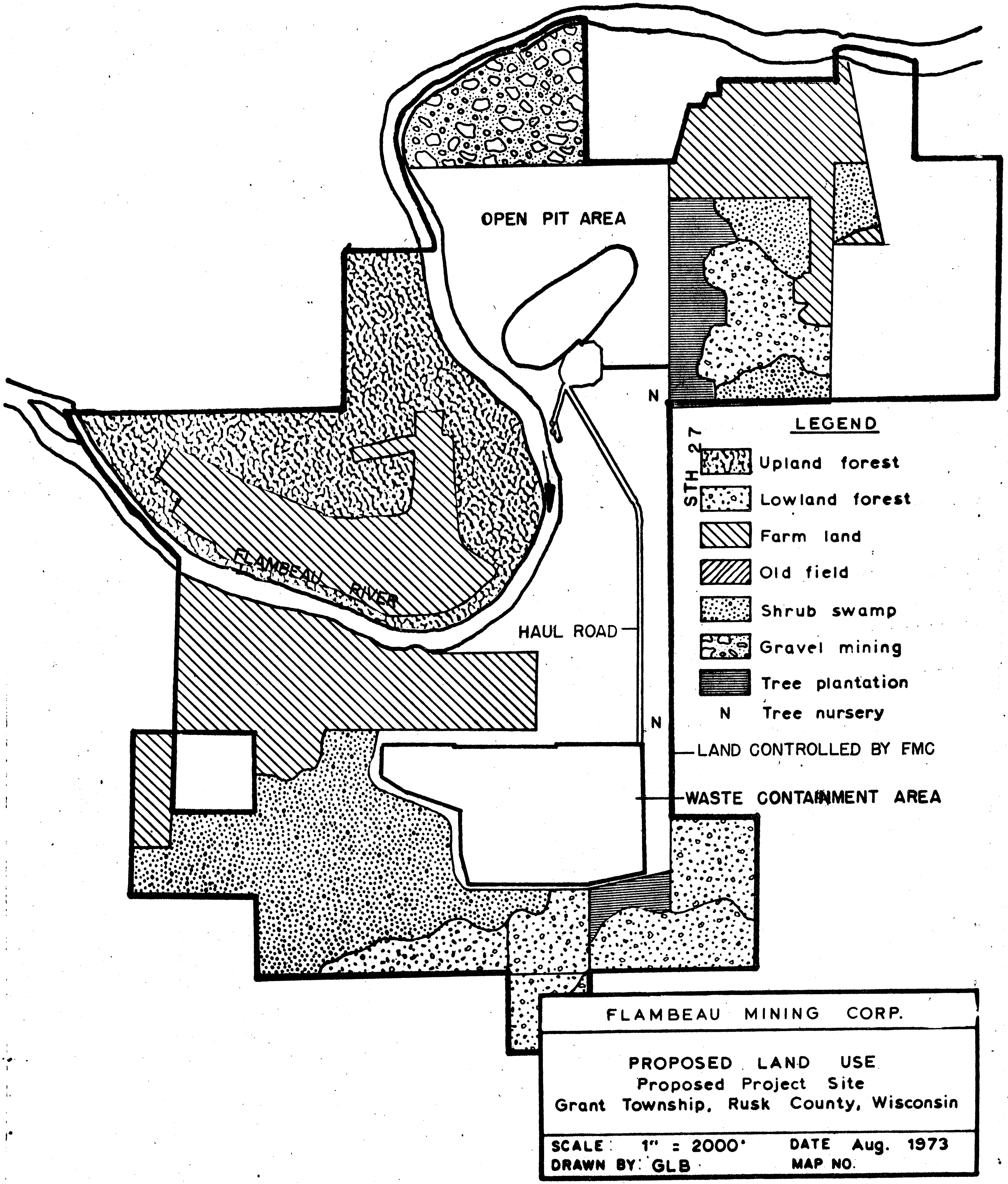

OPEN PIT AREA
FLAMBEAU RIVER
HAUL ROAD
N
STH 27
LEGEND
Upland forest
Lowland forest
Farm land
Old field
Shrub swamp
Gravel mining
Tree plantation
N Tree nursery
LAND CONTROLLED BY FMC
WASTE CONTAINMENT AREA
FLAMBEAU MINING CORP.
PROPOSED LAND USE
Proposed Project Site
Grant Township, Rusk County, Wisconsin
SCALE 1" = 2000'
DATE Aug. 1973
DRAWN BY GLB
MAP NO.

TABLE 29

PROJECTED ZONING CHANGES DUE TO DEVELOPMENT OF THE FLAMBEAU DEPOSIT

Land Use Zones	Approx. Grant Township Zones		Proposed FMC Land Use		Resultant Land Use Zones in Grant Twp.	
	Acres	Percent	Acres	Percent	Acres	Percent
Agricultural	14,072	61.1	1,770	64.3	13,765	59.8
Industrial	290	1.3	528	19.2	597	2.6
Residential	1,000	4.3	176	6.4	1,005	4.4
Resource Conservation	2,330	10.1	120	4.4	2,290	9.9
Forestry	2,006	8.7	116	4.2	2,006	8.7
Commercial	110	0.5	0	0	105	0.5
Incorporated	2,000	8.7	0	0	2,000	8.7
Water and other	1,223	5.3	?	-	1,223	5.3

Transportation

County Highway "P" between its intersection with State Highway "27" and a point 4,400 feet to the west would be significantly altered. To ensure safety and free movement, the FMC heavy truck traffic on the haul road between the mine and the waste containment area would be segregated from public traffic on Highway "P". To accomplish this, Highway "P" would be carried over the FMC haul road by means of an overpass to be constructed at FMC expense and according to specifications approved by the county. During its construction, traffic on County Highway "P" would be inconvenienced for a period of approximately two months. An alternative route from State Highway "27" to the continuation of County Highway "P" west from the southwest corner of Section 20 exists via a gravel township road. Impacts on the flora and fauna, drainage and other factors by this action are expected to be minimal since of this right-of-way has already been disturbed.

Traffic Delays

Other than construction of the rail crossing, no alteration of State Highway "27" is envisioned. Traffic on the highway would be inconvenienced for a period of approximately two weeks during the construction of the crossing. The crossing would be made at a right angle to the centerline of the highway and would be constructed at FMC expense according to specifications approved by the Wisconsin Department of Transportation and the Public Service Commission. Rail traffic on the spur line to the concentrator would interrupt traffic on the highway during two intervals of approximately two minutes' duration each on every other day throughout the life of the mining operation. As far as practicable, rail traffic on the spur would be scheduled for hours of low highway traffic density.

Because of the proximity of the open pit to State Highway "27" and the danger from an occasional flying rock during blasting, it would be necessary to stop traffic for a period of roughly five minutes during some blasts, depending upon the location of the blast. Blasting would take place once per week in the summer and six times per week in the winter as presently planned.

The peak time for a traffic density increase and potential safety hazards would be during the construction phase of the project. There would be 225 persons reporting to work daily during the 14 months as well as deliveries of construction material and equipment. During mine operation, an estimated 30 trips for all company vehicles per day would be made on State Highway "27" and ten or fewer on County Highway "P" for mine company business. Employee trips would be considerably reduced as the arrivals and departures of the 78 employees would be spread over three shifts daily.

There is no way to estimate traffic density changes due to visitors to the mine. The parking lot to be provided at the observation point on the northeast edge of the pit should reduce potential traffic hazards caused by persons stopping along Highway "27" to view the operation.

The existing 34-inch Lakehead Pipeline Company oil line would be crossed by the FMC haul road about ¼ mile north of County "P". A liaison relationship between the two companies has been established to insure that adequate protection of the pipeline would be assured. Details of the crossing of the line are not available, but it is anticipated that construction of, and operation on the haul road could be carried out with no impact on the pipeline.

Economic

The local economy of Rusk County would be affected primarily by payroll expenditures. During the construction phase, the annual payroll would average $1,900,000. An additional $200,000 would be spent locally for goods and services during this period. These $2.1 million would continue to circulate in the local economy and produce indirect secondary benefits which cannot be quantified.

Payroll

The annual direct local economic impact during the operating period would be $1,220,000 consisting of $1,020,000 in wages and $200,000 in local purchases of goods and services. Similarily, this money would circulate in the local economy and would stimulate secondary economic benefits.

Capital Expenditures

Since Wisconsin is a major manufacturing center of mining equipment, some of the $11.2 to $14.2 million dollar expenditure for the plant, machinery, and equipment would probably be made in the state.

Statewide, these economic benefits would be insignificant but locally there would be a major economic benefit if the mine is put into production. Upon closing the operation, some dislocations in the local economy would be expected as community income is reduced.

Income Taxes

The estimated average yearly taxable income for the Flambeau project is $3,600,000. Based on the Wisconsin corporation income tax rate of 7.9 percent, the income to the state from this source would be $284,400 per annum.

The estimated average yearly salary of direct employees on the project during the construction period with the estimated average yearly salary of service jobs created by the project together with the estimated yearly state personal income tax for each of these categories is shown in Tables 30 and 31.

Sales & Excise Taxes

In 1972 the sales and use tax in the state was approximately 63 percent of the personal income tax collected, and the alcohol and tobacco tax about 18 percent of personal income tax. In Rusk County these percentages were 99 percent and 36 percent respectively. Based on the statewide averages, which are more conservative than those for Rusk County, and based on the anticipated income taxes as set forth in Tables 30 and 31, sales and use taxes during the construction period would amount to approximately $146,700. During the operating period, the anticipated sales and use taxes would total $35,700 annually. Annual excise taxes could total approximately $10,200 during this period.

Property Taxes

The method of taxation of both real and personal taxes in Wisconsin has undergone many changes in the recent past. Although these changes are capable of general definition within the framework of this report, revenues that might be expected to be generated at various levels of state and local government are subject to many variables including changes in the law itself, local revenue needs, and final formation of disbursements from the county and municipality shared tax account. With these constraints in mind, the following estimates are made:

Real Estate and Improvements: A copper mining operation is considered for purposes of real estate taxation in Wisconsin to be manufacturing under Wisconsin Statutes, Section 70.995 (1).

The method by which real property used in manufacturing would be subjected to taxation by the local government has recently been changed. Under Wisconsin Statutes, Section 70.995, the Department of Revenue is now responsible for determining the fair market value of the land and improvements used in manufacturing. After this determination has been made, the Department would determine the local assessment rate and certify the manufacturing property to the local assessor at the local rate. Thereafter the local assessor would enter the manufacturing property on the rolls and the tax would be levied.

This procedure for FMC property in Grant Township for 1974 real estate taxes is set forth in Table 32.

Based on the rates in effect in 1974 and the capital expenditures for land and improvements anticipated by FMC, Table 33 sets forth estimated real estate taxes for the operating phase of the proposed project. It should be noted, however, that this estimate is subject to many variables including fair market valuation, the local assessment rate, the mill rate, revenue needs and other sources of revenue of the county and township. Therefore, real estate taxes may be quite different from those anticipated if copper mining does in fact occur.

By law, the Department of Revenue's determination of fair market value for the land used in copper mining may not include the value of the mineral content (Wisconsin Statutes, Section 70.995 (5)). This value is taxed as a production tax under Chapter 283 of the Laws of 1973, now Wisconsin Statutes, Section 70.87.

TABLE 30

ESTIMATED AVERAGE YEARLY SALARIES AND INCOME TAX FOR CONSTRUCTION PERIOD

Class of Worker	Average Number Employed	Average Yearly Income	Yearly State Personal Income Tax	Total Yearly State Personal Income Tax
Construction and operating	120	$15,800	$898	$107,760
Service employees during construction period	34	7,500 (est.)	255	8,670
Total yearly				$116,430
Construction period 2-year total				$232,860

TABLE 31

ESTIMATED AVERAGE YEARLY SALARIES AND INCOME TAX FOR OPERATING PERIOD

Class of Worker	Number Employed	Average Yearly Income	Yearly State Personal Income Tax	Total Yearly State Personal Income Tax
Construction crew including supervision and administration	78	$13,077	$654	$51,012
Service employees during operating period	22	7,500 (est.)	255	5,610
Operating period yearly total				$56,622

TABLE 32

1974 FMC REAL ESTATE TAXES

	Land	Improvements	Total
Full value as determined by Department of Revenue	$1,248,675	$ 51,600	$1,300,275
Local assessment rate (83%)	1,036,400	428,250	1,464,650
Mill rate .036679 - Total Tax			53,722

Distributed as follows:

State	.000241	$ 353
Reassessment	.0014045	2,057
County	.006791	9,946
School - Ladysmith	.028918	42,355
Vocational school	.0015995	2,343
Grant Township	.001	1,565
Gross tax	.039954	$58,519
Less state tax credit	.003275	4,797
Net real estate tax	.036679	$53,722

TABLE 33

ESTIMATED FMC REAL ESTATE TAXES DURING OPERATIONS

	Land	Improvements	Total
Estimated full value	$2,250,000	$1,050,000	$3,300,000
Estimated local assessment rate (83%)	1,867,500	871,500	2,739,000
Mill rate .036679 - Total tax			100,464

Distributed as follows:

State	.000241	$ 660
Reassessment	.0014045	18,294
School - Ladysmith	.028918	79,206
Vocational school	.0015995	4,381
Grant Township	.001	2,739
Gross tax	.039954	$109,434
Less state tax credit	.003275	8,970
Net real estate tax	.036679	$100,464

Production Tax: Chapter 283, Laws of 1973, which became effective June 16, 1974, imposed a production tax equal to 1.5 percent of the fair market value of copper-bearing ores and concentrates mined in Wisconsin.

Distribution of this tax under section 70.90, Wisconsin Statutes, would return 1.25 percent to the county, 2.75 percent to the town, village or city wherein lands from which the minerals being extracted are located, 10 percent to the state general fund and the balance to the municipal and county shared tax account.

Based on these sections of the Wisconsin Statutes and expected production and values, the following might be expected:

TABLE 34

PRODUCTION TAX

Average annual production		
Tons copper		11,286
Ounces gold		13,989
Ounces silver		149,297

Estimated market value of production (1974 dollars)

	High	Low
Copper ($0.85/pound)	$19,186,000	
($0.60/pound)		$13,543,000
Gold ($150.00/ounce)	2,098,000	2,098,000
Silver ($4.50/ounce)	672,000	672,000
TOTAL	$21,956,000	$16,313,000
Production tax - 1.5% of market value	$329,000	$245,000
Rusk County receives 1.25% of tax	4,112	3,062
Grant Township receives 2.75% of tax	9,048	6,738
State general fund receives 10% of tax	32,900	24,500
The balance goes to the municipal and county shared tax account	282,940	210,700

The direct benefit to Grant Township and Rusk County is relatively small under this method of taxation. The ç eatest benefit of the tax would be to the state's municipaland county shared tax account. Tracing the production tax through this account back to Rusk County and Grant Township is a much involved process, subject to many variables, and therefore is not presented in this report.

However, it might be well to note that some of the differences between revenues collected by the state in comparison to disbursements made to Rusk County and Grant Township would be reduced by the production tax, as well as the income taxes discussed above and miscellaneous taxes discussed below.

Personal Property Tax

Manufacturing Machinery and Equipment: This category of property is now exempt from property taxation, Section 70.11 (27), Wis. Stat. if used exclusively and directly by a manufacturer in manufacturing tangible personal property. However, if the local unit of government would have received revenues based on property now exempt under Section 70.11 (27) for 1974, the state would make certain payments to the local unit, Section 70.996, Wisconsin Statutes. FMC had no manufacturing property in Grant Township on May 1, 1974, and therefore the township would not receive any state aid.

Manufacturer's Materials and Finished Products: By 1978 this class of personal property will be exempt from taxation, Section 70.04 (3), Wisconsin Statutes. However, in 1978 for property entered on the tax rolls as of May 1, 1977, the state will pay to the local government unit 100 percent of the tax that would otherwise have been paid and a decreasing amount by 10 percent each year thereafter until 1988 when no further payments will be made. Thus, the amount of revenue that the local unit of government might expect to receive would be dependent upon what value is includable on the May 1, 1977 roll. It will also be dependent upon whether or not unrefined copper ore would be included within this class.

Assuming both these contingencies are met to the local governmental unit's benefit, Grant Township might expect the following revenues:

TABLE 35

MANUFACTURER'S MATERIALS AND FINISHED PRODUCTS TAX

Expected annual production of copper	11,300 tons	
Average weekly inventory on hand (once weekly shipments)	217 tons	
	High	Low
Estimated average inventory value	$422,000	$314,000
Estimated mill rate 1977 (0.036679)		
Tax for 1978 received from state	15,479	11,517
Total payments 1978-1987 from state (5.5 times 1978 payment)	85,135	63,344

Upon closing of the mine, most of these revenues would be lost and Rusk County and the Town of Grant would probably require a disproportionately large share of state aid as they do now.

ALTERNATIVES TO THE PROPOSED ACTION

ACT OF MINING

The major alternatives to the act of mining itself are the deferment of development of the deposit or the abandonment of any development plans for the deposit.

Defer Development

Deferment of the development of this deposit for the indeterminate future would delay the impacts of mining, but would not necessarily reduce the adverse impacts or improve the beneficial aspects. Deferment could require that mining take place after more of the surrounding area is developed and therefore the adverse impacts could be increased. There is some chance that deferment could compromise the economic viability of this deposit, although in light of domestic mineral shortages, this seems unlikely. The technology of mining may advance to the point that adverse environmental impacts would be reduced.

No Development

Abandonment of all development plans would mean that a domestic mineral resource would not be utilized. Increasing demand for copper could increase reliance on foreign sources and/or more rapid depletion of domestic reserves. As third world nations attempt to improve their own economic position, foreign reserves are increasingly unavailable or unreliable sources. Expansion of existing mines would accelerate their depletion, may not be the most economically advantageous way to develop these resources, would provide no growth in supply, and would merely delay meeting the projected mineral shortage.

MINING METHOD

Underground Mining

There are two feasible methods for mining the Flambeau deposit, open pit or underground mining. The lower costs of open pit mining would allow the extraction of more of the shallow low grade ores. Underground mining would require that the shallow ore be left in place to support the till overburden and to protect the underground workings from groundwater inflow along the base of the till.

Surface Disturbance

Open pit mining would provide waste rock and clay material to build the dikes of the waste containment area. The company feels that the traditional method of containing tailings behind dikes built from the course fraction of the tailings themselves is not sufficiently reliable to protect against the possibility of a dike failure. Therefore, if the underground mining method were employed, material to construct the dikes would have to be borrowed from other areas which would not have been disturbed by an open pit mine. The company estimates that between 103 and 130 acres would be disturbed for borrow which could be provided with a surface disruption of 55 acres if the open pit method was used.

Safety

Labor

In addition, the open pit mining is a physically safer method for the operators, including less risk of exposure to chronic health hazards such as silicosis. Skilled labor supply is more easily obtained for an open pit operation than for an underground operation. However, underground mining would require more employees and therefore more money would enter the local economy.

RECLAMATION

Open Pit

There are only two principal reclamation schemes possible for the open pit. The pit could be filled with waste material or it could be filled with water.

The company indicates that because of swell, only 3/4 of the total waste material could be accommodated by the open pit. DNR calculations indicate that the abandoned pit would have a volume in excess of 10,000,000 cubic yards. The proposed mining operation would generate waste material held inside the waste containment area in the following volumes in cubic yards:

	Open Pit Phase	Underground Phase	Totals
Waste Rock	4,109,999	36,344	4,146,343
Tailings	1,744,975	1,870,602	3,615,577
Washing Plant Silt	----	547,051	547,051
Total	5,854,974	2,453,997	8,308,971

Fill Pit With Tailings

It appears that all material held within the waste containment area could be deposited in the pit. Only the dike walls would remain at the site of the waste area. Relocation of the tailings would expose them to oxygen and would possibly increase acid production. However, the tailings would be held in the solid Precambrian rock basin and acid would be unlikely to escape to ground or surface waters. Sealing the tailings at the top of the Precambrian bedrock surface would reduce the possibility of contamination of groundwaters which would flow over the top of the basin. The company has examined this alternative but could not economically justify the combined cost of building the waste containment dikes and then returning the tailings to the pit at mine closing.

Natural Water Inflow

There would be several means of filling the open pit with water. If left unattended, groundwater inflow and precipitation would eventually fill the pit. Although this alternative would have little cost to the company, it would not produce a usable lake for several years and therefore would have no beneficial use during that time.

Untreated Process Water in Lake

The second alternative involves pumping the mill process water and tailings slurry water into the pit upon cessation of mining. This industrial waste water would constitute 135 million gallons of the two billion gallons of water required. The remainder would be filled with river water, groundwater inflow, and precipitation at the following rates:

Source	Rate (gal/min)		Time (days)		Total Gallons
Waste Containment Area	557	x	168	=	134,749,440
River Siphon	5,950	x	168		1,439,424,000
Groundwater Inflow	1,620	x	168		391,910,400
Net Precipitation	124	x	168		29,998,080
Total					1,996,081,920

This plan was initially proposed by the company. It called for the formation of a nonmixing lake in which the polluted wastewater would remain in the bottom of the lake because of its chemical density and thermal stratification within the deep pit lake. It is the Department's opinion that this alternative would constitute environmental pollution as defined in Section 144.30(9), Wis. Stats. This could preclude the issuance of a permit for the pit lake required under Section 30.19, Wis. Statutes.

Waste Containment Area

Location

Five alternate sites for the waste containment area were evaluated, but only two were given serious consideration. The proposed site, Site A, is in Section 21 and is described earlier in this report. Site B is located in Section 10 directly east of the open pit and east of Highway "27" (see Figure 45).

There would be economic and operational advantages to Site B. The distance to haul waste rock and pipe tailings would be considerably reduced. This reduced intervening distance would have reduced the project area and reduced the number of displaced residents. There were major disadvantages associated with Site B, however. An elevated crossing of Highway "27", would be required. The waste containment area would be more visible because of its proximity to Ladysmith and the higher base elevation. The complex would be within 1,500 feet of the Flambeau River and elevated 55 feet above it. This steep gradient could present hazards in the case of an accidental dike failure. The soils underlying Site B were found to be more permeable than below the proposed site, increasing the possibility of groundwater contamination.

Design

An alternative to the basic design of the waste containment facility involves a combination of sealing the basin and collecting the leachate above this impermeable floor.

Various materials could be used to line the basin. There have been large scale industrial applications of synthetic rubber liners which, if properly installed and sealed, would be completely impermeable. This alternative may be prohibitively expensive.

Clay soil materials could also be used as a sealant. With proper spreading, grading, and compaction, a relatively impervious seal could be created which would significantly reduce the flow of leachate through the floor of the waste containment area and facilitate leachate collection. The 101,000 cubic yard clay saprolite surplus (Appendix J) could be a source of some of this material. Borrow from other sources may also be required.

To collect the ponded leachate above the impervious floor, a series of tile lines would be laid on top of the liner. Leachate would flow to and through these lines by gravity to a central wet well collection area from which it would be pumped to a treatment facility.

During mine operation and depending on the water budget, this leachate may be able to be recycled through the mill process water circuit. If this is not possible, the highly alkaline (pH 11) leachate would have to be treated prior to disposal. Treatment would consist primarily of neutralization to a pH of 6 to 9 by the addition of acid. The effluent would probably be discharged to the Flambeau River.

After mine closure, the addition of alkaline process waters would cease. In time, oxidation of the pyrite tailings would produce an acidic condition in the waste containment basin. Metals would be returned to solution under acidic conditions. To remove the metals, the pH would have to be raised to the 8-9 range in the treatment facility. The metals would be precipitated as insoluble metal hydroxides suspended in solution. This partially treated effluent would then pass through a clarifying system, either a mechanical clarifier or clarification ponds, to physically reduce the loading of suspended solids. The treated effluent could then be discharged to the Flambeau River. The solids collected in the clarifier periodically would have to be collected, dewatered and disposed of. Because of the high concentrations, these wastewater treatment sludges would have to be disposed of at a landfill site licenced to accept such waste (NR 151).

Operations of this treatment facility would have to be carried on indefinitely but would significantly reduce the possibilty of groundwater contamination which could occur with the proposed system.

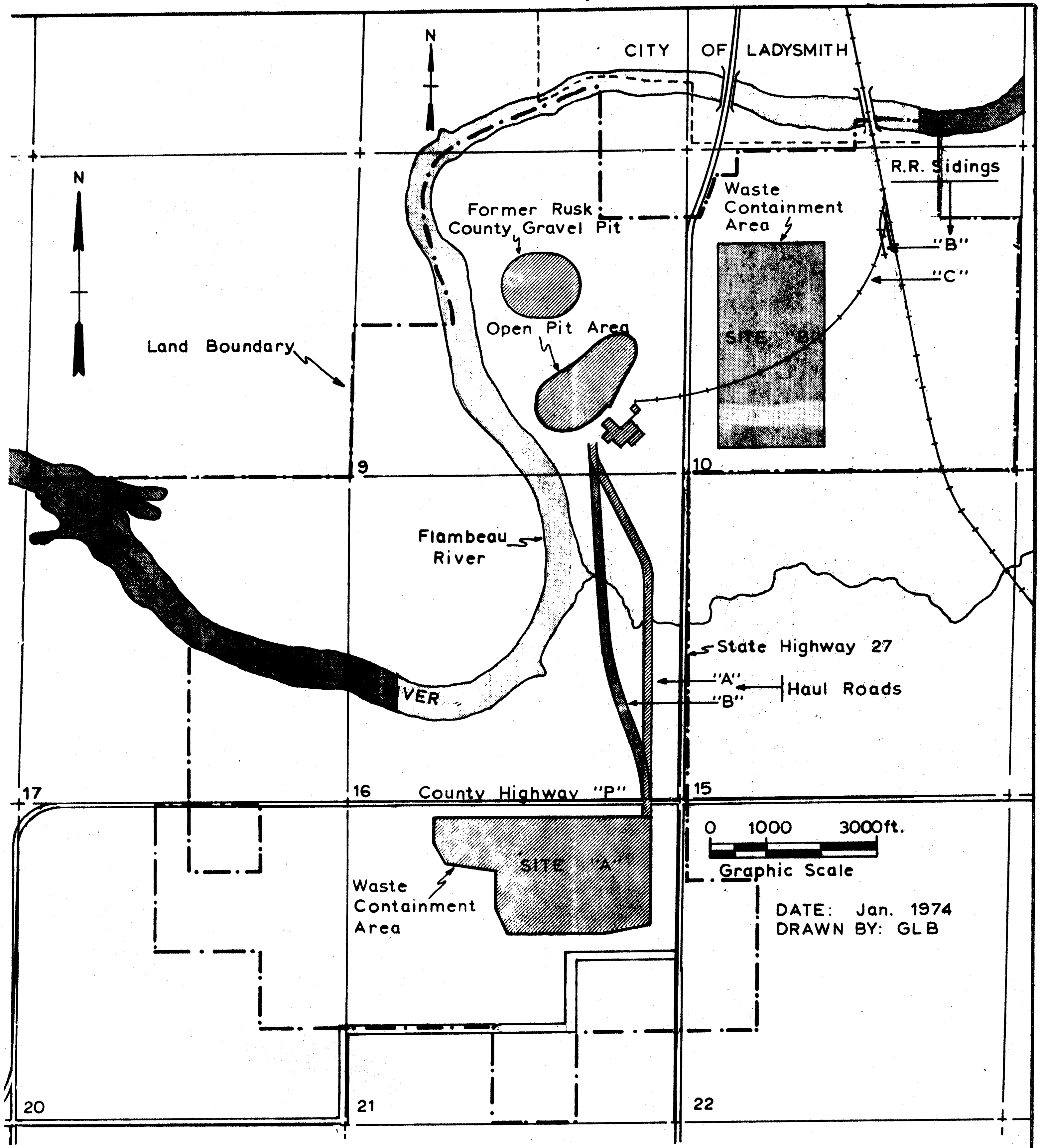
Haul Road Routes

Two alternative haul road routes were considered (Figure 47). Route B is located 500 feet east of the Flambeau River and is the shortest distance from the pit to the waste containment area. Because of its shorter distance, it would cover up less of the land surface. Traffic along this route would produce less noise and dust pollution with respect to the homes in Section 16. On the other hand, traffic on this route would be visible from the river and there would be a greater chance of accidental spills entering the river. The route would cross the floodplain of two tributaries near to the river where long, low-level, expensive bridges would be required. The preferred Route A is located 1,500 feet east of the river. It uses, in part, the existing traffic corridor of State Highway "27". Because of extensive existing tree screening, with gaps filled in by recent tree plantings, it would partially be hidden from view both from the river and the highway. An overpass would be provided in County Road "P" where it crosses the haul road. The haul road would cross the tributaries where they are narrow, thus providing minimum interference with the stream beds.

Plant Site

There are no serious alternatives to the plant site. The proposed site would be as close as possible to the open pit thus providing ease of access and supervision. The existing tree screens can be improved so that it will be virtually invisible from the river and only partly visible from State Highway "27". It would be located to the south of the pit rather than to the north so that it would be further removed from the city and the college-hospital complex, and also so that the products from the pit, namely the ore and waste rock, move in one direction. Sited roughly midway between State Highway "27" and the river, pollution in the form of noise and dust would have minimum impact on either. The exact location of the components within the plant site would be dependent on further soil testing and detailed design work.

FIGURE 47



ALTERNATIVE
WASTE CONTAINMENT AREAS
RAILROAD SIDINGS
AND
HAUL ROADS

Railroad Spur

Three alternative railroad plans were considered (Figure 45):

Plan A - Use the existing Soo Line facility at Ladysmith.

Plan B - Provide a rail siding along the main line in Section 10.

Plan C - Provide a rail spur from the Soo Line into the plant site.

Existing Facilities

Siding in Section 10

Plan A has merit in that by using existing Soo Line facilities, there would be minimal installation cost, no additional new disturbance to site or land use in the township and minimal visual impact. The reasons for its rejection were the long haul from the plant site, the increased traffic within the city and the fact that the corporation wishes to maintain close supervision over the transfer of goods and concentrates from the plant. This is to keep corporate control over spills, dust or noise for which the corporation would be liable. Plan B, to provide a rail siding in Section 10, was investigated and rejected as not being a satisfactory total solution. While long truck haulage through Ladysmith would be eliminated, the plant-truck-rail transfer still remained with the attendant difficulty in total control. A sizable heated storage structure for concentrates would have to be constructed and maintained at a remote location from the plant in addition to the rail trackage.

Spur to the Plant Site

Plan C, to provide a spur from the main line into the plant area, is the preferred plan. While it was recognized that some additional land would be required for trackage (12.8 acres, 100-foot right-of-way), the sizable remote storage facility would not be required. The spur would cross State Highway "27" with an inherent traffic interruption during train movements. However, this cyclic interruption was believed to be superior in safety to the alternative of continuous heavy trucks merging with normal vehicular highway traffic. With all transfer activities confined within the plant, the corporation can better control spills and dust.

Concentration & Smelting

There are no competitive alternatives to the on-site process of concentration by flotation. In recent years, metallurgical research has been increasingly focused on hydrometallurgical alternatives to the smelting process of producing metals from concentrates. This is because of the high capital and operating costs of complying with air pollution laws applicable to smelters. To date, however, none has proved competitive. Accordingly, the concentrates would be shipped out of the state for smelting in existing smelting facilities. The post-concentrating processes are continually being researched by KCC and the position with regard to FMC's concentrate would be continually reviewed.

Industrial Water Supply

Industrial water supplies are expected to be provided by groundwater inflow into the pit and precipitation into the pit and waste containment area. It is difficult to accurately predict long-term rates of inflow, but during pit operations the rate should not exceed 1,620 gpm. Experience with other pits indicates that this rate would decrease rapidly and may be as low as 320 gpm after hydrostatic stabilization. It is estimated that 73 gpm would be lost through concentrate shipments and in the waste containment area. In addition, 150 gpm would be needed for road wetting, shops and irrigation purposes. Accumulated precipitation and groundwater flow into the pit would supply these needs if the actual groundwater inflow exceeds 146 gpm. If this amount of groundwater inflow was not realized, additional water supply would be obtained from high capacity wells located in the vicinity of the gravel pit.

Sewerage Disposal & Potable Water

Connect to Ladysmith System

Several alternatives exist for sewage disposal on site. At a cost of approximately $200,000, a water line and return sewage line could be constructed to municipal lines at Ladysmith. Outside of the cost involved, this alternative involves the construction of a large sewage sump and lift station. A gravity feed sewer is not possible.

Package Treatment System

A second alternative would be to install a small package treatment unit. Effluent could be discharged to an existing lagoon which has sufficient capacity to hold the average 2 gpm discharge during the winter. During warm weather months the lagoon would be drawn down to provide irrigation waters and some nutrients to maintain vegetation within the water table depletion zone around the open pit. Because of the surge of flow through such a plant caused by great inflows at the end of each shift, effective operation of such a plant would be most difficult. A licensed operator would have to be retained to manage the plant. This alternative may prove to be economically and environmentally unfeasible.

Because of the high cost of obtaining water from Ladysmith, the company has chosen to get its potable water supply from a well at the mine site.

PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

Dust and Heating System Emissions

There would be some minor deterioration of air quality because of the mine operation. Fugitive dust would be generated by blasting in the open pit and from truck movement on the haul road. Other emissions would be produced by the heating system in the plant.

Blasting Noise

A minor increase in noise levels would be expected from normal operation. Blasting would produce short duration noise increases.

Lower Water Table Near Open Pit

During mine operation, the groundwater gradient would be altered around the open pit. The southeast to northwest flow would be intercepted and soils around the pit would be dewatered. No producing wells would be affected, but there would be a loss of vegetation due to the lowered water table.

Alteration of Tributary Streams

Stream B, a tributary of the Flambeau River, would be eliminated since its watershed lies within the perimeter of the open pit. Stream E would be rerouted to the south and would alter some flow patterns in the wetlands in the NE¼ of Section 21. Stream G would lose a portion of its watershed to the waste containment facility. In addition, the keyed clay core of the dikes may inhibit groundwater flow into the wetlands drained by Stream G. This loss of natural flow would accentuate the effects of tailings seepage since the dilution factor would be reduced.

Flambeau River Quality

The discharge of 135 million gallons of waste process water would slightly degrade the Flambeau River's water quality. However, it is anticipated that this discharge could meet current effluent limitation standards (see footnote, page 56). The impact of this discharge would be relatively short term since it would be a single discharge over a 180-day period at which time the waste containment area would be dewatered.

Acidic Seepage

The waste containment area would yield up to 25 gallons per minute of seepage which could be extremely acidic in time and could contain elevated concentrations of heavy metal ions. This seepage would enter a peat bog which in turn is drained by a tributary of the Flambeau River. If heavy metal ions flow through the drainage system and into the Flambeau River, they could be detrimental to the vegetation of the intervening wetlands and also to the fish and aquatic life of the Flambeau.

Altered Landscape

The open pit operation would eliminate the existence of the ore body and would destroy 55 acres of woodlands and field. The waste containment area would destroy 186 acres of wetlands and fields. The proposed pit lake and the revegetated waste containment area would replace the natural landscape features of the site.

Soil Loss

The open pit operation would disturb some gravel deposits along the northwest corner of the pit. This gravel, along with other soil material stripped from over the orebody, would be used to construct facilities such as access roads, the haul road, and the waste containment dikes. During the soil stripping, stockpiling, and later construction uses there would be some erosion which reduces the quantity of the soil resource and the quality of the lands and/or waters in which the soil is deposited. In addition, 206 acres of soil would be permanently covered by mine facilities. Their productivity would be lost forever.

Loss of Vegetation

Significant losses of productive agricultural fields and the mixed deciduous-coniferous upland forest would occur on the project site. Other wetland vegetation types could be significantly affected if tailings seepage becomes acidic and carries high concentration of heavy metal ions.

Some Wildlife Loss

The disruption of a total of 349 acres would alter or eliminate wildlife habitat and ultimately reduce the wildlife populations. This loss cannot be quantified. No rare or endangered species would be affected.

Housing Shortages

Unemployment

Employment opportunities would attract some workers from outside of the county. This could create housing shortages, escalate rent prices, and lead to the development of some temporary housing culsters. Upon cessation of mining, some unemployment would result which may place some burden on local and state governments for human resource assistance.

Some Aesthetic Determinations

There would be a negative visual impact during the construction phase of the project. The presence of a large mill complex, stripped soil areas, and road and dike construction would alter the existing landscape.

Traffic Stoppages

Periodic traffic delays would be caused by blasting operations in the pit and rail shipments of concentrate.

THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Short-term Economic Benefits

Within the space of one generation the operation would extract an entire mineral deposit. During mine life, a significant economic benefit would accrue to the local municipalities and, to a lesser extent, to the state. It is characteristic of the mineral extraction process that resources are depleted and that the presence of mining in a locale is short-term. There is no way that the benefits of mineral production can be extended in a single economic setting beyond the physical and economic limits of the deposit.

Continued Agricultural & Forest Production

With the exception of about 350 acres, the land of the project site would continue to provide agricultural and forest products as has been its history. Of the disturbed acreage, some could be rehabilitated to its previous uses. The pit lake would produce a permanent resource not now available on the site.

Indefinite Seepage Problem

There is a possibility that seepage from the waste containment area would constitute a long-term problem requiring surveillance for centuries.

Some Unemployment

Unemployment at mine closing may create long-term dislocation for a few, but should not cause major strains on the community's resources since the local economy is not mine dependent.

Stimulate Mineral Exploration

The development of this deposit would undoubtedly intensify exploration for and possible exploitation of other deposits in northern Wisconsin. This could be a significant long-term economic and environmental consequence to the entire state.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES IF THE PROJECT IS IMPLEMENTED

The proposed mining operation would entail irreversible commitments of the following resources: minerals, land, energy, manpower, and materials.

Copper Reserve Exhausted

The known copper reserves contained within the project area which are recoverable by open pit mining would be totally exhausted by the proposed mining operation. Approximately 116,000 tons of refined copper metal would be produced from the extraction and processing of these reserves during the anticipated 11-year life of the operation at an average of 11,000 tons per year (except during the last two years). Most, if not all, of this copper would enter the domestic economy. The anticipated FMC production of 11,000 tons per year is 0.5 percent of the total 1971 United States consumption of refined copper. With respect to Grant Township, extraction of the copper contained in the FMC deposit is a completely irreversible commitment of resources. From a national viewpoint, however, the commitment is not entirely irreversible. Many copper uses are of long duration and it can be assumed that much of the FMC production would enter the domestic copper in-use pool that is ultimately recoverable. As the recovery of copper in all forms from old scrap now equals 20 percent of U. S. Consumption, it can be assumed that at least this percentage of the future FMC production would be recycled at least once.

Associated Minerals Extracted

Possible Disposal of Zinc and Pyrite

Potential by-products contained in the copper reserve are gold, silver, zinc and the iron sulfide mineral pyrite. Self-interest would assure optimal recovery of these commodities by FMC. At least 60 percent of the gold and silver contained in the ore would be recovered in the processing of the copper concentrates. The remainder would be lost in processing, although some of this may ultimately be recoverable from the mill tailings. The zinc contained in the ore would be recovered if it is found profitable to do so at the time mining reaches the zinc-bearing portion of the orebody. Should zinc recovery prove to be economically unfeasible under those future circumstances, the zinc mineral sphalerite would be left in the tailings. The pyrite-bearing tailings constitute a potential sulfur and iron resource which would not otherwise be available. Pyrite is not marketable at this time, therefore, it is planned to deposit the pyritic tailings in the waste containment area. Although this material could later be retrieved and reprocessed to recover the pyrite together with a portion of the previously-discarded gold, silver and zinc, the economic and environmental costs of doing so may be prohibitive.

Extraction of the copper mineralization which will remain below the bottom of the open pit would be contingent upon future circumstances. Yet-to-be-determined characteristics of the deposit itself, such as rock strengths and the nature of the ore-to-waste contacts in detail, which would become known as mining progresses, plus future technology and economics, would determine the ultimate extraction. Should steeper-than-planned pit slopes prove feasible, the economical depth of the pit would be greater, thus reducing the amount of mineralization remaining available for underground mining. A commitment on the extraction of this potential resource would be made during the later years of the open pit mining operation, when all of the parameters would be better known.

Permanent Land Alteration

Two parcels of land - the 55-acre open pit site and the 186-acre waste containment area - would be irreversibly committed to a new use entailing a permanent change in the contour of the land.

Excavation of the open pit to its planned depth of 285 feet will destroy 55 acres of land surface now occupied by upland forest and old-field pasture. A new aquatic and shoreland habitat would be created on this acreage when the pit is rehabilitated to a lake upon the cessation of mining. In man's timeframe, this change will be permanent.

Utilization of the waste containment area would destroy 186 acres of surface now occupied by farmland and wetlands. This area will be covered to a depth of at least 20 feet with the solid waste products to be generated by the mining operation. The entire 186-acre area would be committed to such use from the outset of the operation as the waste containment facility is designed to provide capacity for all waste materials generated by both the open pit and the possible underground mining operations. The surface area to be affected would be the same in all cases; the height of the accumulated waste materials would be dependent upon contingencies related to sales of by-product pyrite and the feasibility of underground mining. When rehabilitated, the waste containment area would form a flat-topped hill from 30 to 50 feet high supporting a vegetation of grasses and shrubs. It would probably never be usable for agriculture because of the potential dangers of bioconcentration of metals by plants grown upon it.

Should underground mining of the mineralization below the economic depth of the open pit prove feasible, the extraction of gravel to be used as underground fill would destroy approximately 30 acres of land surface now occupied by old-field pasture and upland forest. This acreage, which adjoins the former Rusk County gravel pit, would be rehabilitated after use to form a smoothly-contoured depression some 15 feet deep and vegetated with local shrubs and grasses.

Fossil Fuels & Electric Power

Another major commitment of resources would be the energy consumed by the mining operation. Nearly all of the energy used in the operation would be derived from middle-distillate fuels and electric power reserves. On-site energy requirements for the construction period and 11-year open pit operation are estimated to be:

Electric power:	125.4 million KWH
Diesel fuel:	2.7 million gallons
Fuel oil:	1.3 million gallons
Gasoline:	0.5 million gallons

Labor

The commitment of approximately 1,100 man-years of work on the site during the full 2-year construction and start-up period and 11-year operating life of the open pit mine, represent an irreversible commitment of human resources by society at large. In the local system where unemployment is high and job opportunities generally restricted, this would seem to represent a wise investment of human resources.

The capital investment of approximately $15 million by FMC to construct and equip the mine and concentrator would constitute an irreversible commitment of financial resources only if the enterprise should fail. A viable enterprise would not only return the original investment, but would also generate capital for investment in new business activity.

Construction Materials

The commitment of materials required for construction and operation of the mine is not considered to be significant because of the relatively small quantities involved and the fact that much of the material and equipment would have sufficient salvage value to assure its ultimate recovery.

APPENDIX A

WOODY SPECIES WITHIN THE OPEN PIT AREA

FALL SURVEY

GYMNOSPERMAE

PINACEAE
- Pinus rosinosa - red pine
- Pinus strobus - white pine
- Larix larcicina - tamarack
- Abies balsamea - balsam fir
- Tsuga canadensis - hemlock

TAXACEAE
- Taxus canadensis - American yew

ANGIOSPERMAE

ACERACEAE
- Acer rubrum - red maple
- Acer saccharum - sugar maple
- Acer saccharinum - silver maple
- Acer spicatum - mountain maple

ANACARDIACEAE
- Rhus radicans - poison ivy
- Rhus typhina - staghorn sumac

AQUIFOLIACEAE
- Ilex verticillata - black alder
- Nemopanthus mucronata - mountain holly

BETULACEAE
- Corylus americana - American hazelnut
- Corylus cornuta - beaked hazelnut
- Ostrya virginiana - ironwood
- Carpinus caroliniana - bluebeech
- Betula lutea - yellow birch
- Betula papyrifera - white birch
- Alnus rugosa - alder

CAPRIFOLIACEAE
- Diervilla lonicera - bush honeysuckle
- Lonicera canadensis - American fly honeysuckle
- Lonicera tatarica - tartarian honeysuckle
- Sambucus canadensis - common elder
- Viburnum lentago - nannyberry

CORNACEAE
- Cornus alternifolia - pagoda dogwood
- Cornus racemosa - gray dogwood
- Cornus stolonifera - red-osier dogwood

ERICACEAE
- Gaultheria procumbens - wintergreen

FAGACEAE
- Quercus macrocarpa - bur oak
- Quercus rubra - red oak

JUGLANDACEAE
- Juglans cincerea - butternut
- Carya cordiformis - bitternut hickory

OLEACEAE
- Fraxinus nigra - black ash
- Fraxinus pennsylvanica - green ash

ROSACEAE
- Spirea alba - meadow sweet
- Crataegus sp. - thornapple
- Rubus allegheniensis - blackberry
- Rubus idaeus - red raspberry
- Rubus oxidentalis - black raspberry
- Prunus americana - American plum
- Prunus pennsylvanica - pin cherry
- Prunus serotina - wild black cherry
- Prunus virginiana - choke cherry

RUBIACEAE
- Mitchella repens - partridgeberry

RUTACEAE
- Xanthoxylum americanum - prickly ash

SALICACEAE
- Salix Bebbiana -
- Salix discolor - pussy willow
- Salix fragilis - crack willow
- Salix rigida -
- Populus grandidentata - large-toothed aspen
- Populus tremuloides - quaking aspen

SAXIFRAGACEAE
- Ribes cyanosbati -
- Ribes hirtellum - smooth gooseberry
- Ribes rotundifolium -

THYMELACEA
- Dirca palustris - leatherwood

TILIACEAE
- Tilia americana - basswood

ULMACEAE
- Ulmus americana - American elm
- Ulmus rubra - slippery elm
- Ulmus thomasii - cork elm

VITACEAE
- Parthenocissus quinquenfolia - Virginia creeper

APPENDIX B

FERNS AND FERN ALLIES OF THE OPEN PIT AREA

POLYPODIACEAE

- Pteridium aquilinum - bracken fern
- Adiantum pedatum - maidenhair fern
- Atherium Felix - femina - lady fern
- Dryopteris cristata - crested fern
- Dryopteris spinulosa - florist fern
- Dryopteris phegopteris - long beech fern
- Dryopteris disjuncta - oak fern
- Onoclea sensibilis - sensitive fern
- Pteretis pennsylvanica - ostrich fern

OSMUNDACEAE

- Osmunda claytoniana - interrupted fern
- Osmunda cinnamomea - cinnamon fern

OPHIOGLOSSACEAE

- Botrychium virginianum - rattlesnake fern

LYCOPODIACEAE

- Lycopodium lucidulum - shining clubmoss
- Lycopodium obscurum - groundpine (flatbranch)
- Lycopodium annotinum - bristly clubmoss
- Lycopodium complanatum - groundpine

EQUISETACEAE

- Equisetum hymelae - tall scouring-rush

APPENDIX C

LARGER MAMMALS OF PROJECT SITE

Family/Species	Observations (Sightings, Scat, Tracks etc.) Fall	Winter	Spring	Home Range (Acres or Radius from Home Site)
Cervidae				
White-tailed deer (*Odocoileus virginianus*)	X	X	X	80-200 acres
Felidae				
Bobcat (*Lynx rufus*)	X		X	1-2 miles
Mustelidae				
River Otter (*Lutra canadensis*)	X	X	X	not uncommonly, up to 100 miles; normally 20-30 miles
Badger (*Taxidea taxus*)	X		X	1200' from den
Striped skunk (*Mephitis mephitis*)	X	X	X	1/2 mile
Mink (*Mustela vison*)	X	X	X	30-80 acres
Weasel (prob. 3 species, Mustela erminea positive)	X	X sp?	X sp?	30-40 acres
Castoridae				
Beaver (*Castor canadensis*)		X	X	up to 30 miles, but normally near dam site
Canidae				
Red Fox (*Vulpes fulva*)	X	X	X	1 mile
Procyonidae				
Raccoon (*Procyon lotor*)	X	X	X	2 miles
Leporidae				
Snowshoe hare (*Lepus americanus*)		X	X	600-800'
Sciuridae				
Woodchuck (*Marmota monax*)			X	200-300' of burrow
Franklin's ground squirrel (*Citellus franklinii*)			X	1,500'
Thirteen-lined ground squirrel (*Citellus tridecemlineatus*)			X	200'
Cricetidae				
Muskrat (*Ondatra zibethica*)	X	X	X	1 acre

APPENDIX D

SPRING AND SUMMER BIRD SIGHTINGS 1973
(BCMC - EIS)

Month	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7	7	7	7	7	7	7	7	7	7
Day	12	16	21	23	26	28	30	4	6	9	11	13	16	18	20	21	22	24	26	28	29	1	3	5	6	8	10	12	13	15	17	18	16	17	18	19	20	21	22	23	24	25	27	28	29	1	2	3	5	6	7	8	9	10	11	12
Grebe, Homed (Horned)																			1																																					
Grebe, P-b								1					1																																								1			
Heron, G-b									1																																															
Bittern, Am.																						1				2																														
Duck, Wood																							2									2																			2					
Duck, Am-Gold-eye		2	1	1				1			1		1																																											
Duck, Buf.-head	1	4		1	2	6		1	2			1	4	2																																										
Hawk, S-s																											1																													
Hawk, B-w																								1																																
Hawk, Marsh								1																																													2			
Hawk, Sparrow	1											1							1									1					1	1					1										1				2			
Rail, Sora																																1																								
Killdeer	1	1			1				2	1	2	2	1		2				1	1				1	1	1		1	2	3	2	1	1	1		1	2			1	2			1	3	4	2	3	4	1		2	3	1	3	4
Woodcock																1		2			1						1				1				2				1			2	2	1	1	3	1	1	2	1	2	2	2	1	2	1
Snipe, Wilson's																					1				1			2			4	1		3		1					3				1			1								
Plower, Upland															1																																									
Tern, Black																																																					2	10	4	7
Dove, Rock	Common →																																																							
Dove, Mourning											1			2			1	2	3			1	1	1	2	1	1	3	1	1	1	1	2			1	1	1	2	2	1	1				1	1	1	1	1	2			2	1	1
Cuckoo, B-b																																																		1				1		
Nighthawk																																																					1			
Swift, Chimney																				1			2						3		1												1					2								
Kingfisher, B.																				1																1															1					
Flicker, Y-s								1						2	1		1		1	1			1			1	1	2	1	1		1		1	1	1	2	1	1					1		1			1	2	1	1	1	1	1	1
Woodpecker, R-h																																					1														1					
Sapsucker, Y-b																		1		1					1							1								1													2	1		1
Woodpecker, Hairy					1						1						1					1				1					1									1											1					
Woodpecker, Downy	1			2			1					1				1			2				1	1			1						1			1			1				1			1				1			1			
Kingbird, East.																													1								1										1									
Flycatcher, Great.																																																					1		1	
Phoebe, East.																					2																																			
Swallow, Tree														1	1			2	1	2	2	3	4	Common →																																
Swallow, Barn																						2	3	2	4	1	2	3	4	6	2	1	3	3	2	2	4	6	8	5	2	4	8	6	4	5	2	4	6	8	10	10	10	8	10	10
Swallow, Cliff																									1	1	2	1	3	4	1	2	3	4	6	2	4	3	1		4	6	8	2	4	6	10	8	12	15	10	25	20	15	10	10
Martin, Purple															1				2				1						4			1		2			1			4			1			2	2				2	6		4		3
Blue Jay			1			2	1			1	2	2		2	1	1	1			1		2			1				1			1					2	1				1			2				1				1	2		
Crow	1		2	1	2	3	1		2	4	5	1	1	2	2	4		1	2	4	2	1	2	3	2	2	2	3	4	1	2		4	2	4	2	2	2	1	4	3	1		4	5	3	4	2	3	2	5	1	2	4	5	2
Chickadee, Bl-c	1		2	1	1	1		2	1	1	2	1	1	2			1	1	2	1	2	2	2		1	1	3	2	3	3	1	3	1	2	1	1	1	2	1	1			1	2	1	1	2	1	1	1		2	1	2	1	1
Nuthatch, W-b	1		2	1			2			1	1	1	2	1		1	2	2				1	2	1	1	1	2	1	1			1			1	1			1	1	1	1	1	2	2	1	1				1	1			1	
Wren, House																												1						1					1		1							1			1		1	1	1	1
Wren, S-b Marsh																																1	2	1	3	4	4	5	6	5	Common →															
Catbird																													1	1			1	2	2	1	1			1	1	1	2	1	1	1			1	1		1	1	1	2	1
Brown Thrasher																1	2	1	1	1	1		1			1	1		1	2	1	2	2	1	1		1	1	1	2	1	2	3	1	1	1	1	2	2		1		1	1		1
Robin	Common →				⇥		Abundant →											⇥		Common →																																				
Veery																												1			1	2	1	2	3	1	2		1			3	1	1	2	3	3	2	3	3		1	2	3	2	2
Bluebird, East.	3	4	6	8	6	8	10	4	3	6	8	6	5	4	2				2	1	1	2		1	1	1	1									1	2		1	2	3	4	1		2	1	1						1	1		
Kinglet, G-c									1							1																																								
Waxwing, Cedar																																1			1						1												1	1		
Starling	Common →																																																							
Vireo, R-e																																	1	2	1		1	3	4	6	Common →															
Vireo, Warbling																																			1									1									1			
Warbler, Yellow																															2			3	2	3	4	Common →																		
Warbler, Y-th																														4	6	8	Common →																							
Warbler, C-nut-sided																																	1	2		1	1	2	3	1	2	1	4	3	2	2	1	3	1	4	1	2	2	3	4	2
Oven-bird																										1					1					1											1					1				
Redstart																																																				1				
Sparrow, House	Common →																																																							
Bobolink																											1			2		1			1	2	6	8	10	Common →																
Meadowlark, East.				1	2		1	2	3	4	6	Common →																																												
Meadowlark, West.				1	2		3	4	5	Fairly Common →																																														
Blackbird, R-w	Abundant →																																																							
Oriole, Balt.																															1					2				2																
Blackbrid, Rusty	Common →																							⇥																																
Blackbird, Brew.																						8	6	4	4	2	3	2	3	4	5	6	2	3	1	3	6	7	2	3	4		1	3	4	2		2	3	4		1	3	4	5	
Grackle	Common →												⇥																																											
Cowbird												2	2	3	4	6	Common →												⇥																											
Tanager, Scar.																											1				1																									
Grosbeak, R-b																																1		2			1					2				1	1	1	3	1		1	2	1		1
Bunting, Indigo																																				1				2			1					1				2				
Grosbeak, Eve.	8	10	12	9	10	6			5	8	10	5	6	4			8	2		1	4	6	10		4	3	2	1	6	2																										
Finch, Purple		2		1			2	3	4		2	1		2	4	6	3	1		4	2	1		3	2	6	5	1	2	4	1						1		2				3	1	2		1		2				1			
Goldfinch	Common →																																																							
Towhee																																1			2		1	1		1	2	1		1	1	2	1		1	1	1			1	1	
Sparrow, Sav.											1	2	1	1	1	2	4	5	6	2	3	5	6	Common →																																
Sparrow, Le Conte's																																																						2	1	1
Sparrow, Vesp.											1		2	3		5	1	2	4	2																																				
Junco, S-c	Abundant →																				⇥	Common →					⇥																													
Sparrow, Tree	Common →																				⇥																																			
Sparrow, Chip.													1		1	2	1		1			1	1	1	2	1	1	1	1	2		1	1	2	1		1	1	1		1	2	1	1	1	1	1			1	1		2	1	1	
Sparrow, Cl-c																																2	1	1		3	2	2	3	1		2	2			3	1	1	1			1	1		1	2
Sparrow, W-th																						1			2	1				1					1	2				1				1	1	1		1	1			1	1			
Sparrow, Fox	2	1	1		2		1		1	3	1	1	2		3	1																																								
Sparrow, Swamp																	1			1	1		1	2	3	1	2	2	1	1	3	4	2	1		1	2	3	1	2	2	4	1	2	5	1	2	1	5	2	1	2	1	5	2	1
Sparrow, Song	Common →																																																							

APPENDIX E

COMPOSITE BIRD SITING LIST
(and where observed)

Name	Pit Area	Road Side
Grebe, Horned	x	
Grebe, P-b	x	
Heron, G-b		x
Bittern, Am.		x
Duck, Wood	x	x
Duck, Am-Gold-eye	x	
Duck, Buf.-head	x	
Hawk, S-s		x
Hawk, B-w		x
Hawk, Marsh		x
Hawk, Sparrow		x
Rail, Sora		x
Killdeer	x	x
Woodcock		x
Snipe, Wilson's		x
Plover, Upland		x
Tern, Black		x
Dove, Rock		x
Dove, Mourning	x	x
Cuckoo, B-b		x
Nighthawk		x
Swift, Chimney	x	x
Kingfisher, B.	x	x
Flicker, U-s	x	x
Woodpecker, R-h	x	x
Sapsucker, Y-b	x	x
Woodpecker, Hairy	x	x
Woodpecker, Downy	x	x
Kingbird, East.	x	x
Flycatcher, Crest.		x
Phoebe, East.		x
Swallow, Tree	x	x
Swallow, Barn		x
Swallow, Cliff		x
Martin, Purple		x
Blue Jay	x	x
Crow	x	x
Chickadee, Bl-c	x	x
Nuthatch, W-b	x	x
Wren, House		x
Wren, S-b Marsh	x	x
Catbird	x	x

Name	Pit Area	Road Side
Brown Trasher		x
Robin	x	x
Veery	x	x
Bluebird, East.	x	x
Kinglet, G-c	x	
Waxwing, Cedar		x
Starling	x	x
Vireo, R-e	x	x
Vireo, Warbling		x
Warbler, Yellow	x	x
Warbler, Y-th	x	x
Warbler, C-nut-sided	x	x
Oven-bird	x	x
Redstart		x
Sparrow, House		x
Bobolink	x	x
Meadowlark, East.	x	x
Meadowlark, West.	x	x
Blackbird, R-w	x	x
Oriole, Balt.		x
Blackbird, Rusty	x	x
Blackbird, Breu.		x
Grackle	x	x
Cowbird	x	x
Tanager, Scar.		x
Grosbeak, R-b		x
Bunting, Indigo		x
Grosbeak, Eve.		x
Finch, Purple		x
Goldfinch	x	x
Towhee	x	x
Sparrow, Sav.	x	x
Sparrow, Le Conte's		x
Sparrow, Vesn.	x	x
Junco, S-cl	x	x
Sparrow, Tree	x	x
Sparrow, Chip.	x	x
Sparrow, Cl-c		x
Sparrow, W-th	x	
Sparrow, Fox	x	x
Sparrow, Swamp	x	x
Sparrow, Song	x	x

APPENDIX F

HYPOTHETICAL SPECIES LIST OF REPTILES AND AMPHIBIANS (FMC Holdings - Spring 1973)

A hypothetical species list of reptiles and amphibians that may be found on the survey plots exclusive of those species already found:

Class Reptilia
- Family Testudinidae
  - Wood Turtle (Clemmys insculpta)
  - Map turtle (Graptemys geographica)
  - Blanding's turtle (Emydoidea blandingi)
- Family Trionychidae
  - E. spiny softshell turtle (Trionyx spinifer)
- Family Teiidae
  - Five-lined skink (Eumeces fasciatus)
- Family Colubridae
  - Black water snake (Natrix sipedon)
  - Red-bellied snake (Storeria occipitomaceulata)
  - Hognose snake (Heterodon platyhinos)
  - Ringneck snake (Diadophis punctatus)
  - Smooth green snake (Opheodrys vernalis)
  - Bullsnake (Pituophis melanoleucus)

Class Amphibia
- Family Cryptobranchidae
  - Mudpuppy (Necturus maculosus)
- Family Salamandridae
  - Red-spotted newt (Diemictylus viridescens)
  - Four-toed salamander (Hemidactylum scutatum)
- Family Hylaidae
  - Boreal chorus frog (Pseudacris triseriata)
- Family Ranidae
  - Bullfrog (Rana catesbeiana)
  - Green frog (Rana clamitans)

APPENDIX G

REPRESENTATIVE ORDERS AND FAMILIES OF INSECTS
FOUND ON THE PROJECT SITE

Order Collembola
Family Entomobryidae - springtails

Order Ephemeroptera
Family Ephemeridae - mayflies

Order Odonata
Family Aeshnidae - darners
Family Libellulidae - skimmers
Family Coenagrionidae - damselflies

Order Orthoptera
Family Acrididae - short horned grasshoppers
Family Tettigoniidae - long horned grasshoppers
Family Gryllidae - crickets
Family Blattidae - roaches

Order Plecoptera
Family Perlidae - stoneflies

Order Thysanoptera
Family Thripidae - common thrips

Order Hemiptera
Family Corixidae - water boatmen
Family Notonectidae - backswimmers
Family Nepidae - water scorpions
Family Gelastocoridae - toad bugs
Family Balostomatidae - giant water bugs
Family Gerridae - water striders
Family Miridae - leaf bugs
Family Phymatidae - ambush bugs
Family Reduviidae - assassin bugs
Family Tingididae - lace bugs
Family Lygaeidae - lygaeid bugs
Family Coreidae - leaf-footed bugs
Family Corizidae - grass bugs
Family Pentatomidae - stink bugs

Order Homoptera
Family Cicadidae - cicadas
Family Membracidae - treehoppers
Family Cercopidae - spittlebugs
Family Cicadellidae - leafhoppers
Family Fulgoridae - planthoppers
Family Aleyrodidae - white flies
Family Aphididae - plant lice
Family Coccidae - scales

Order Neuroptera
Family Corydalidae - dobson flies
Family Chrysopidae - lacewings

Order Coleoptera
Family Cicindelidae - tiger beetles
Family Carabidae - ground beetles
Family Dytiscidae - predaceous diving beetles
Family Gyrinidae - whirligig beetles
Family Histeridae - hister beetles
Family Hydrophilidae - water scavenger beetles
Family Silphidae - carrion beetles
Family Staphylinidae - rove beetles
Family Cantharidae - soldier beetles
Family Lampyridae - fireflies
Family Dermestidae - skin beetles
Family Cleridae - checkered beetles
Family Elateridae - click beetles
Family Buprestidae - mettalic wood borers
Family Phalacridae - shining flower beetles
Family Cocconellidae - ladybird beetles
Family Meloidae - blister beetles
Family Mordellidae - tumbling flower beetles
Family Tenebrionidae - darkling beetles
Family Scarabaeidae - scarabs
Family Cerambycidae - long horned wood borers
Family Chrysomelidae - leaf beetles
Family Mylabridae - weevils
Family Curculionidae - snout beetles
Family Scolytidae - bark beetles

Order Mecoptera
Family Panorpidae - scorpionflies

Order Trichoptera
Family Limnephilidae - caddisflies

Order Lepidoptera
Family Papilionidae - swallowtails
Family Pieridae - whites and sulfurs
Family Danaidae - milkweed butterflies
Family Satyridae - wood nymphs
Family Nymphalidae - four-footed butterflies
Family Lycaenidae - blues, coppers and hair streaks
Family Sphingidae - hawk moths
Family Arctiidae - tiger moths
Family Noctuidae - noctuid moths
Family Liparidae - tussock moths
Family Geometridae - measuring worms
Family Gelechiidae - leaf miners and gall moths
Family Gracilariidae - leaf miners

Order Diptera
Family Tipulidae - crane flies
Family Psychodidae - sand flies
Family Chironomidae - midges
Family Ceratopogonidae - punkies
Family Simuliidae - buffalo gnats
Family Culicidae - mosquitoes
Family Cecidomyiidae - gall midges
Family Tabanidae - horse and deer flies
Family Bombyliidae - bee flies
Family Asilidae - robber flies
Family Empididae - dance flies
Family Syrphidae - syrphid flies
Family Tachinidae - tachinid flies
Family Calliphoridae - blow flies
Family Sarcophagidae - flesh flies
Family Muscidae - house flies

Order Hymenoptera
Family Tenthredinidae - sawflies
Family Ichneumonidae - ichneumons
Family Braconidae - braconids
Family Cynipidae - gall wasps
Family Chrysididae - cuckoo wasps
Family Formicidae - ants
Family Vespidae - wasps
Family Apidae - bees

APPENDIX H

FISHES OF THE FLAMBEAU RIVER BETWEEN LADYSMITH AND THE THORNAPPLE DAM

Family Common Name	Scientific Name
Acipenseridae	
Lake sturgeon	_Acipenser fulvescens_ Rafinesque
Catostomidae	
White sucker	_Catostomus commersoni_ (Lacepede)
River redhorse	_Moxostoma carinatum_ (Cope)
Shorthead redhorse	_Moxostoma macrolepidotum_
Centrarchidae	
Black crappie	_Pomoxis nigromaculatus_ (Lesueur)
Bluegill	_Lepomis macrochirus_ Rafinesque
Pumpkinseed	_Lepomis gibbosus_ (Linnaeus)
Rock bass	_Ambloplites rupestris_ (Rafinesque)
Smallmouth bass	_Micropterus dolomieui_ (Lacepede)
Cyprinidae	
Blacknose dace	_Rhinichthys atratulus_ (Hermann)
Common shiner	_Notropis cornutus_ (Mitchill)
Creek chub	_Semotilus atromaculatus_ (Mitchill)
Emerald shiner	_Notropis atherinoides_ Rafinesque
Hornyhead chub	_Nocomis biguttatus_ (Kirtland)
Longnose dace	_Rhinichthys cataractae_ (Valenciennes)
Northern red-belly dace	_Phoxinus eos_ (Cope)
Redside dace	_Clinostomus elongatus_ (Kirtland)
Esocidae	
Muskellunge	_Esox masquinongy_ (Mitchill)
Northern pike	_Esox lucius_ Linnaeus
Gadidae	
Burbot	_Lota lota_ (Linnaeus)
Ictaluridae	
Black bullhead	_Ictaluras melas_ (Rafinesque)
Channel catfish	_Ictaluras punctatus_ (Rafinesque)
Percidae	
Johnny darter	_Etheostoma nigrum_ Rafinesque
Walleye	_Stizostedion vitreum vitreum_ (Mitchill)
Yellow perch	_Perca flavescens_ (Mitchill)
Percopsidae	
Trout-perch	_Percopsis omiscomaycus_ (Walbaum)

BY PFZ	DATE 7-9-73
CHECKED	DATE
REFERENCE	

KENNECOTT COPPER CORPORATION
ENGINEERING CENTER - METAL MINING DIVISION
1515 MINERAL SQUARE, SALT LAKE CITY, UTAH 84111

DIVISION MMD DEPT EC
TITLE WASTE MATERIALS PRODUCTION SCHEDULE 300,000 TPY OPERATION
AFE NO JOB NO 506
DATE SHEET OF

FLAMBEAU MINING OPERATION
WASTE MATERIALS PRODUCTION SCHEDULE
300,000 TPY OPERATION

	Mine Waste		Till		Total Mine		Concentrator Tailings		Washing Plant Silt		Total Tailings and Silt	
	Tons	Cu Yds	Tons	Cu Yds	Tons	Cu Yds	Tons	Cu Yds	Tons	Cu Yds	Tons	Cu Yds
Open Pit Operation												
Pre-Production Period	844,370	594,000	729,562	485,000	1,573,932	1,079,000	--	--	--	--	--	--
Production Period												
Year												
1	412,000	289,926	824,000	547,402	1,236,000	837,928	232,713	155,142			232,713	155,142
2	618,000	434,889	618,000	410,552	1,236,000	845,441	242,104	161,403			242,104	161,403
3	752,212	529,333	487,788	324,048	1,236,000	853,381	239,318	159,545			239,318	159,545
4	1,236,000	833,148			1,236,000	833,148	244,169	162,779			244,169	162,779
5	1,236,000	833,148			1,236,000	833,148	257,172	171,448			257,172	171,448
6	1,236,000	833,148			1,236,000	833,148	247,060	164,707			247,060	164,707
7	1,236,000	833,148			1,236,000	833,148	253,337	168,891			253,337	168,891
8	1,236,000	833,148			1,236,000	833,148	256,320	170,880			256,320	170,880
9	1,236,000	833,148			1,236,000	833,148	268,678	179,119			268,678	179,119
10	1,236,000	833,148			1,236,000	833,148	277,947	185,298			277,947	185,298
11	418,910	235,815			418,910	235,815	98,645	65,763			98,645	65,763
Subtotal	10,853,122	7,321,999	1,929,788	1,282,002	12,778,910	8,604,001	2,617,463	1,744,975	--	--	2,617,463	1,744,975
Underground Operation												
Pre-Production Period												
8 - 11	64,487	36,344	--	--	64,487	36,344	--	--	--	--	--	--
Production Period												
11							176,051	114,010	43,442	32,179	219,493	146,189
12							268,777	174,207	66,493	49,254	335,270	223,461
13							264,954	171,729	66,493	49,254	331,447	220,983
14							267,715	173,519	66,493	49,254	334,208	222,773
15							270,052	175,034	66,493	49,254	336,545	224,287
16							269,414	174,620	66,493	49,254	335,907	223,874
17							267,397	173,313	66,493	49,254	333,890	222,567
18							267,397	173,313	66,493	49,254	333,890	222,567
19							262,193	169,940	66,493	49,254	328,686	219,194
20							257,945	167,187	66,493	49,254	324,438	216,440
21							219,607	142,338	66,493	49,254	286,100	191,592
22							94,719	61,392	30,149	22,332	124,868	83,724
Subtotal	64,487	36,344	--	--	64,487	36,344	2,886,221	1,870,602	738,521	547,051	3,624,742	2,417,651
TOTAL	11,761,979	7,952,343	2,658,562	1,767,002	14,417,329	9,719,345	5,503,684	3,615,577	738,521	547,051	6,242,205	4,162,626

Notes:
1. Silt from stope backfill washing plant to be stored in tailings pond.
2. Underground pre-production development mine waste to be produced in last four years of open pit operation.
3. Underground waste during production period, years 11 - 22, to be retained in the mine.

BY PFZ	DATE 7-9-73
CHECKED	DATE
REFERENCE	

KENNECOTT COPPER CORPORATION
ENGINEERING CENTER - METAL MINING DIVISION
1515 MINERAL SQUARE, SALT LAKE CITY, UTAH 84111

DIVISION MMD DEPT EC
TITLE DISPOSITION OF WASTE MATERIALS
FLAMBEAU MINING OPERATION
AFE NO JOB NO 506
DATE SHEET OF

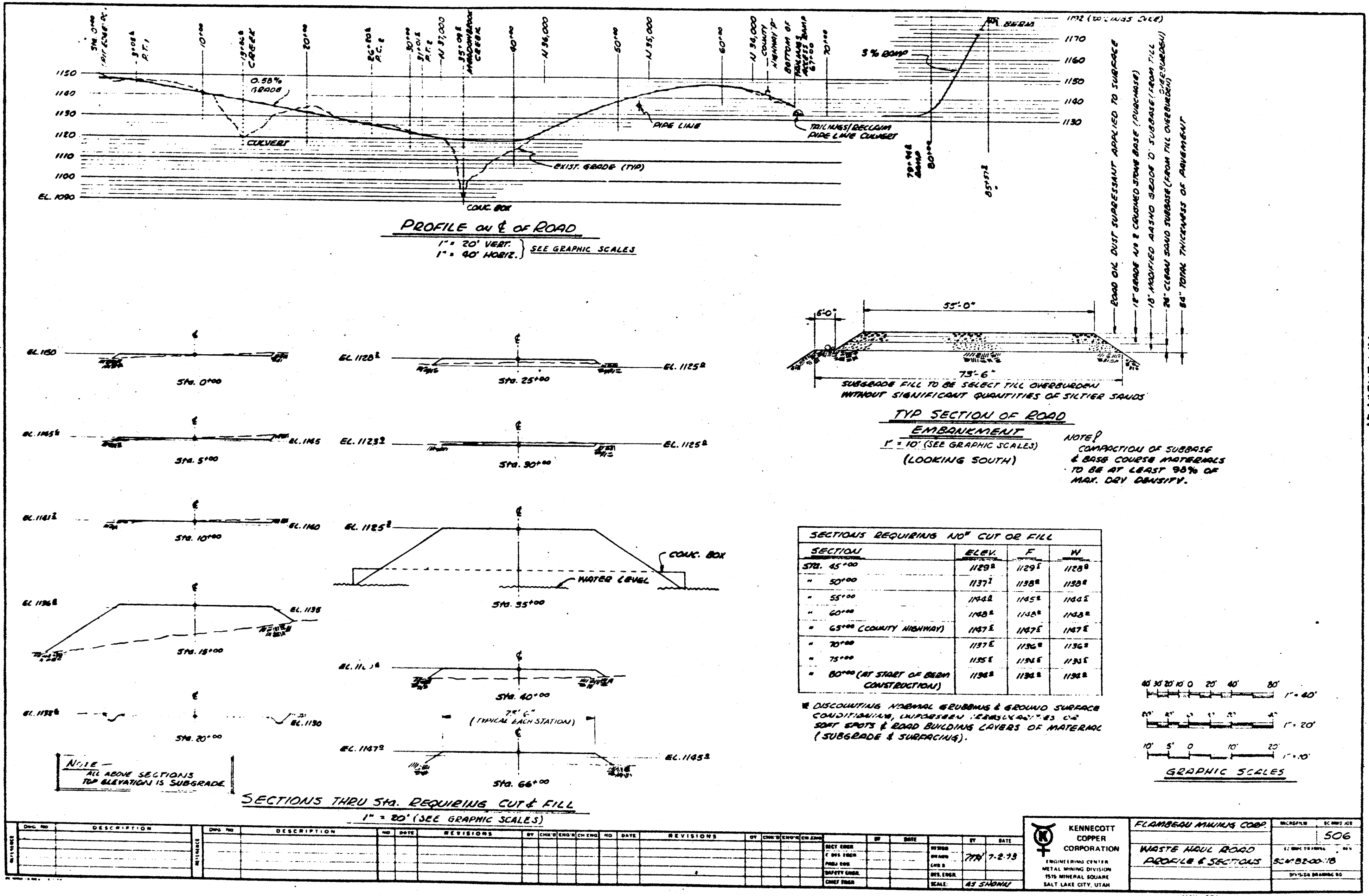
Cubic Yards	Pre-Production Period			Production Period			Post Production Period		
	Produced	Used in Const.	Net to Storage	Produced	Used in Const.	Net to Storage	Net in Storage	Used Reclaim	Total Storage
TOPSOIL									
Pit Area	22,000	--	22,000						
Dike Foundation Area	131,000	--	131,000						
Plant Area	All reused at site		--						
Subtotal	153,000	--	153,000	--	--	--	153,000	153,000	--
TILL									
Open Pit Material	485,000			1,282,002					
Haulage Roads		160,000							
Outer Dike Surface		143,000			952,000				
Subtotal	485,000	303,000	182,000	1,282,002	952,000	330,002	512,002	512,002	--
WASTE ROCK									
Common Open Pit Material	200,000			6,677,999					
Dike Wall		200,000	--		2,669,000				
Subtotal	200,000	200,000	--	6,677,999	2,669,000	4,008,999	4,008,999	--	4,008,999
Saprolite Open Pit Material	394,000			664,000					
Dike Core		114,344			799,656				
Trench Lining		22,000							
Ditch Lining		1,000							
Subtotal	394,000	137,344	256,656	664,000	799,656	(155,656)	101,000	--	101,000
Underground Development Rock	--	--	--	36,344	--	36,344			
Subtotal	--	--	--	36,344	--	36,344	36,344	--	36,344
TOTAL WASTE ROCK	594,000	337,344	256,656	7,358,343	3,468,656	3,889,687	4,146,343	--	4,146,343
CONCENTRATOR TAILINGS									
Subtotal	--	--	--	3,615,577	--	3,615,577	3,615,577	--	3,615,577
WASHING PLANT SILT									
Subtotal	--	--	--	547,051	--	547,051	547,051	--	547,051
TOTALS	1,232,000	640,344	591,656	12,802,973	4,420,656	8,382,317	8,973,973	665,002	8,308,971

Total Waste Material Produced	14,034,973
Material Not Stored - Road Construction	160,000
Net Contained or in Construction of Waste Containment Site	13,874,973

Waste Containment Site	186 acres, 14,000,000 cu yds capacity. Site covered and revegetated during post production period.
Stockpile "A"	8.5 acres for 153,000 cu yds of topsoil. restored to original state during post production period.
Stockpile "B"	27.5 acres for 512,002 cu yds of till. Restored to original state during post production period.
Stockpile "C"	Temporary storage of 256,656 cu yds of saprolite from pre-production period within permanent waste containment site.

EC-MMD 21-A 5-1-72

APPENDIX K


PROFILE ON ℄ OF ROAD
1" = 20' VERT.
1" = 40' HORIZ.
SEE GRAPHIC SCALES
0.58% GRADE
CULVERT
CONC. BOX
EXIST. GRADE (TYP)
PIPE LINE
TRAILINGS/RECLAIM PIPE LINE CULVERT
3% RAMP
BERM
1192 (TAILINGS DIKE)
TYP SECTION OF ROAD EMBANKMENT
1" = 10' (SEE GRAPHIC SCALES)
(LOOKING SOUTH)
55'-0"
6'-0"
73'-6"
SUBGRADE FILL TO BE SELECT TILL OVERBURDEN WITHOUT SIGNIFICANT QUANTITIES OF SILTIER SANDS
ROAD OIL DUST SUPRESSANT APPLIED TO SURFACE
12" GRADE NO 2 CRUSHED STONE BASE (PURCHASE)
18" MODIFIED AASHO GRADE 'D' SUBBASE (FROM TILL OVERBURDEN)
36" CLEAN SAND SUBBASE (FROM TILL OVERBURDEN)
84" TOTAL THICKNESS OF PAVEMENT
NOTE
COMPACTION OF SUBBASE & BASE COURSE MATERIALS TO BE AT LEAST 98% OF MAX. DRY DENSITY.
SECTIONS REQUIRING NO* CUT OR FILL
SECTION | ELEV. | F | W
* DISCOUNTING NORMAL GRUBBING & GROUND SURFACE CONDITIONING, UNFORSEEN IRREGULARITIES OR SOFT SPOTS & ROAD BUILDING LAYERS OF MATERIAL (SUBGRADE & SURFACING).
GRAPHIC SCALES
1" = 40'
1" = 20'
1" = 10'
SECTIONS THRU Sta. REQUIRING CUT & FILL
1" = 20' (SEE GRAPHIC SCALES)
NOTE —
ALL ABOVE SECTIONS TOP ELEVATION IS SUBGRADE
WATER LEVEL
73'-6" (TYPICAL EACH STATION)
KENNECOTT COPPER CORPORATION
ENGINEERING CENTER
METAL MINING DIVISION
1515 MINERAL SQUARE
SALT LAKE CITY, UTAH
FLAMBEAU MINING CORP.
WASTE HAUL ROAD PROFILE & SECTIONS
506
AS SHOWN
7-2-73
MAY, 1974

APPENDIX L

WATER BUDGET

A collection ditch would be installed inside the pit perimeter at the top of the clay saprolite layer, approximately at the 1,085-foot elevation. This ditch would collect groundwater inflow and precipitation falling on the adjacent surface and the uppermost pit slopes to prevent their contact with sulfide-bearing bedrock. The collected water would be used for industrial purposes. Any excess would be pumped to the gravel pit for settling and return by percolation to the groundwater system. Waters escaping from the upper collection system and those entering directly as precipitation below the 1,085 level would be collected in the pit bottom and pumped to the waste containment area for storage and subsequent industrial use. If necessary, additional water supply to meet industrial needs would be obtained from wells located in the vicinity of the gravel pit.

In order to predict water supply and disposal conditions during the various stages of mine development and process operations, a water balance study was made by the company. Water flow rates during construction, initial production, yearly average operation, summer and winter operations, during storms and at shutdown were developed using both the calculated theoretical and the expected rates of groundwater flow into the pit. Theoretical flow rates are shown on Figures L-1 through L-7 and are explained below. Expected flow rates are shown in Figures L-8 through L-12.

During the construction phase (Figure L-1), sufficient prestripping would be done to expose a three months' supply of ore. Groundwater inflow to the pit from the glacial tills and the sandstone, estimated to average 1,620 gpm, would be collected in the 1,085 level ditch and gravitated to sump B. Precipitation above the 1,085 level estimated to average a net 96 gpm after evaporation, would be collected in the same ditch. Thus, sump B would receive an average of 1,716 gpm. Of this, 50 gpm would be diverted for sundry uses, such as road sprinkling, and the remaining 1,666 gpm pumped to the gravel pit for disposal. Precipitation below the 1,085 level, estimated to average 29 gpm after evaporation, would be collected in sump A at the center of the new pit and pumped to the gravel pit also. The gravel pit would thus receive an average of 1,695 gpm from the mine in the final stage of the construction period.

The water flows during the initial production phase are shown on Figure L-2. Process water required for operation of the concentrator (mill) would be taken from the Flambeau River at the rate of 492 gpm until, together with 1,544 gpm pumped to the waste containment area from the pit, a total reserve of 40 million gallons would be accumulated in the waste containment area (tailings pond). This is estimated to take 14 days, during which time a total of 10 million gallons would have been taken from the river. No water would be disposed of in the gravel pit during this period.

The pit sumps would continue to receive 1,744 gpm, as during the construction phase. Of this, 200 gpm would be diverted for sundry uses and the remaining 1,544 gpm would be pumped to the waste containment area. An additional 488 gpm would be pumped from the mill (4 gpm of the 492 gpm entering the mill from the river is retained as moisture in the copper concentrates shipped out), making a total flow of 2,032 gpm into the waste containment area. Of this total, an estimated 44 gpm would remain entrained in the tailings, and an estimated maximum of 25 gpm would escape by seepage through the dikes and the floor of the pond. It is assumed that evaporation from the pond will equal precipitation. Thus, available water would accumulate in the waste containment area at the rate of 1,963 gpm.

During yearly average operations, an essentially closed system would be maintained and the average yearly net accumulation of available water in the waste containment area would be zero as shown in Figure L-3. Except for potable water, no outside source of water would be required if groundwater inflow to the pit exceeds 146 gpm. Water collected in sump B in excess of that required for industrial use would be disposed of in the gravel pit. If the calculated theoretical groundwater inflow of 1,620 gpm is realized, the excess to be disposed of would be 950 gpm.

To secure an increased operating reserve for the winter months, flows would be adjusted during the six summer months to allow 6.2 million gallons to accumulate in the waste containment area at an average rate of 24 gpm as shown in Figure L-4. Excess water from sump B to be disposed of in the gravel pit would average 1,442 gpm.

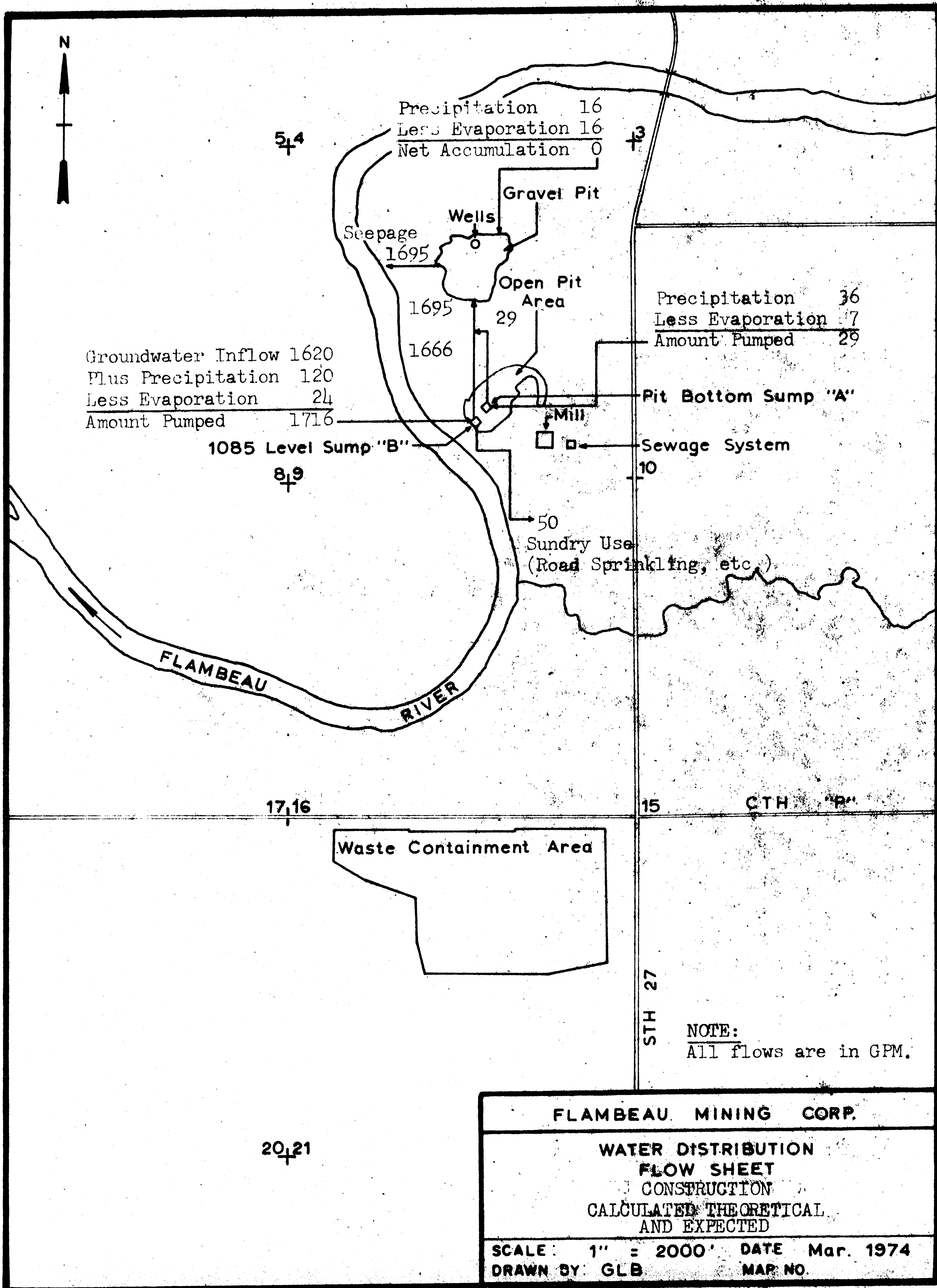
During the six winter months, the 6.2 million gallon reserve accumulated in the waste containment area during the summer would be depleted at an average rate of 24 gpm as shown in Figure L-5. Excess water from sump B to be disposed of in the gravel pit would average 458 gpm. Should it be found in practice that pond icing in winter interferes with decant recovery, it may be necessary to increase the accumulated reserve in the waste containment area by diverting additional flow from sump B to the waste containment area.

Appendix L (cont.)

Water flows during storm conditions are presented in Figure L-6. These estimates are based on a rainfall intensity of 4.06 inches in 6 hours. A net accumulation of 6,877 gpm would be expected in the waste containment area. Significant increases of flows to the gravel pit would also be expected.

Upon the cessation of mining, the open pit would be flooded with water from the waste containment area, the Flambeau River, and the normal inflows of groundwater and incident precipitation. Approximately 2 billion gallons of water would be required to fill the pit to the 1,092 level. Approximately 1.5 billion gallons of this would be obtained by siphoning from the river at a rate of 5,950 gpm. At this rate of siphoning, it would take 180 days to fill the pit if water from the other sources is obtained at the rates shown in Figure L-7.

FIGURE LI


N
Precipitation 16
Less Evaporation 16
Net Accumulation 0
5 4
3
Gravel Pit
Wells
Seepage
1695
Open Pit
Area
1695
29
Precipitation 36
Less Evaporation 7
Amount Pumped 29
1666
Groundwater Inflow 1620
Plus Precipitation 120
Less Evaporation 24
Amount Pumped 1716
Pit Bottom Sump "A"
Mill
1085 Level Sump "B"
Sewage System
8 9
10
50
Sundry Use
(Road Sprinkling, etc.)
FLAMBEAU
RIVER
17 16
15
CTH "P"
Waste Containment Area
STH 27
NOTE:
All flows are in GPM.
20 21
FLAMBEAU MINING CORP.
WATER DISTRIBUTION
FLOW SHEET
CONSTRUCTION
CALCULATED THEORETICAL
AND EXPECTED
SCALE: 1" = 2000'
DATE Mar. 1974
DRAWN BY: GLB
MAP NO.

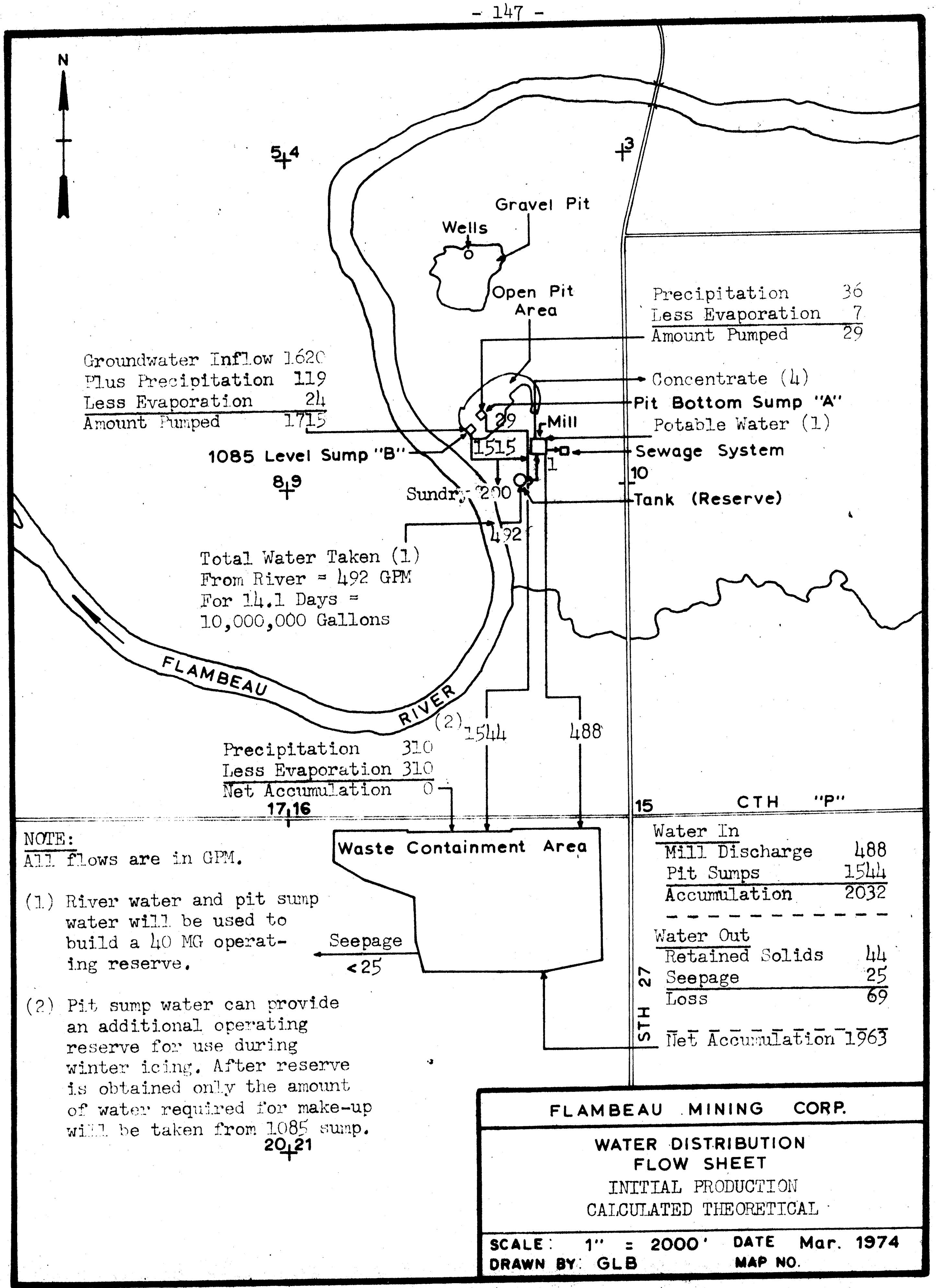

N
5 4
3
Gravel Pit
Wells
Open Pit Area
Precipitation 36
Less Evaporation 7
Amount Pumped 29
Groundwater Inflow 1620
Plus Precipitation 119
Less Evaporation 24
Amount Pumped 1715
Concentrate (4)
Pit Bottom Sump "A"
29
Mill
Potable Water (1)
1515
1085 Level Sump "B"
Sewage System
1
10
8 9
Sundry 200
Tank (Reserve)
492
Total Water Taken (1)
From River = 492 GPM
For 14.1 Days =
10,000,000 Gallons
FLAMBEAU RIVER
(2) 1544
488
Precipitation 310
Less Evaporation 310
Net Accumulation 0
17 16
15
CTH "P"
NOTE:
All flows are in GPM.
(1) River water and pit sump water will be used to build a 40 MG operating reserve.
(2) Pit sump water can provide an additional operating reserve for use during winter icing. After reserve is obtained only the amount of water required for make-up will be taken from 1085 sump.
Waste Containment Area
Seepage
<25
Water In
Mill Discharge 488
Pit Sumps 1544
Accumulation 2032
Water Out
Retained Solids 44
Seepage 25
Loss 69
Net Accumulation 1963
STH 27
20 21
FLAMBEAU MINING CORP.
WATER DISTRIBUTION
FLOW SHEET
INITIAL PRODUCTION
CALCULATED THEORETICAL
SCALE: 1" = 2000'
DATE Mar. 1974
DRAWN BY: GLB
MAP NO.

FIGURE L3

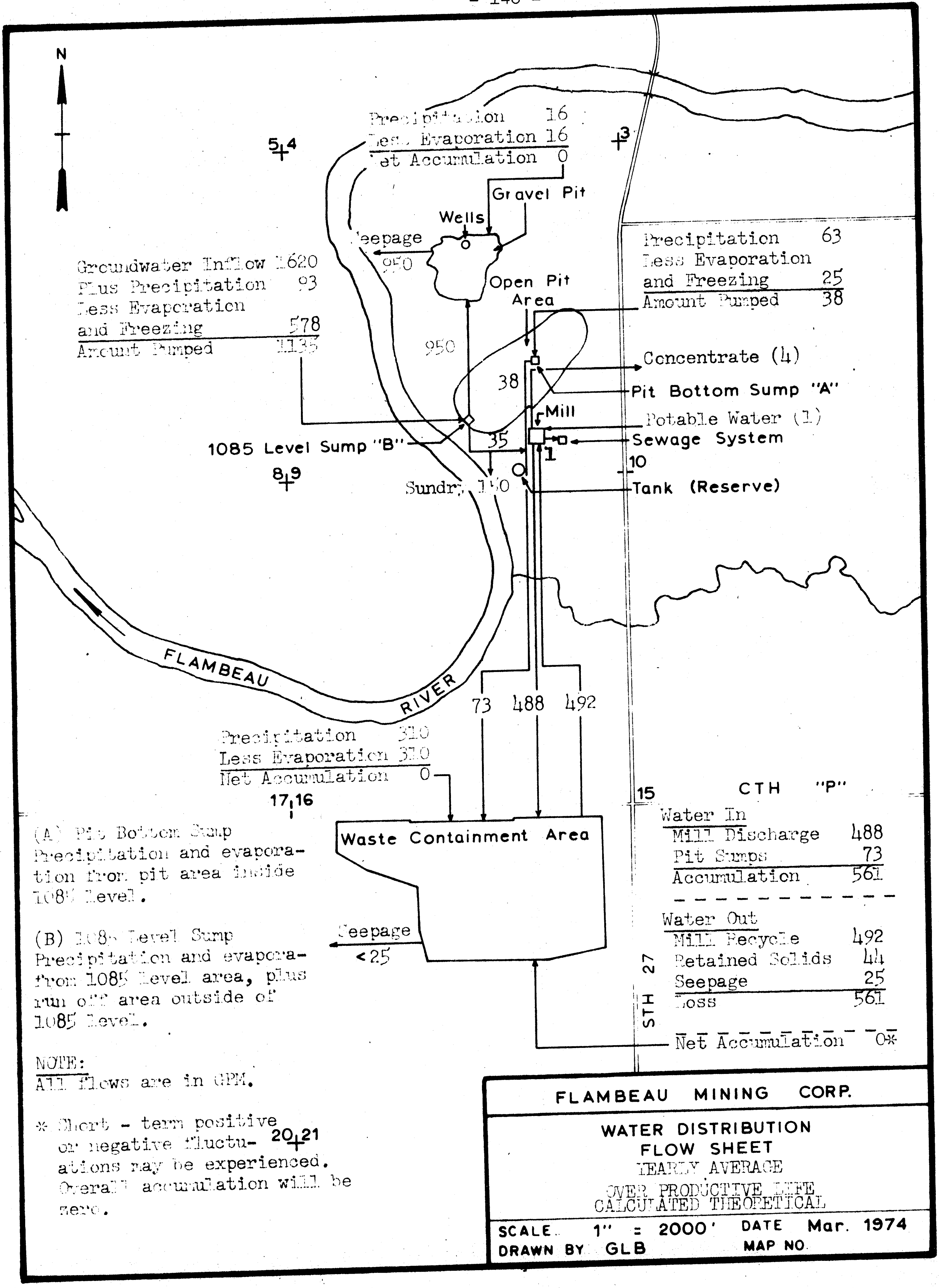

N
Precipitation 16
Less Evaporation 16
Net Accumulation 0
Gravel Pit
Wells
Seepage
950
Open Pit Area
Groundwater Inflow 1620
Plus Precipitation 93
Less Evaporation and Freezing 578
Amount Pumped 1135
950
Precipitation 63
Less Evaporation and Freezing 25
Amount Pumped 38
38
Concentrate (4)
Pit Bottom Sump "A"
Mill
Potable Water (1)
Sewage System
1
35
1085 Level Sump "B"
10
Sundry 150
Tank (Reserve)
FLAMBEAU RIVER
73
488
492
Precipitation 310
Less Evaporation 310
Net Accumulation 0
15
CTH "P"
Water In
Mill Discharge 488
Pit Sumps 73
Accumulation 561
Water Out
Mill Recycle 492
Retained Solids 44
Seepage 25
Loss 561
Waste Containment Area
Seepage
<25
STH 27
Net Accumulation 0*
(A) Pit Bottom Sump
Precipitation and evaporation from pit area inside 1085 Level.
(B) 1085 Level Sump
Precipitation and evaporation from 1085 Level area, plus run off area outside of 1085 Level.
NOTE:
All flows are in GPM.
* Short - term positive or negative fluctuations may be experienced. Overall accumulation will be zero.
FLAMBEAU MINING CORP.
WATER DISTRIBUTION
FLOW SHEET
YEARLY AVERAGE
OVER PRODUCTIVE LIFE
CALCULATED THEORETICAL
SCALE 1" = 2000'
DATE Mar. 1974
DRAWN BY GLB
MAP NO.

FIGURE L4

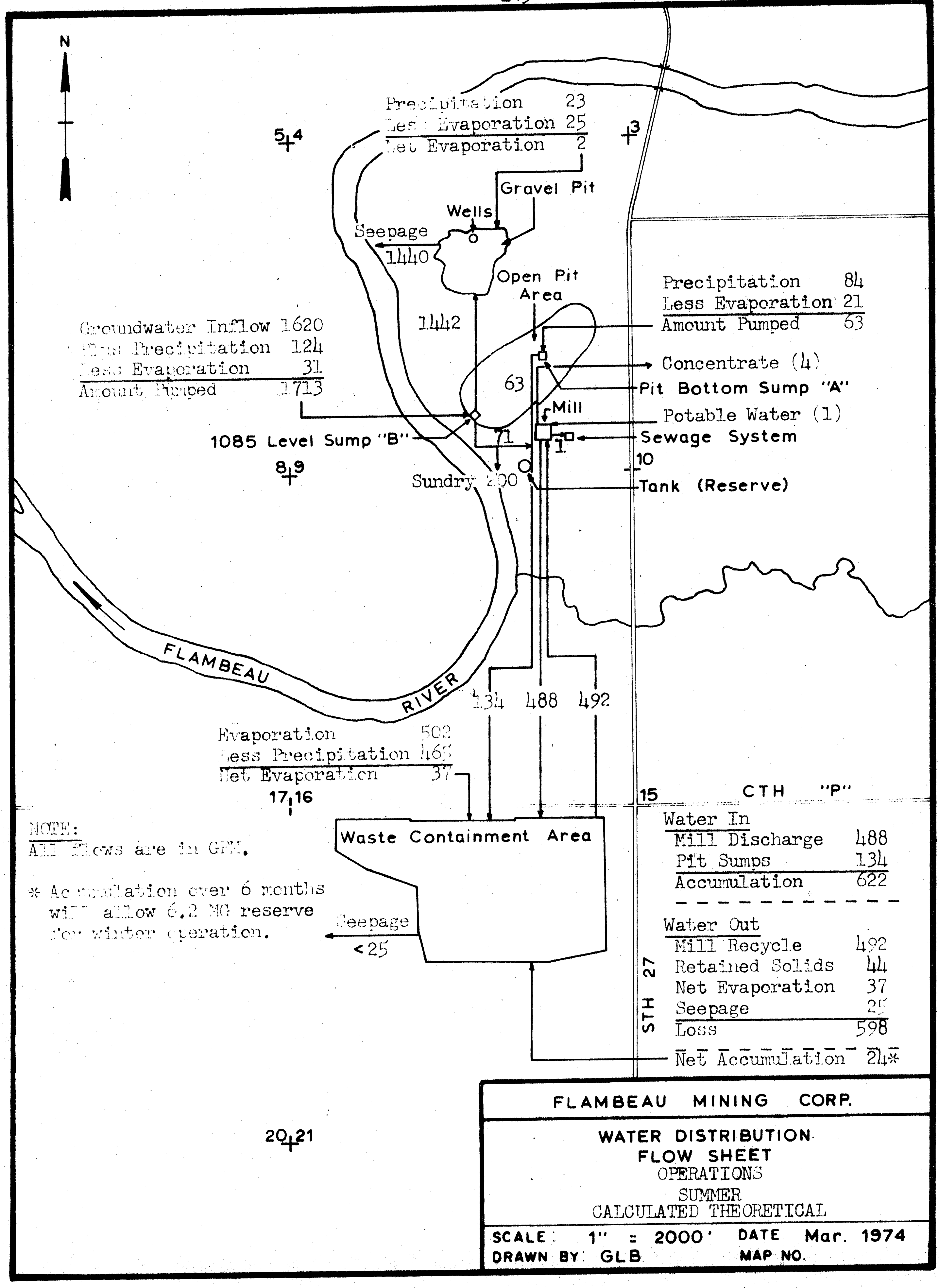

N
Precipitation 23
Less Evaporation 25
Net Evaporation 2
5 4
3
Gravel Pit
Wells
Seepage
1440
Open Pit
Area
1442
Precipitation 84
Less Evaporation 21
Amount Pumped 63
Groundwater Inflow 1620
Plus Precipitation 124
Less Evaporation 31
Amount Pumped 1713
63
Concentrate (4)
Pit Bottom Sump "A"
Mill
Potable Water (1)
1085 Level Sump "B"
71
1
Sewage System
8 9
10
Sundry 200
Tank (Reserve)
FLAMBEAU RIVER
134
488
492
Evaporation 502
Less Precipitation 465
Net Evaporation 37
17 16
15
CTH "P"
NOTE:
All flows are in GPM.
* Accumulation over 6 months will allow 6.2 MG reserve for winter operation.
Waste Containment Area
Seepage
<25
Water In
Mill Discharge 488
Pit Sumps 134
Accumulation 622
Water Out
Mill Recycle 492
Retained Solids 44
Net Evaporation 37
Seepage 25
Loss 598
Net Accumulation 24*
STH 27
20 21
FLAMBEAU MINING CORP.
WATER DISTRIBUTION
FLOW SHEET
OPERATIONS
SUMMER
CALCULATED THEORETICAL
SCALE: 1" = 2000'
DATE Mar. 1974
DRAWN BY: GLB
MAP NO.

FIGURE L5

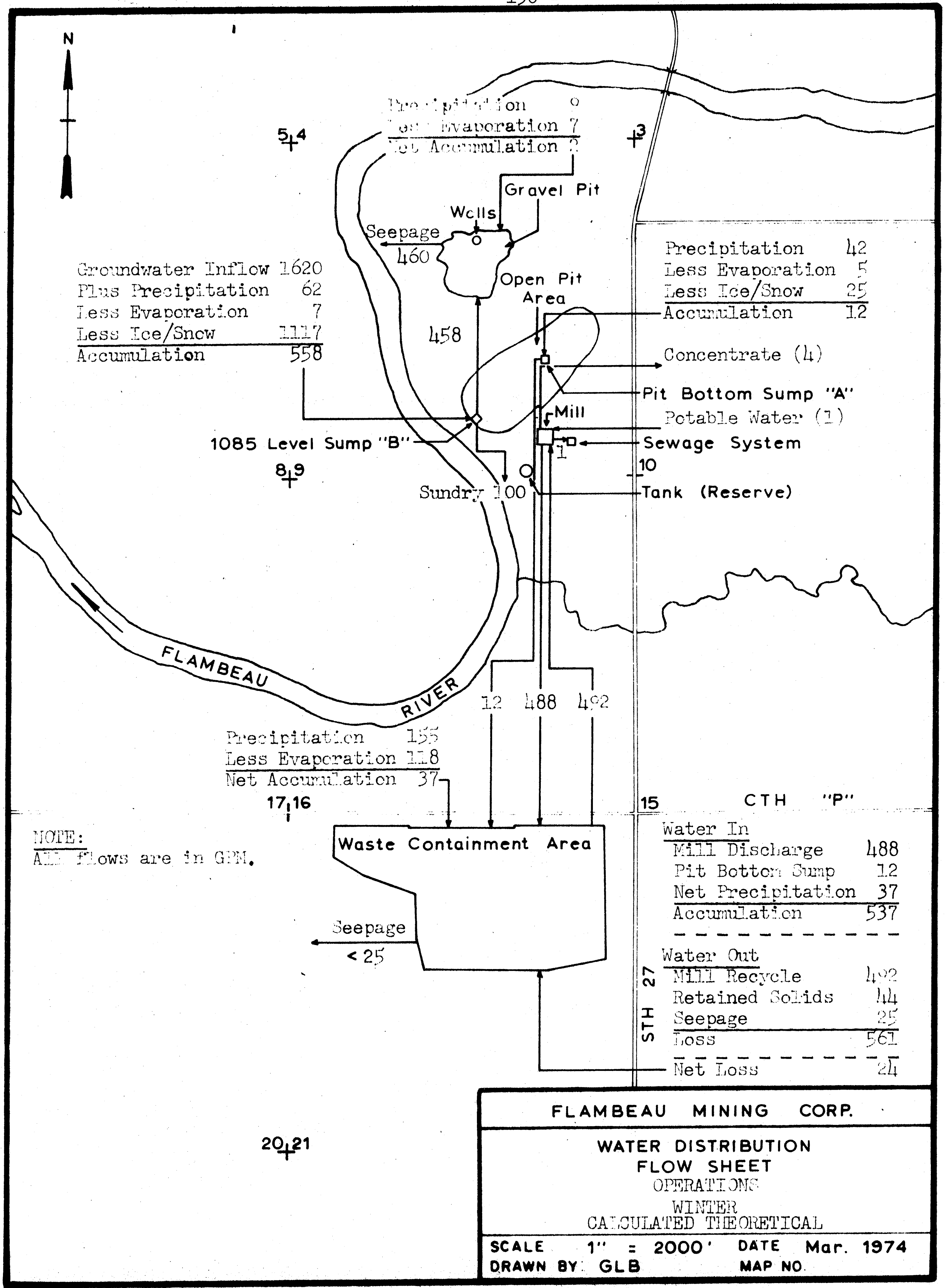
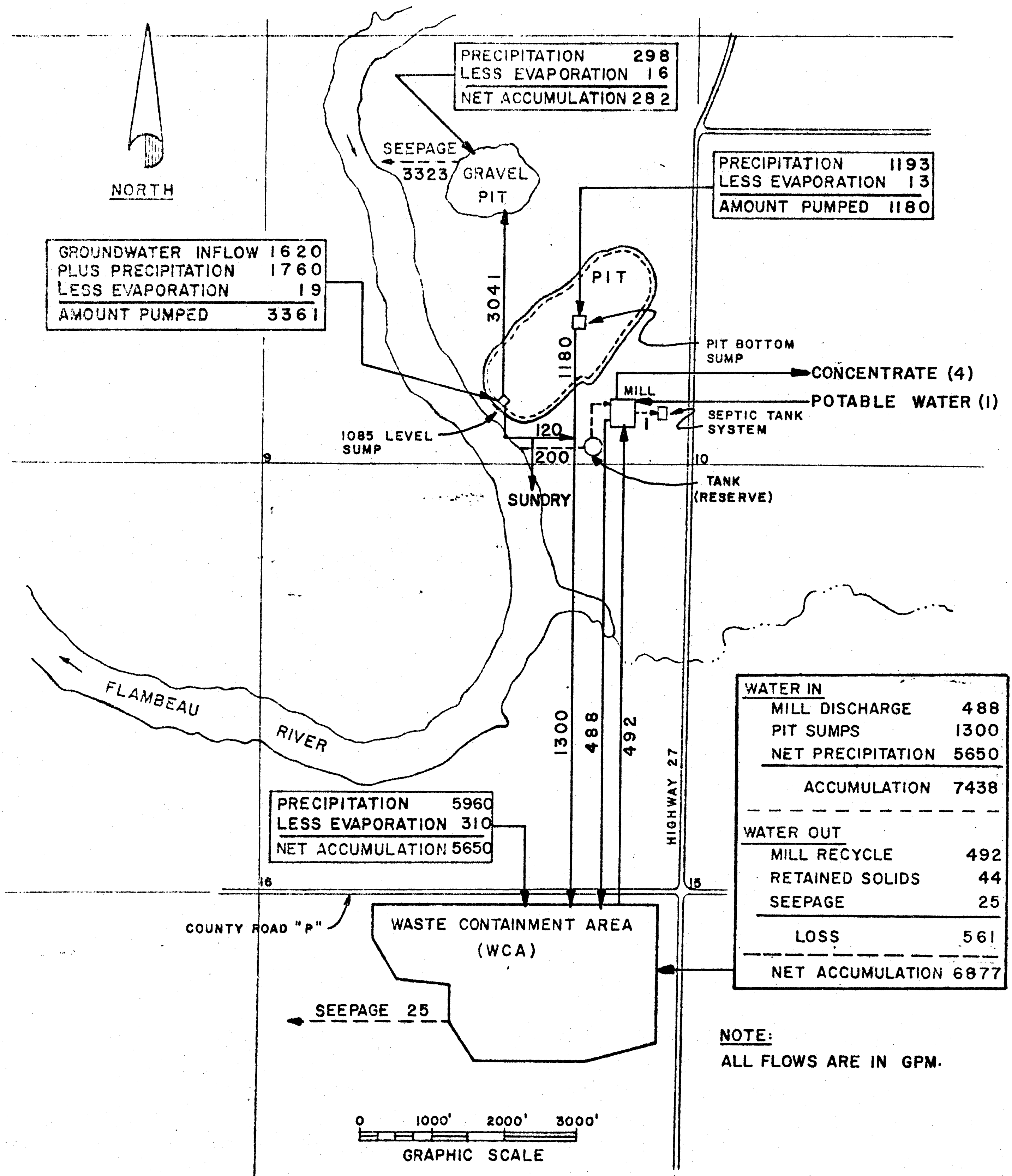

N
Evaporation 7
Accumulation
5 4
3
Gravel Pit
Wells
Seepage
460
Groundwater Inflow 1620
Plus Precipitation 62
Less Evaporation 7
Less Ice/Snow 1117
Accumulation 558
Open Pit
Area
458
Precipitation 42
Less Evaporation 5
Less Ice/Snow 25
Accumulation 12
Concentrate (4)
Pit Bottom Sump "A"
Mill
Potable Water (1)
1085 Level Sump "B"
Sewage System
1
8 9
10
Sundry 100
Tank (Reserve)
FLAMBEAU RIVER
12
488
492
Precipitation 155
Less Evaporation 118
Net Accumulation 37
17 16
15
CTH "P"
NOTE:
All flows are in GPM.
Waste Containment Area
Water In
Mill Discharge 488
Pit Bottom Sump 12
Net Precipitation 37
Accumulation 537
Water Out
Mill Recycle 492
Retained Solids 44
Seepage 25
Loss 561
Net Loss 24
Seepage
< 25
STH 27
20 21
FLAMBEAU MINING CORP.
WATER DISTRIBUTION
FLOW SHEET
OPERATIONS
WINTER
CALCULATED THEORETICAL
SCALE 1" = 2000'
DATE Mar. 1974
DRAWN BY: GLB
MAP NO.

FIGURE L6



KENNECOTT COPPER CORPORATION METAL MINING DIVISION ENGINEERING DEPARTMENT SALT LAKE CITY, UTAH	FLAMBEAU MINING CORP. WATER DISTRIBUTION FLOW SHEET OPERATIONS STORM	MICROFILM / MMD JOB MMD DRAWING / REV. DIV. DRAWING NO.

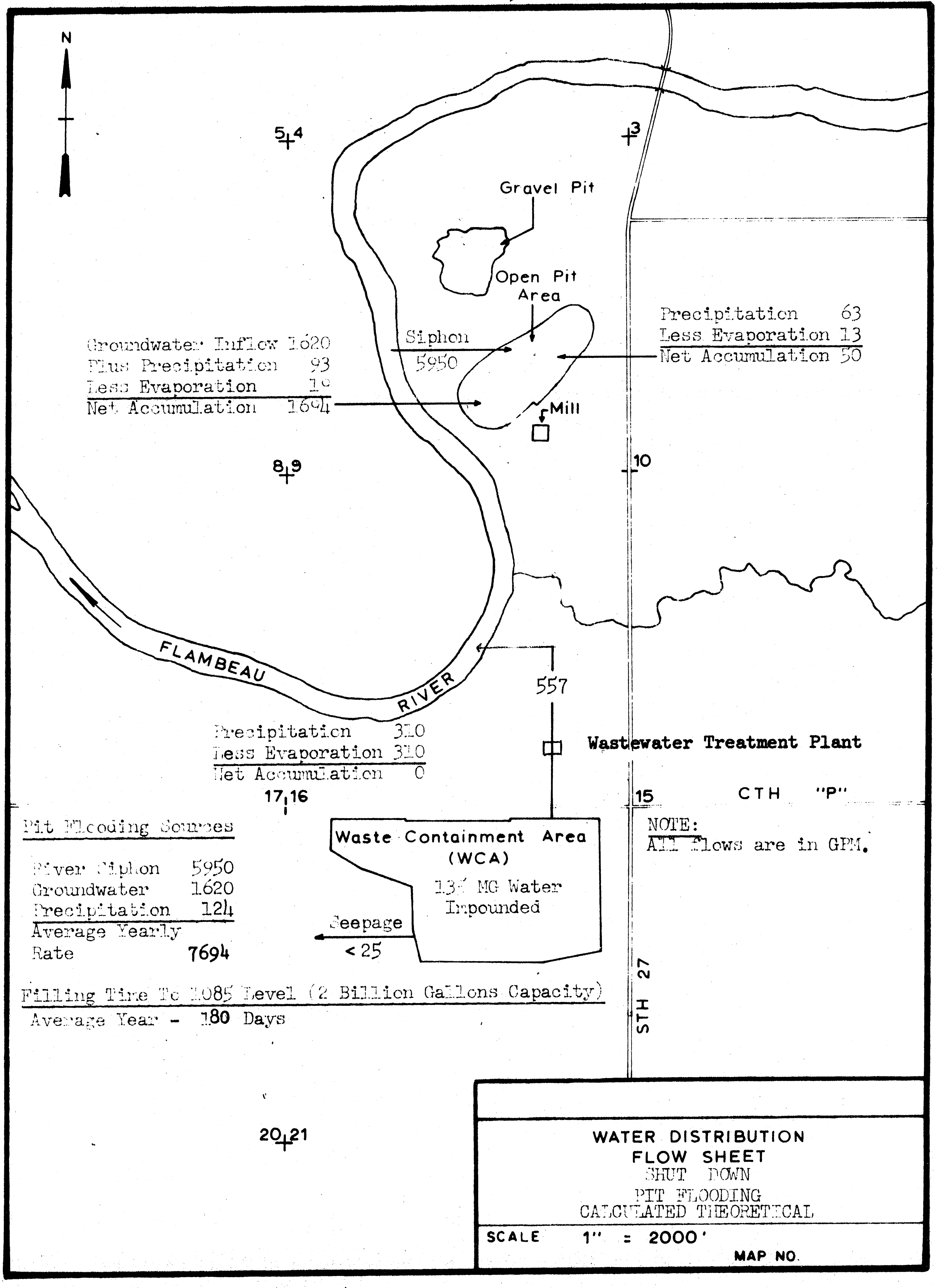

N
Gravel Pit
Open Pit Area
Siphon
5950
Groundwater Inflow 1620
Plus Precipitation 93
Less Evaporation 19
Net Accumulation 1694
Precipitation 63
Less Evaporation 13
Net Accumulation 50
Mill
5 4
3
8 9
10
FLAMBEAU RIVER
557
Precipitation 310
Less Evaporation 310
Net Accumulation 0
Wastewater Treatment Plant
17 16
15
CTH "P"
Pit Flooding Sources
River Siphon 5950
Groundwater 1620
Precipitation 124
Average Yearly Rate 7694
Waste Containment Area (WCA)
13_ MG Water Impounded
Seepage < 25
NOTE:
All flows are in GPM.
Filling Time To 1085 Level (2 Billion Gallons Capacity)
Average Year - 180 Days
STH 27
20 21
WATER DISTRIBUTION
FLOW SHEET
SHUT DOWN
PIT FLOODING
CALCULATED THEORETICAL
SCALE 1" = 2000'
MAP NO.

FIGURE L8

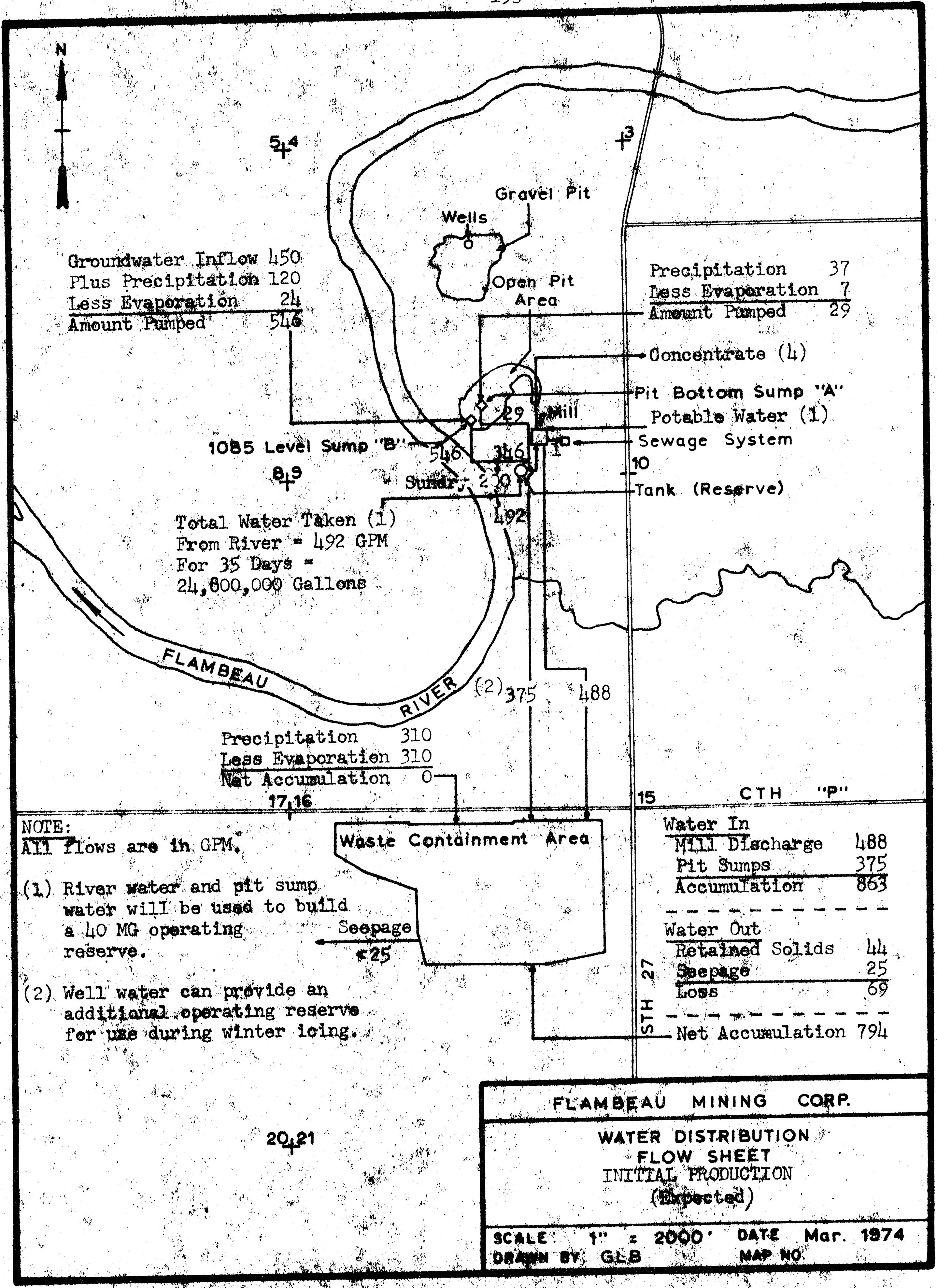

N
Gravel Pit
Wells
Open Pit Area
Groundwater Inflow 450
Plus Precipitation 120
Less Evaporation 24
Amount Pumped 546
Precipitation 37
Less Evaporation 7
Amount Pumped 29
Concentrate (4)
Pit Bottom Sump "A"
29
Mill
Potable Water (1)
1085 Level Sump "B"
546
346
1
Sewage System
10
Sundry
230
Tank (Reserve)
492
Total Water Taken (1)
From River = 492 GPM
For 35 Days =
24,800,000 Gallons
FLAMBEAU RIVER
(2) 375
488
Precipitation 310
Less Evaporation 310
Net Accumulation 0
17,16
15
CTH "P"
NOTE:
All flows are in GPM.
(1) River water and pit sump water will be used to build a 40 MG operating reserve.
(2) Well water can provide an additional operating reserve for use during winter icing.
Waste Containment Area
Seepage
≤25
Water In
Mill Discharge 488
Pit Sumps 375
Accumulation 863
Water Out
Retained Solids 44
Seepage 25
Loss 69
STH 27
Net Accumulation 794
20,21
FLAMBEAU MINING CORP.
WATER DISTRIBUTION
FLOW SHEET
INITIAL PRODUCTION
(Expected)
SCALE 1" = 2000'
DATE Mar. 1974
DRAWN BY GLB
MAP NO.

FIGURE L9

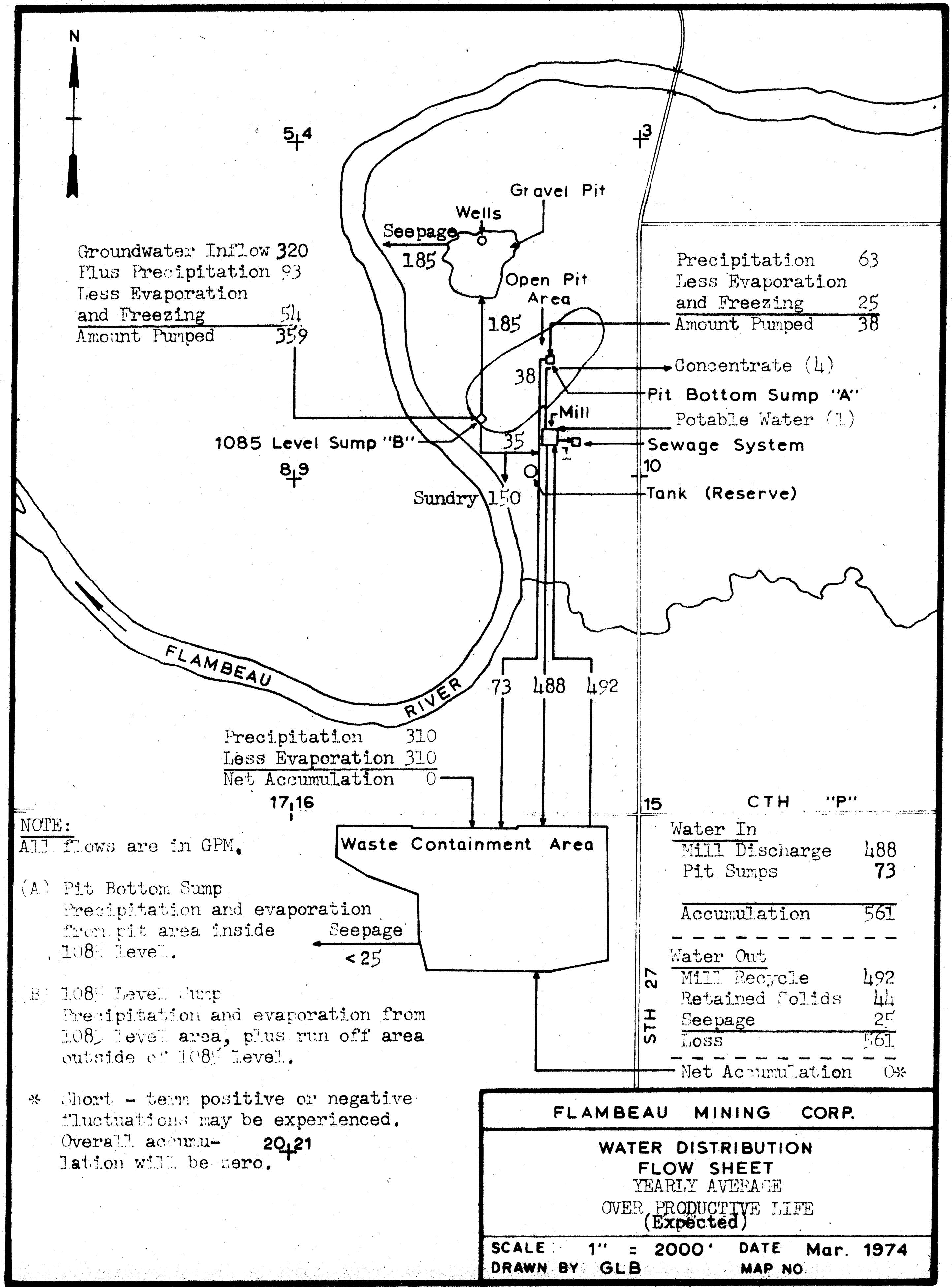

N
5 4
3
Gravel Pit
Wells
Seepage
185
Groundwater Inflow 320
Plus Precipitation 93
Less Evaporation and Freezing 54
Amount Pumped 359
Open Pit Area
185
Precipitation 63
Less Evaporation and Freezing 25
Amount Pumped 38
38
Concentrate (4)
Pit Bottom Sump "A"
Mill
Potable Water (1)
1085 Level Sump "B"
35
1
Sewage System
8 9
10
Sundry 150
Tank (Reserve)
FLAMBEAU RIVER
73
488
492
Precipitation 310
Less Evaporation 310
Net Accumulation 0
17 16
15
CTH "P"
NOTE:
All flows are in GPM.
(A) Pit Bottom Sump Precipitation and evaporation from pit area inside 1085 Level.
(B) 1085 Level Sump Precipitation and evaporation from 1085 Level area, plus run off area outside of 1085 Level.
* Short - term positive or negative fluctuations may be experienced. Overall accumulation will be zero.
Waste Containment Area
Seepage
<25
Water In
Mill Discharge 488
Pit Sumps 73
Accumulation 561
Water Out
Mill Recycle 492
Retained Solids 44
Seepage 25
Loss 561
Net Accumulation 0*
STH 27
20 21
FLAMBEAU MINING CORP.
WATER DISTRIBUTION FLOW SHEET
YEARLY AVERAGE OVER PRODUCTIVE LIFE
(Expected)
SCALE 1" = 2000'
DATE Mar. 1974
DRAWN BY GLB
MAP NO.

FIGURE L 10

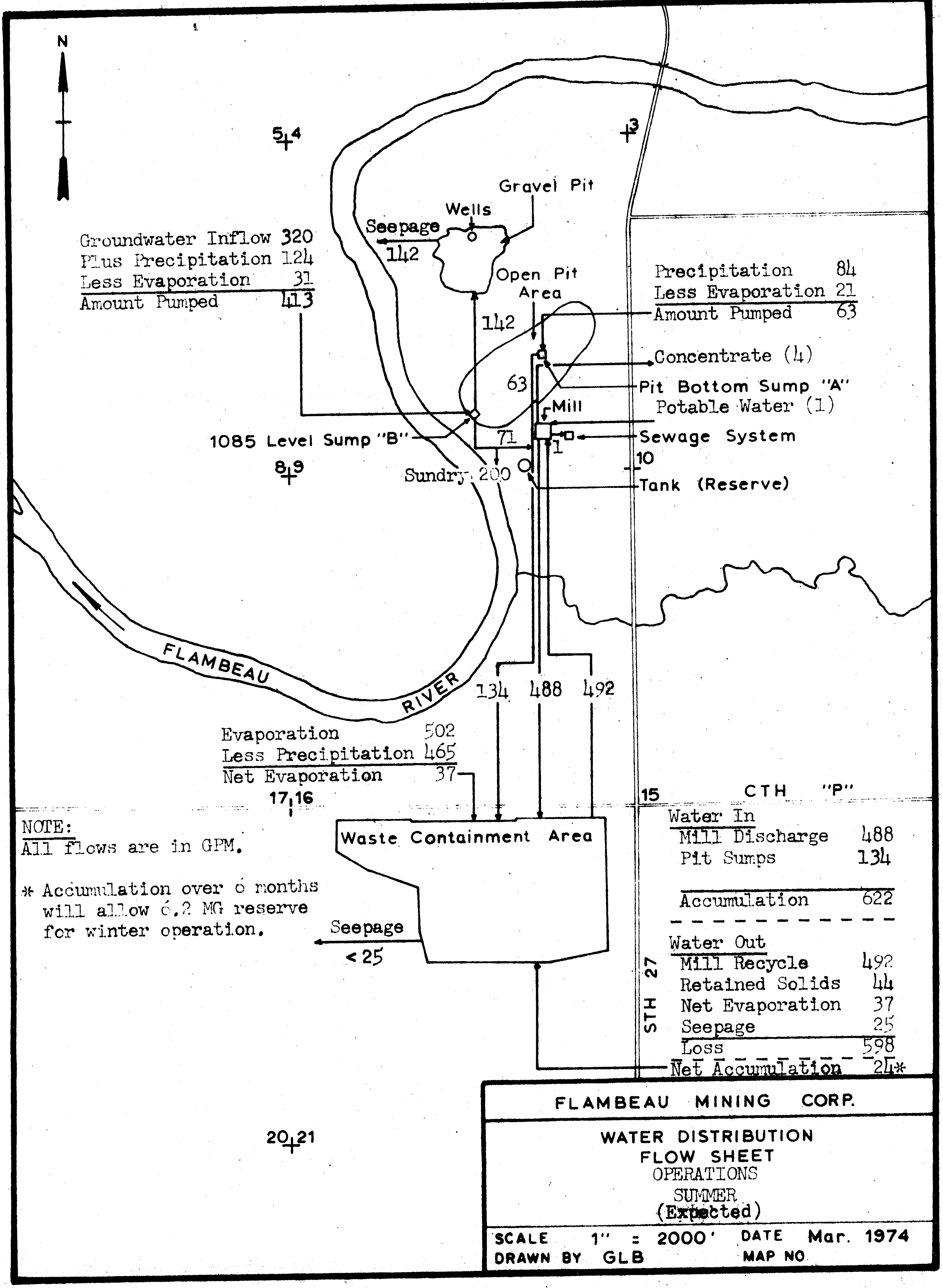

N
5 4
3
Gravel Pit
Wells
Seepage
142
Groundwater Inflow 320
Plus Precipitation 124
Less Evaporation 31
Amount Pumped 413
Open Pit Area
142
Precipitation 84
Less Evaporation 21
Amount Pumped 63
Concentrate (4)
63
Pit Bottom Sump "A"
Mill
Potable Water (1)
1085 Level Sump "B"
71
Sewage System
1
8 9
10
Sundry 200
Tank (Reserve)
FLAMBEAU RIVER
134
488
492
Evaporation 502
Less Precipitation 465
Net Evaporation 37
17 16
15
CTH "P"
Water In
Mill Discharge 488
Pit Sumps 134
Accumulation 622
NOTE:
All flows are in GPM.
* Accumulation over 6 months will allow 6.2 MG reserve for winter operation.
Waste Containment Area
Seepage
< 25
Water Out
Mill Recycle 492
Retained Solids 44
Net Evaporation 37
Seepage 25
Loss 598
Net Accumulation 24*
STH 27
FLAMBEAU MINING CORP.
20 21
WATER DISTRIBUTION
FLOW SHEET
OPERATIONS
SUMMER
(Expected)
SCALE 1" = 2000'
DATE Mar. 1974
DRAWN BY GLB
MAP NO.

FIGURE L II

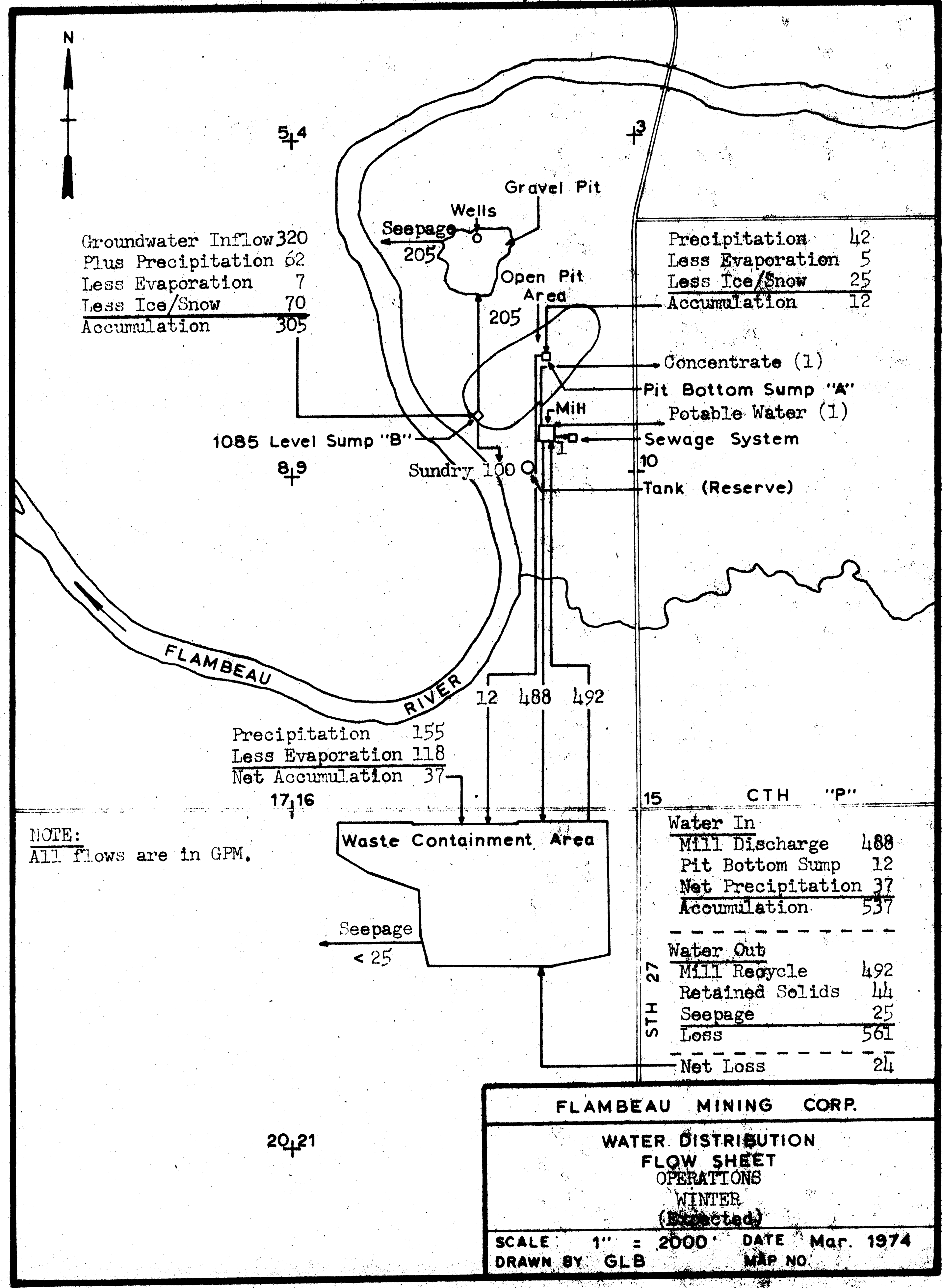
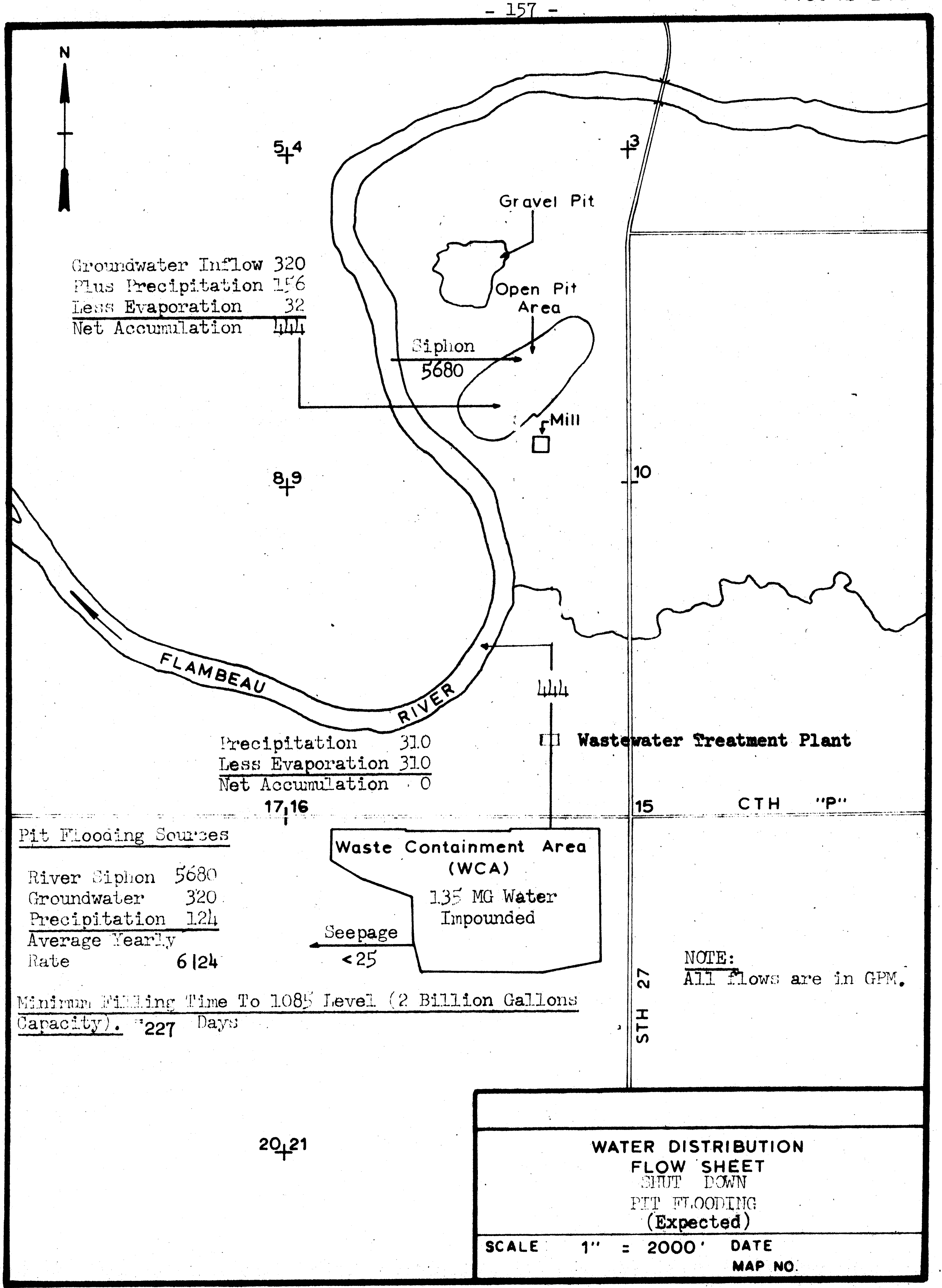

N
5 4
3
Gravel Pit
Wells
Seepage
205
Groundwater Inflow 320
Plus Precipitation 62
Less Evaporation 7
Less Ice/Snow 70
Accumulation 305
Open Pit Area
205
Precipitation 42
Less Evaporation 5
Less Ice/Snow 25
Accumulation 12
Concentrate (1)
Pit Bottom Sump "A"
Mill
Potable Water (1)
1085 Level Sump "B"
Sewage System
1
8 9
Sundry 100
10
Tank (Reserve)
FLAMBEAU RIVER
12
488
492
Precipitation 155
Less Evaporation 118
Net Accumulation 37
17 16
15
CTH "P"
NOTE:
All flows are in GPM.
Waste Containment Area
Water In
Mill Discharge 488
Pit Bottom Sump 12
Net Precipitation 37
Accumulation 537
Seepage
< 25
Water Out
Mill Recycle 492
Retained Solids 44
Seepage 25
Loss 561
STH 27
Net Loss 24
20 21
FLAMBEAU MINING CORP.
WATER DISTRIBUTION
FLOW SHEET
OPERATIONS
WINTER
(Expected)
SCALE 1" = 2000'
DATE Mar. 1974
DRAWN BY GLB
MAP NO.

FIGURE L 12


N
5 4
3
Gravel Pit
Groundwater Inflow 320
Plus Precipitation 156
Less Evaporation 32
Net Accumulation 444
Open Pit Area
Siphon 5680
Mill
8 9
10
FLAMBEAU RIVER
444
Precipitation 310
Less Evaporation 310
Net Accumulation 0
Wastewater Treatment Plant
17 16
15
CTH "P"
Pit Flooding Sources
River Siphon 5680
Groundwater 320
Precipitation 124
Average Yearly Rate 6124
Waste Containment Area (WCA)
135 MG Water Impounded
Seepage <25
NOTE: All flows are in GPM.
STH 27
Minimum Filling Time To 1085 Level (2 Billion Gallons Capacity). 227 Days
20 21
WATER DISTRIBUTION FLOW SHEET
SHUT DOWN
PIT FLOODING
(Expected)
SCALE 1" = 2000'
DATE
MAP NO.

APPENDIX M

NOISE LEVEL CALCULATIONS

SAND AND GRAVEL COMMUNITY CONTRIBUTION*

$$Lp = Lx - 20 \log \frac{r}{rx}$$

where:

Lx = measured sound pressure level

rx = distance from sound source of measure level (constant)
r = distance from source, varying distances

Lp = sound level at distance r

$$Lp = 91.7 - 20 \log \frac{r'}{65'}$$

$$Lp = 91.7 - 20 \log \frac{100'}{65'} = 88.0 \text{ dBA}$$

$$Lp = 91.7 - 20 \log \frac{200'}{65'} = 81.9 \text{ dBA}$$

$$Lp = 91.7 - 20 \log \frac{400'}{65'} = 75.9 \text{ dBA}$$

$$lP = 91.7 - 20 \log \frac{600'}{65'} = 72.4 \text{ dBA}$$

$$Lp = 91.7 - 20 \log \frac{800'}{65'} = 69.9 \text{ dBA}$$

$$Lp = 91.7 - 20 \log \frac{1000'}{65'} = 68.0 \text{ dBA}$$

$$Lp = 91.7 - 20 \log \frac{1800'}{65'} = 62.9 \text{ dBA}$$

$$Lp = 91.7 - 20 \log \frac{3000'}{65'} = 58.4 \text{ dBA}$$

$$Lp = 91.7 - 20 \log \frac{4000'}{65'} = 55.9 \text{ dBA}$$

$$Lp = 91.7 - 20 \log \frac{5000'}{65'} = 54.0 \text{ dBA}$$

$$Lp = 91.7 - 20 \log \frac{6000'}{65'} = 52.4 \text{ dBA}$$

$$Lp = 91.7 - 20 \log \frac{6100'}{65'} = 52.3 \text{ dBA}$$

$$Lp = 91.7 - 20 \log \frac{6200'}{65'} = 52.1 \text{ dBA}$$

*Sand and Gravel Pit to Ladysmith
Assume highest SPL
S pressure reading taken at 65' from the crusher
(crusher outside-not enclosed) 91.7 dBA

Appendix M (cont.)

CRUSHER CONTRIBUTION TO COMMUNITY*

$$Lp = 88.0 - 20 \log \frac{X'}{3'} =$$

$$Lp = 88.0 - 20 \log \frac{100}{3} = 57.5 \text{ dBA}$$

$$Lp = 88.0 - 20 \log \frac{200}{3} = 51.5 \text{ dBA}$$

$$Lp = 88.0 - 20 \log \frac{400}{3} = 45.5 \text{ dBA}$$

$$Lp = 88.0 - 20 \log \frac{600}{3} = 42.0 \text{ dBA}$$

$$Lp = 88.0 - 20 \log \frac{800}{3} = 39.5 \text{ dBA}$$

$$Lp = 88.0 - 20 \log \frac{1000}{3} = 37.5 \text{ dBA}$$

$$Lp = 88.0 - 20 \log \frac{2000}{3} = 31.5 \text{ dBA}$$

$$Lp = 88.0 - 20 \log \frac{3000}{3} = 28.0 \text{ dBA}$$

$$Lp = 88.0 - 20 \log \frac{4000}{3} = 25.5 \text{ dBA}$$

$$Lp = 88.0 - 20 \log \frac{5000}{3} = 23.6 \text{ dBA}$$

$$Lp = 88.0 - 20 \log \frac{6000}{3} = 22.0 \text{ dBA}$$

$$Lp = 88.0 - 20 \log \frac{6100}{3} = 21.8 \text{ dB}$$

$$Lp = 88.0 - 20 \log \frac{6200}{3} = 21.7 \text{ dB}$$

*KCC Crusher to Ladysmith
Use 35000 TPD crusher data with a SPL of 88.0 dBA outside of building three feet from open door.

HEAVY EQUIPMENT CONTRIBUTION TO COMMUNITY FROM PIT*

$$Lp = 100 - 20 \log \frac{x'}{3'}$$

x	=	100'	=	69.5 dB
1x	=	200'	=	63.5 dB
2x	=	400'	=	57.5 dB
3x	=	600'	=	54.0 dB
4x	=	800'	=	51.5 dB
5x	=	1000'	=	49.5 dB
10x	=	2000'	=	43.5 dB
15x	=	3000'	=	40.0 dB
20x	=	4000'	=	37.5 dB
x	=	5000'	=	35.6 dB
x	=	6000'	=	34.0 dB

*Extreme pit limit to Ladysmith assuming a level of 100 dBA 3 feet from truck engine.

Appendix M (cont.)

ROADSIDE NOISE DISTRIBUTION

$$Lp = 88.5 - 20 \log \frac{r}{50'}$$

r	=	100	=	82.5 dBA
r	=	200	=	76.5 dBA
r	=	400	=	70.4 dBA
r	=	600	=	66.9 dBA
r	=	800	=	64.4 dBA
r	=	1000	=	62.5 dBA
r	=	1500	=	59.0 dBA
r	=	2000	=	56.5 dBA
r	=	3000	=	52.9 dBA
r	=	4000	=	50.4 dBA
r	=	4400	=	49.6 dBA
r	=	5000	=	48.5 dBA
r	=	6000	=	46.9 dBA

APPENDIX N

BASIS FOR EMPLOYMENT AND POPULATION ESTIMATES

Column A - The construction schedule for the project is estimated at 18 months; the estimated operating period for the open pit phase of the mining is 10.5 years.

Column B - The number of employees is based on a construction schedule for the project.

Column C - The total number of operating employees is based on description of the operating crew.

Column D - It is assumed that 15 percent of the construction crew and 60 percent of the operating crew would be recruited from residents of the county. Column D then is essentially equal to 0.15B ÷ 0.6C except during the first 14 months when operating employees are starting to be recruited for the project. During this period it is assumed that less than the expected 60 percent of the operating employees would be available while recruiting of residents from the county progresses to the expected 60 percent.

Column E - In general, the jobs in counties in Wisconsin involving agriculture, mining, manufacturing and construction constitute about 50 percent of the work force except in counties having large universities or large government installations. The other jobs involving retail and wholesale trade, utilities, education, etc., are considered as service jobs in this study. In a stabilized economic situation, one job in a basic economic activity including agriculture, mining, manufacturing and construction will conservatively result in 0.85 other jobs in one of the service industries. For this study the multiplier was modified in accordance with the discussion above. It was therefore assumed that for every job on the project site, 0.28 service job will arise. Column E then is essentially equal to (B + C) x 0.28.

Column F - It has been assumed that 75 percent of the new service employees will be recruited from present residents of the county.

Column G - G is equal to (B + C) - D + (E - F).

Column H - It was assumed that for each new construction employee, a total of one and one-half new county residents will be added. Also, it was assumed that each new operating employee and service employee will add 3.5 new residents to the county. This extrapolation is believed to be reasonably valid during the construction period and the early years of operation; however, many unforeseen events can affect this type of extrapolation if extended for too many years.

8-1-75
lk ($9.93)