RESERVE MINING COMPANY

PETER MITCHELL MINE

APPLICATION FOR A PERMIT TO MINE

AS REQUIRED BY 6MCAR SEC.1.0403

FEBRUARY 1981

RESERVE MINING COMPANY
SILVER BAY, MINNESOTA 55614

MATTHEW R. BANOVETZ
PRESIDENT

February 23, 1981

Mr. Joseph N. Alexander, Commissioner
Department of Natural Resources
State of Minnesota
Centennial Office Building
Saint Paul, Minnesota 55155

Dear Mr. Alexander:

Pursuant to Minnesota Statutes, Sections 93.44 to 93.51 and the Rules Relating to Mineland Reclamation adopted thereunder, Reserve Mining Company hereby applies for a permit to mine. The information, required by the statute and rules in support of this permit application, is enclosed with this letter.

The information supporting this application for a permit to mine was prepared with the assistance of our consultant, Barr Engineering Co. and incorporates information developed for Reserve by the Department of Natural Resources, Arthur D. Little Inc., Klohn Leonoff Consultants Ltd., E. A. Hickok & Associates, and others.

As you may be aware, Reserve has also been considering the possibility of requesting a variance from certain portions of the rules pertaining to stockpiles. Members of your staff have pointed out, however, that a large part of the justification for such a request--conflicting needs and demands for land--is at present somewhat conjectural. For this reason and others we have chosen not to request a variance at this time but may do so in the foreseeable future.

Very truly yours,

M Banovetz

MRB:se
Enc.

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*Note: APPENDIX B and APPENDIX C are bound separate from application.

PETER MITCHELL MINE
RESERVE MINING COMPANY
APPLICATION FOR A PERMIT
TO MINE AS REQUIRED
BY 6MCAR SEC. 10403

1. DOCUMENTS

a. Certificate of Insurance - Enclosed herein are the required Certificates (3).

b. Notice and Affidavit of Publication - The required publication and affidavit will follow the submission of this application.

c. Certification of Authority for a Foreign Corporation to do Business in Minnesota - Not Applicable.

d. Financial and Income Statements - See Appendix A.

2. ORGANIZATION DATA

a. Address of Application

Reserve Mining Company
Silver Bay, Minnesota 55614

b. Organization Structure - Reserve Mining Company is organized and exists under the laws and statutes of the State of Minnesota. The corporate shares of Reserve Mining Company are owned by:

50% - Armco, Inc.
50% - Republic Steel Corporation

c. Management Agents or Subsidiaries Which May Be Involved in the Mining Operation - Reserve Mining Company is both an operating and managing company having no subsidiaries. Reserve Mining Company does lease land used for mining purposes from Northern Land Company. Northern Land

SET TAB STOPS AT ARROWS

Certificate of Insurance

acord

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES LISTED BELOW.

NAME AND ADDRESS OF AGENCY

Corroon and Black Company of N.Y.
150 William Street
New York, New York 10038

COMPANIES AFFORDING COVERAGES

COMPANY LETTER A Travelers Indemnity Company

COMPANY LETTER B

COMPANY LETTER C

COMPANY LETTER D

COMPANY LETTER E

NAME AND ADDRESS OF INSURED

Reserve Mining Company
Silver Bay, Minnesota 55614

This is to certify that policies of insurance listed below have been issued to the insured named above and are in force at this time. Notwithstanding any requirement, term or condition of any contract or other document with respect to which this certificate may be issued or may pertain, the insurance afforded by the policies described herein is subject to all the terms, exclusions and conditions of such policies.

COMPANY LETTER	TYPE OF INSURANCE	POLICY NUMBER	POLICY EXPIRATION DATE	Limits of Liability in Thousands (000)	EACH OCCURRENCE	AGGREGATE
A	**GENERAL LIABILITY** X COMPREHENSIVE FORM X PREMISES—OPERATIONS ☐ EXPLOSION AND COLLAPSE HAZARD ☐ UNDERGROUND HAZARD X PRODUCTS/COMPLETED OPERATIONS HAZARD X CONTRACTUAL INSURANCE ☐ BROAD FORM PROPERTY DAMAGE X INDEPENDENT CONTRACTORS X PERSONAL INJURY	T-SLG-162T783-9-80	7/1/81	BODILY INJURY	$	$
				PROPERTY DAMAGE	$	$
				BODILY INJURY AND PROPERTY DAMAGE COMBINED	1,000	1,000
				PERSONAL INJURY		1,000
A	**AUTOMOBILE LIABILITY** X COMPREHENSIVE FORM X OWNED X HIRED X NON-OWNED	T-CAP-162T784-0-80	7/1/81	BODILY INJURY (EACH PERSON)	$	
				BODILY INJURY (EACH ACCIDENT)	$	
				PROPERTY DAMAGE	$	
				BODILY INJURY AND PROPERTY DAMAGE COMBINED	$ 1,500	
	EXCESS LIABILITY ☐ UMBRELLA FORM ☐ OTHER THAN UMBRELLA FORM			BODILY INJURY AND PROPERTY DAMAGE COMBINED	$	$
	WORKERS' COMPENSATION and EMPLOYERS' LIABILITY			STATUTORY		
					$	(EACH ACCIDENT)
	OTHER					

DESCRIPTION OF OPERATIONS/LOCATIONS/VEHICLES

Cancellation: Should any of the above described policies be cancelled before the expiration date thereof, the issuing company will endeavor to mail 30 days written notice to the below named certificate holder, but failure to mail such notice shall impose no obligation or liability of any kind upon the company.

NAME AND ADDRESS OF CERTIFICATE HOLDER:

Commissioner pf Natural Resources
State of Minnesota
St. Paul, Minnesota

DATE ISSUED: January 20, 1981

Albert H. Cordon (MFIT)

AUTHORIZED REPRESENTATIVE

CORD 25 (1-79)

VERIFICATION OF INSURANCE

To: COMMISSIONER OF NATURAL RESOURCES
State of Minnesota
St. Paul, Minnesota

We, the undersigned Insurance Brokers, hereby certify that the following described insurance is in force at this date, of which 100 per cent is insured with Certain Insurance Companies.

ASSURED: RESERVE MINING COMPANY AND
SILVER BAY COUNTRY CLUB

ADDRESS: Silver Bay, Minnesota 55614

LOCATION OF RISK: Coverage Applies Worldwide

TYPE OF INSURANCE: Umbrella Liability Insurance

POLICY OR CERTIFICATE NO.: SF 2894

PERIOD: From 7/1/80 To 7/1/83

LIMITS OF LIABILITY: ~~Bodily Injury~~ $5,000,000 Excess of Scheduled Underlying Insurance or $25,000 Self Insured Retention.

~~Property Damage~~

This document is furnished to you as a matter of information only. The issuance of this document does not make the person or organization to whom it is issued an additional assured, nor does it modify in any manner the contract of insurance between the Assured and the Companies. Any amendment, change or extension of such contract can only be affected by specific endorsement attached thereto.

Should the abovementioned contract of insurance be cancelled, assigned or changed during the above named policy period in such manner as to effect this document, we, the Undersigned, will endeavor to give 30 days written notice to the holder of this document, but failure to give such notice shall impose no obligation of any kind upon the Undersigned or upon the Companies.

PACIFIC INTERNATIONAL BROKERS, LTD.

Dated January 20, 1981

By H. R. Ludwig
H. R. Ludwig

SLP 5085 (COMPANIES) PRINTED IN U.S.A.

VERIFICATION OF INSURANCE

To: COMMISSIONER OF NATURAL RESOURCES
State of Minnesota
St. Paul, Minnesota

We, the undersigned Insurance Brokers, hereby certify that the following described insurance is in force at this date, of which 65.50 per cent is insured with Certain Insurance Companies.

ASSURED: RESERVE MINING COMPANY AND
SILVER BAY COUNTRY CLUB

ADDRESS: Silver Bay, Minnesota 55614

LOCATION OF RISK: Coverage Applies Worldwide

TYPE OF INSURANCE: Excess Umbrella Liability Insurance

~~XXXXXXXXXX~~ CERTIFICATE NO.: SF 2895

PERIOD: From 7/1/80 To 7/1/83

LIMITS OF LIABILITY: ~~XXXXXXXXX~~ $5,000,000 excess of $5,000,000 excess of Scheduled Underlying Insurance or $25,000 Self Insured Retention

~~XXXXXXXXXXXXXX~~

This document is furnished to you as a matter of information only. The issuance of this document does not make the person or organization to whom it is issued an additional assured, nor does it modify in any manner the contract of insurance between the Assured and the Companies. Any amendment, change or extension of such contract can only be affected by specific endorsement attached thereto.

Should the abovementioned contract of insurance be cancelled, assigned or changed during the above named policy period in such manner as to effect this document, we, the Undersigned, will endeavor to give 30 days written notice to the holder of this document, but failure to give such notice shall impose no obligation of any kind upon the Undersigned or upon the Companies.

PACIFIC INTERNATIONAL BROKERS, LTD.

Dated January 27, 1981

By H. R. Ludwig

SLP 5085 (COMPANIES) PRINTED IN U.S.A.

VERIFICATION OF INSURANCE

To: COMMISSIONER OF NATURAL RESOURCES
State of Minnesota
St. Paul, Minnesota

We, the undersigned Insurance Brokers, hereby certify that the following described insurance is in force at this date, of which 34.50 per cent is insured with Underwriters at Lloyd's London:

ASSURED: RESERVE MINING COMPANY AND
SILVER BAY COUNTRY CLUB

ADDRESS: Silver Bay, Minnesota 55614

LOCATION OF RISK: Coverage Applies Worldwide

TYPE OF INSURANCE: Excess Umbrella Liability Insurance

CERTIFICATE NO.: SF 2895

PERIOD: From 7/1/80 To 7/1/83

LIMITS OF LIABILITY: ~~Bodily Injury~~ $5,000,000 excess of $5,000,000 excess of Scheduled Underlying Insurance or $25,000 Self Insured Retention.

~~Property Damage~~

This document is furnished to you as a matter of information only. The issuance of this document does not make the person or organization to whom it is issued an additional assured, nor does it modify in any manner the contract of insurance between the Assured and the Underwriters. Any amendment, change or extension of such contract can only be affected by specific endorsement attached thereto.

Should the above mentioned contract of insurance be cancelled, assigned or changed during the above named Certificate period in such manner as to effect this document, we, the Undersigned, will endeavor to give 30 days written notice to the holder of this document, but failure to give such notice shall impose no obligation of any kind upon the Undersigned or upon the Underwriters.

PACIFIC INTERNATIONAL BROKERS, LTD.

Dated January 27, 1981

By H. R. Ludwig

SLP 5085 (LLOYDS) PRINTED IN U.S.A.

Company is a Minnesota corporation owned equally by Armco, Inc. and Republic Steel Corporation.

d. Organization Relationships Between or Among Joint Applicants - This is covered in Item c.

3. ENVIRONMENTAL SETTING MAPS

Babbitt Operations

The environmental setting maps of the Babbitt operations required are included in Appendix B. They are as follows:

1)	Bedrock Geology	Figure B-1
2)	Water Basins, Watercourses and Wetlands	Figure B-2
3)	Boundaries of Watersheds	Figure B-3
4)	Details of Ground Water Conditions	Figure B-4
5)	Natural Resource Sites Identified by the Commissioner of the DNR	Figure B-5
6)	Forest Inventory	
	6-A Combined Vegetation	Figure B-6A
	6-B Combined Vegetation Size Class	Figure B-6B
	6-C Combined Vegetation Density	Figure B-6C
7)	Soils Inventory	Figure B-7
8)	Past Mining Facilities	Figure B-8
9)	Surface Ownership of Record within the Mining Area Which will be Excavated or Covered with Mineral Waste	Figure B-9

Severed Mineral Rights of Record within the Mining Area Which Will be Excavated or Covered with Mineral Waste — Figure B-10

10) Exclusion, Advoidance and Setback Areas (This is not applicable to the Babbitt operations)

Silver Bay Operations

The environmental setting maps and environmental setting analysis of the Silver Bay operations are as follows:

The environmental aspects of these operations have previously been covered in greater detail than is required in this permit application. This was accomplished in the many environmental studies that were carried out in conjunction with Reserve Mining Company's conversion from in-lake tailing disposal to the Milepost 7 on-land disposal.

The information presented in this section was extracted from the following two listed reports.

Klohn Leonoff Consultants, Ltd., Engineering Report on Geotechnical, Hydrology, and Hydraulic Design for Tailing Disposal Milepost No. 7 Site for Reserve Mining Company, Volume I, August, 1976.

Arthur D. Little, Inc., Inventory of Water Resources Milepost 7 Tailing Disposal Site, Environmental Report Concerning On-Land Tailing Disposal and Air Quality Plan for the E. W. Davis Works - Reserve Mining Company, Volume II, April 30, 1975.

a. <u>Bedrock Geology</u> -- Klohn Leonoff

The geology of the Milepost 7 tailing disposal area is shown in plan and section on drawing number 292-0024 included herein.

Bedrock in the site area is igneous in origin, comprising both intrusive and extrusive rocks of Upper Precambrian age. The intrusive rocks are part of the Beaver Creek Complex and are mainly fine textured gabbro. The extrusive rocks are part of the North Shore Volcanic Group and are predominantly fine to medium grained andesite and basalt, in places amygdaloidal. Both the intrusive and extrusive rocks are included in the Keweenawan Unit and are situated on the southern edge of the Canadian Shield.

The extrusive volcanic rocks are the older and occupy the bottom of the proposed tailing basin. The intrusive Beaver Bay series have penetrated the older rocks along zones of weakness and now occupy the east and west ridges flanking the tailing pond site. The contact along the east ridge has been reasonably well established by drilling and appears to be vertical or nearly vertical. Exact location and dip of the contact along the west ridge has not been established because it lies mainly below considerable depths of dense glacial till. The major bedrock exposures are along the ridge at the east of the disposal area. There are smaller exposures within the basin and along the west side.

Two main sets of fractures (joints) were observed in both the intrusive and the extrusive formations, one trending NNE and the other ESE, and dipping steeply to near vertical. Some slickensides were noted in drill core fractures within the intrusive rocks at or close to the contact between the two formations, indicating possible minor faulting. No evidence was found of major faulting. Most of the joints and fault planes encountered in the drilling were tight and have been infilled with various minerals.

The Canadian Shield is a very ancient and stable region and seismic activity is minimal to non-existent. The faults that have developed as a result of ancient tectonic movements are inactive. In the Silver Bay area, the faulting associated with the intrusive flows occurred during late Precambrian times, some 1000 million years ago. At that time, the present rock surface was buried beneath at least 2,000 feet of rock which has been subsequently removed by erosion. More recently, it has been loaded by ice at least 1,000 feet thick without apparent distress.

Glacial and Recent Geology -- About 15,000 years ago, the area was overrun by the Wisconsin Glacier which deposited a mantle of dense basal till over most of the area. The till fills all of the depressions in the bedrock surface. Within the till are localized deposits of clean sands and/or gravels which probably are glacial outwash or stream gravels laid down under the ice or during periods of temporary ice retreat. The tills and the glacio-fluvial sands and gravels within the till mass are extremely dense, having been subjected to consolidation by ice loadings in excess of 1,000 feet depth.

The glacier appears to have moved predominantly in the west-north-west direction riding up over the east ridge from the Lake Superior side. Consequently, the western face of that ridge is practically untouched by the glacier.

At the end of the glacial period, extensive laking occurred and a lacustrine formation of clay was deposited in the areas below about elevation 1150 at the Damsite No. 1 end and elevation 1200 at Damsite 2-3 end of the proposed tailing basin area. The clays have not been subjected to significant loading although the laboratory testing indicates a minor amount of over-consolidation probably caused by desiccation.

Concurrently with the clay deposition, limited amounts of sands and gravels were deposited under a glacio-lacustrine environment, to form localized deposits within the clays or directly overlying the glacial tills. These materials were laid down mainly underwater and therefore are of low to medium density.

Weathered rock-falls and talus slopes line the base of the steep east ridge face, for the most part masking the till-rock contact in that area. Contiguous with the talus along the east ridge slope are deposits of unstratified coarse sediments that are probably glacial till debris or slope wash deposits. The talus deposits are relatively thin, in many areas only a foot or two thick, and are laid down on the glacial tills, not under. The coarse sediments are in deposits of up to about 15 feet thickness and also are more recent than the till deposits.

Principal characteristics of the overburden soils that are relevant to this project are as follows:

1) Glacial Till -- The tills are primarily fine-grained but contain a wide range of gravel, cobbles and boulders. The matrix is typically a reddish brown sandy, silty clay, of moderate plasticity. As noted above, they are very dense, having been heavily loaded by the ice and the natural moisture content is at or slightly above Proctor optimum. Maximum thickness observed is 106 feet and the average thickness of the formation is about 50 feet.

2) Lacustrine Clay -- The lower portion of this deposit is varved, with layers of red-brown highly-plastic clay alternating with layers of grey silty clay. The red-brown varves average 0.5 inches thick and the grey varves range from 3/4 inch to 4 inches. In the upper portion, the deposit is weathered and has been desiccated; the varves are not visible, probably because of weathering, and the structure is nuggetty. The average thickness of the deposit is generally 15 to 20 feet and the maximum observed thickness is 45 feet.

These lacustrine clays are highly compressible and have low strength characteristics. They have had a considerable influence on the designs for the dams at this site.

3) Sands and Gravels -- As indicated above these are of two types:

a) The glacio-fluvial sands and gravels within the till mass are generally clean and are very dense.

b) The glacio-lacustrine sands and gravels overlying the till have a high fines (silt) content. They are generally of low to medium density.

4) Coarse Deposits -- These deposits of talus and reworked glacial till debris are minor in nature and will be removed from all critical areas prior to construction.

292-0024

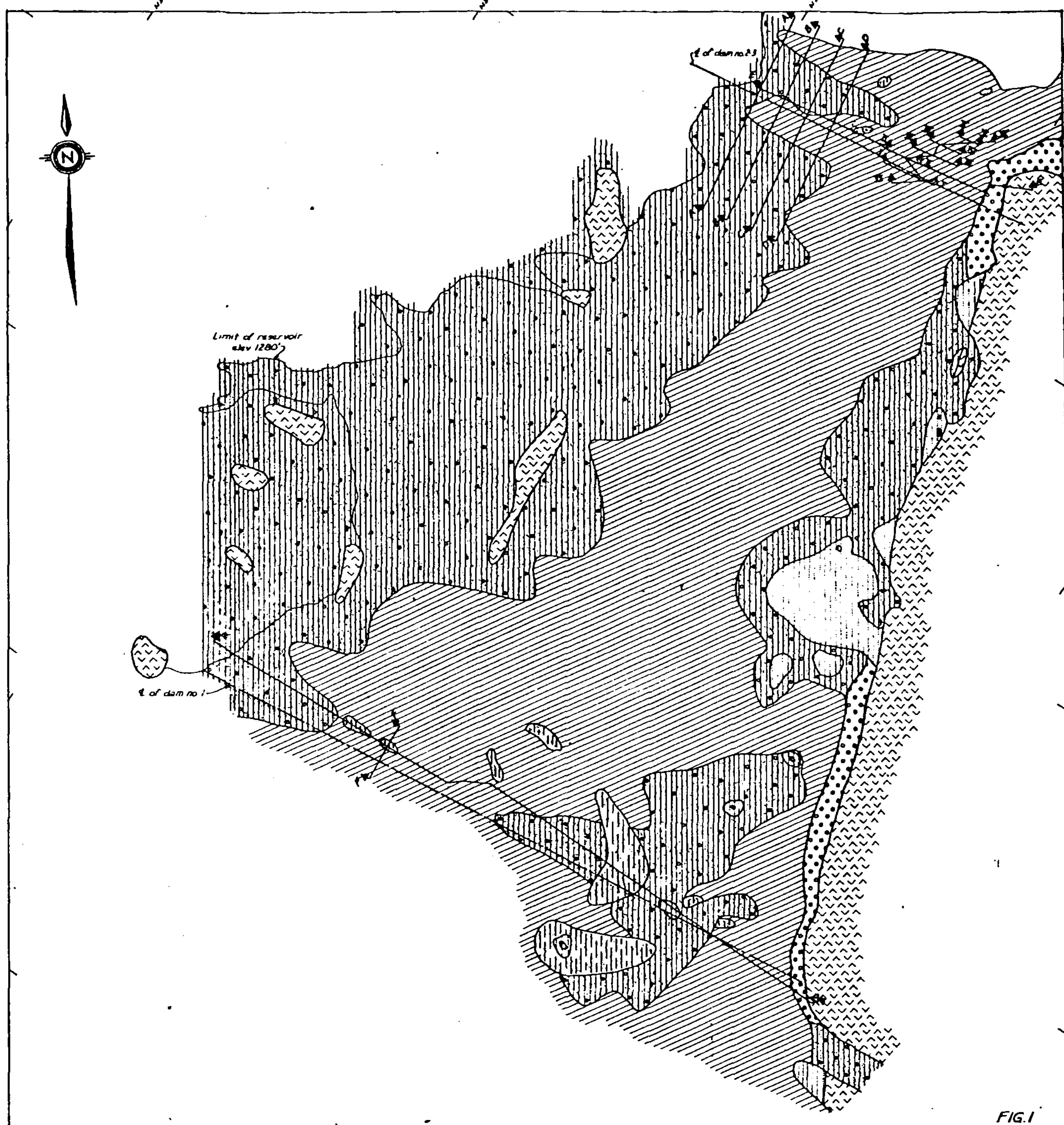
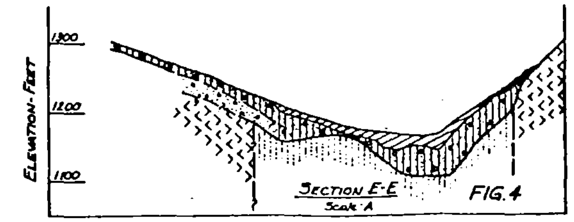
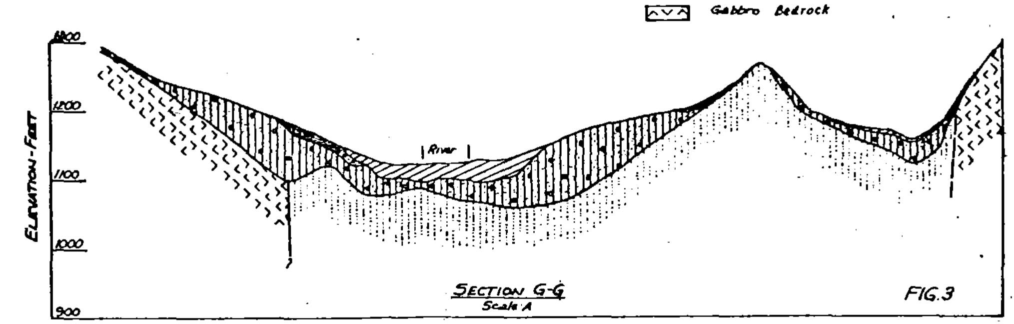


FIG. 1

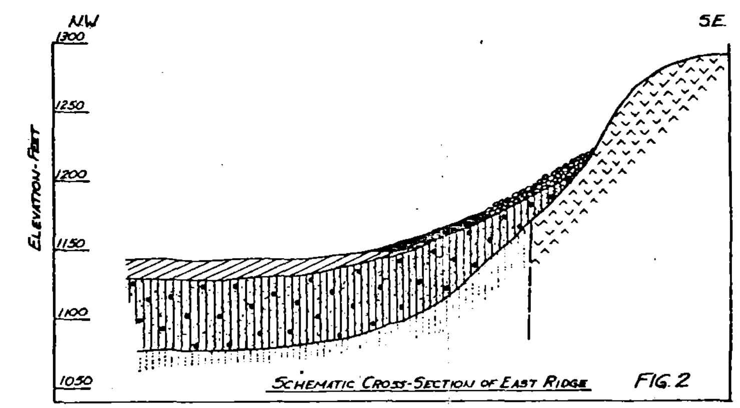
GEOLOGIC PLAN
Scale A



SECTION E-E
Scale A
FIG. 4



SECTION G-G
Scale A
FIG. 3



SCHEMATIC CROSS-SECTION OF EAST RIDGE
FIG. 2

BILL OF MATERIAL

LEGEND FOR SECTIONS

- Sand & Gravel
- Silt
- Clay
- Glacial Till
- Talus & Coarse Sediments
- Volcanic Bedrock
- Gabbro Bedrock

LEGEND FOR PLAN

Quaternary — Lacustrine Sediments
- Coarse Sediments
- Silt & Sand
- Clay
- Glacial Till

Upper Precambrian — Outcrop
- Volcanic Bedrock
- Gabbro Bedrock

REFERENCE DRAWINGS:

292-0025	Geologic cross-sections AA, BB, CC, DD, FF and I-VI.
292-0120	General layout and location plan.

Scale A 1000' 0 1000' 2000'

REVISIONS			
1	Aug '76	Dam No 2-3 center line changed	

Kloha Leonoff Consultants Ltd.
CIVIL & GEOTECHNICAL ENGINEERS

SILVER BAY, MINNESOTA
RESERVE MINING COMPANY
DAM SITES

DRAWN E Plwrey 1-16-76
CHECKED
ENGINEER
APPROVED
SCALE As shown

MILE POST No. 7 SITE
TAILING DISPOSAL AREA
GEOLOGIC PLAN & SECTIONS

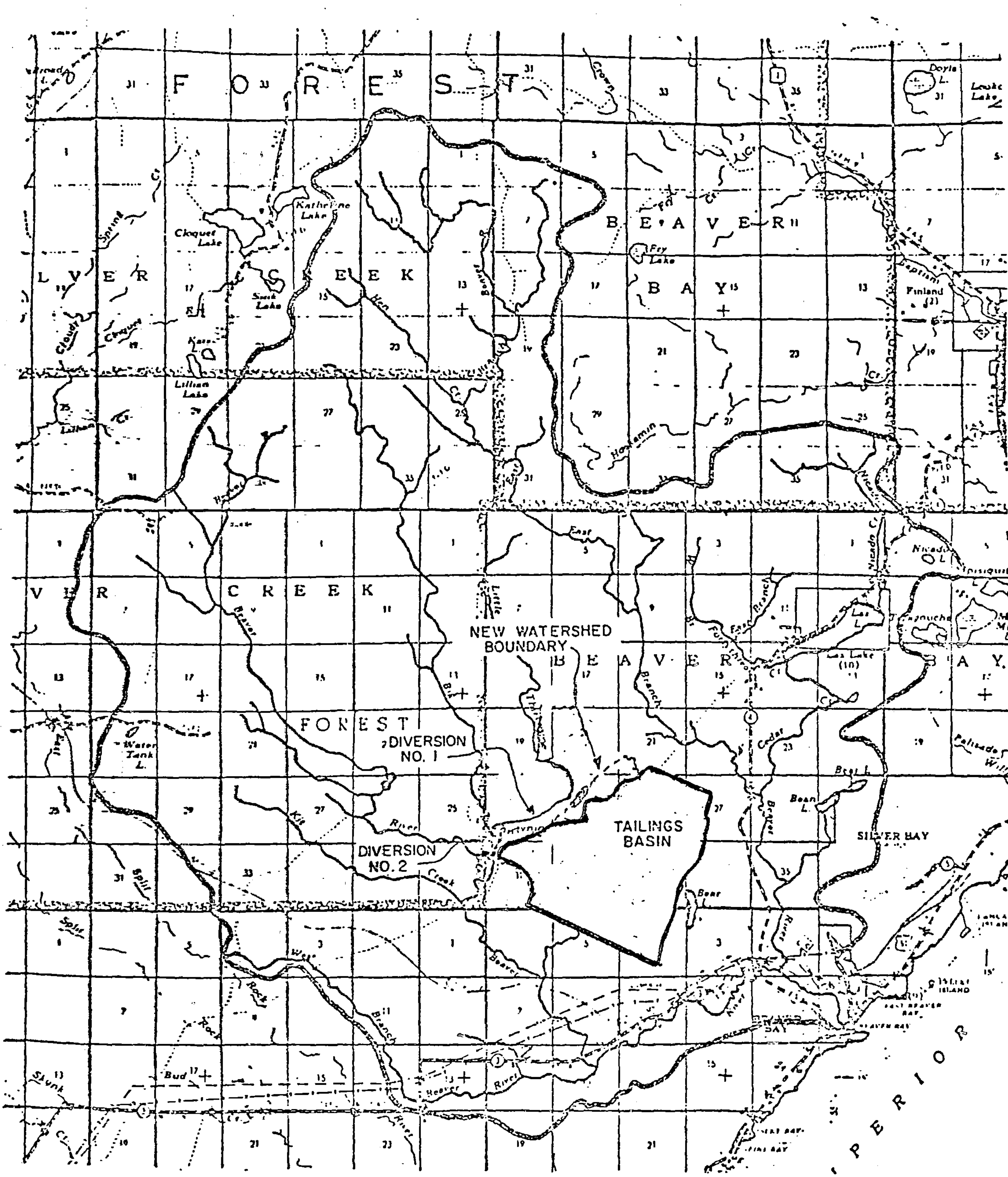
292-0024
REVISION 1

TABLE 2.1.4.2-A

Average Areas of Water Resources Within Each Watershed

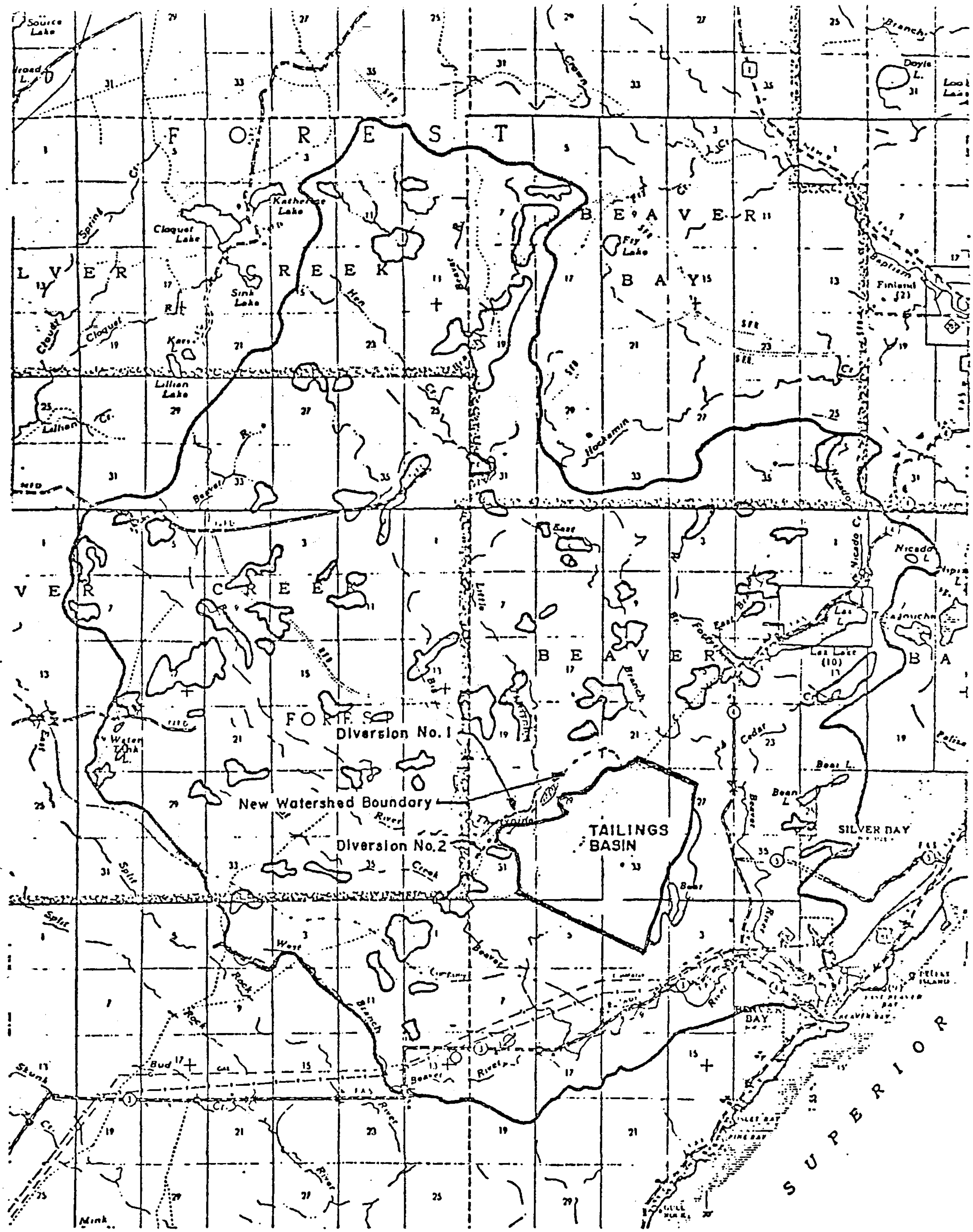
Watershed	Total Area (Sq. mi.)	Swamps/Peat (Sq. mi.)	Creeks/Streams/River (mi.)	Lakes Name	Lakes Area (sq. mi.)
Beaver River	50.43	3.10	66	-	-
Big 39 Creek	24.2	2.59	23	-	-
Little 39 Creek	7.1	0.27	8	Bear	0.06
East Branch	34.52	2.67	39	Bear Bear	0.05 0.03
Cedar Creek	16.30	0.86	15	Lax	0.44
TOTALS	132.55	9.49	151		0.58

Source: Arthur D. Little, Inc.



Source: E.A. Hickok & Associates

FIGURE 2.1.4.2–A BEAVER RIVER DRAINAGE BASIN – RIVERS, STREAMS AND LAKES



Source: E.A. Hickok & Associates

FIGURE 2.1.4.2–B BEAVER RIVER DRAINAGE BASIN–PEAT BOGS AND SWAMPS

b & c. <u>Water Basins, Water Courses, Wetlands and Watershed Boundaries</u> -- Arthur D. Little

Surface water resources of the area affected by the project include rivers, creeks, peat areas, swamps, and lakes. For analysis, the Beaver River watershed was subdivided into five watersheds (Figure 2.1.4.1-A), all feeding the Beaver River which flows into Lake Superior just to the north of the City of Beaver Bay. Inventory results of the surface water resources given in Table 2.1.4.2-A are based on planimeter measurements of "to scale" USGS quadrangles. Figures 2.1.4.2-A and 2.1.4.2-B depict rivers, streams, lakes, and peat areas and swamps, respectively.

Bedrock formations of lava flows and interbedded and intruded gabbros and diabases form the foundation to the Beaver River watershed; in many places the intrusions have formed rocky ridges and outcrops which protrude prominently along the shore line of Lake Superior - over 90% of this drainage basin (Lake Superior sub-basin) and as previously mentioned, is called the Highland area of northeastern Minnesota. There are many such basins along the shores of Lake Superior from Duluth all the way to the Pigeon River near Grand Marais on the Canadian border - the basin generally getting more rugged and steep towards Grand Marais. Landforms in a greater part of Minnesota are determined by glacial action, but particularly in northeastern Minnesota - glacial action in this area is erosional instead of depositional and because of this, glacial deposition is generally only 50 feet thick. Also in this area are found depositional sediments from the remnant glacial lakes of the Ice Age - Glacial Lake Duluth (Lake Algonquin, Lake Nipissing). These thick glacial deposits and lacustrine deposits from glacial lakes form the immediate surface across which the waters of the Beaver River and its tributaries flow.

The boundary or watershed divide between the Lake Superior sub-basin and the St. Louis sub-basin (both forming collectively the Lake Superior basin) is a glacial deposit ridge (as a boundary of the Toimi drumlin area to the west) called the Highland Moraine, this boundary generally coincides with the northwest limit of Precambrian surficial lava flows (Minn. St. Bulletin - 1966). This boundary in the Beaver River drainage basin is a southwest-northeast trending line running between the Cloquet River watershed to the west-northwest (in the St. Louis watershed) and the headwaters of the Beaver River itself.

The Beaver River drainage basin is a combination of a flat, gently rolling plain sloping towards Lake Superior to the southeast, in the northwestern and western portion of the basin to the Highlands area along Lake Superior characterized by ridgelines and cliffs. The generally flat, rolling portion of the basin has been laid down by glaciers which cut through the Highlands, generally west to northwest. These glaciers have left a thin supply of glacial sediments and have cut the surface in a southeast-northwest direction, leaving hillocks and occasional rock outcrops aligned to this general trend of glacial scour. Drainageways and streambeds are also aligned to these glacial scours, the streams and rivers flowing generally in an east-southeast direction, as do most of the North Shore streams.

The Highlands area along Lake Superior is characterized by gabbroic, diabasic intrusions trending in a southwest-northeast direction, outcropping from 3 to 4 miles inland from the lake. There is a singular band of these cliff-like outcrops running directly along Lake Superior, forming the southeasternmost boundary of the site. Bear Lake is located within this ridgeline. A continuation of this ridgeline outcrop formation stretches to the north-northwest from Lax Lake, 2 miles to the north of the proposed tailing basin. This formation extends directly into the center of the Beaver River drainage basin. A continuation of this ridgeline extends to the southwest through the drainage basin, but elevations of these intrusion-outcrop areas are 300-400 feet below those of the prominent ridges just discussed. These bedrock areas are more nearly expressed as isolated hillocks and a more rolling topography, such as forms the westernmost boundary of the proposed tailing basin. Lowland surfaces in this Highlands area are covered by lacustrine deposits of red varved clays deposited in glacial times when the level of Glacial Lake Duluth was above the present level of Lake Superior. The cover over the ridgeline-outcrop area is very sparse, past glacial erosion having carried most of this away. The clays are found in deposits of from 50-100 feet in this area, but on the site itself are only 50-70 feet in depth. The glacial sediments of the upper watershed are also thin, being generally around 50-100 feet in thickness, reaching greater thickness where post-glacial erosion has acted upon them.

The drainage pattern of the Beaver River drainage basin is dendritic with 3 to 4 main river branches as collectors, feeding into the main branch of the

Beaver River through the center, right-center of the basin. The drainage basin itself is divided into five sub-basins -- Beaver River, Big Thirtynine Creek, Little Thirtynine Creek, East Branch of the Beaver River, and Cedar Creek. The longest branch of the Beaver River is the East Branch, but the largest and most active part of the drainage basin is the Beaver River sub-basin itself with over 50 square miles of drainage area and 66 miles of tributaries and waterways. This Beaver River sub-basin experiences the most discharge of any of the streams of the basin and the widest streambeds. The headwaters of the main branch of the Beaver River are located in the west-southwestern portion of the basin, just to the south of Cloquet Lake and the headwaters of the Cloquet River (St. Louis River drainage basin). The Beaver River is joined by a number of small unnamed creeks draining relatively flat glacial sediment areas and by Kit Creek (to the extreme southwestern boundary of the site) to form the main branch of the Beaver River which flows to the south of the tailing basin and there is joined by the West Branch of the Beaver River, a short tributary in the southern portion of the basin, and an unnamed creek paralleling the Reserve Mining grade to the north. All these streams flow to the southeast to the junction of the East Branch and the main branch of the Beaver River. From there they flow through the Highlands ridge area adjacent to Lake Superior, in a northeastern direction toward Beaver Bay to the east of the Milepost #7 site.

The middle portion of the river basin is drained via two small streams, namely the Big and Little Thirtynine Creeks, both of which have their own individual drainage sub-basins, and previously drained southeast through the Milepost #7 site to their former juncture area in the middle of the tailing basin proper and from there to the main branch of the Beaver River, directly south of the southernmost dam location for the tailing basin (to a point just before the juncture of the Beaver River with the East Branch).

In order to control runoff into the basin, the Little and Big Thirtynine Creeks were diverted to the Beaver River above their entrance into the basin. The diversions were constructed with the advice of the Minnesota Department of Natural Resources and U.S. Fisheries Department. Diversion dams and diversion water channels have been vegetated with tested grasses, netting, where required, and experimental tree plantings began in 1980. High potential erosion areas were riprapped.

The far northwest corner of the Beaver River drainage basin is drained via the East Branch of the Beaver River which also runs in a southeast direction through the innermost portion of the Highlands projecting into the middle of the basin, west of Lax Lake, to the north of the tailing basin (closest point of approach to the basin being about 1/10 of a mile), and from there, running in a southeasterly direction, through the Highlands abutting Lake Superior to the east of Bear Lake, and finally joining the main branch of the Beaver River in the Highlands about 2 miles from Lake Superior. The East Branch is joined by the Cedar Creek draining the northeasternmost corner of the basin -- the Lax Lake/Highlands area -- at about 1/4 mile from the northeast corner of the proposed tailing basin.

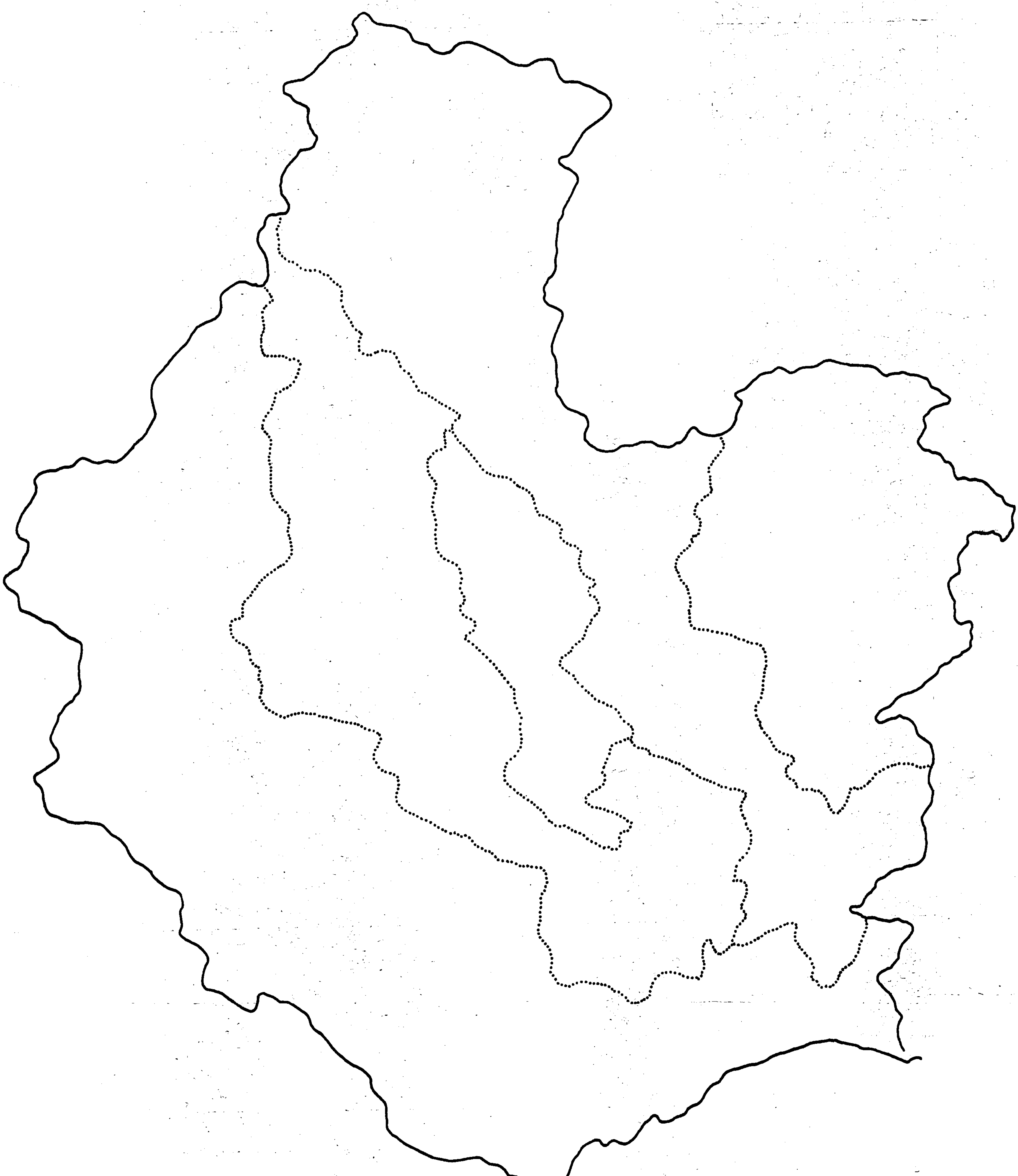
Stream gradients in the upper parts of the drainage sub-basins of the Beaver River watershed are higher than those of the St. Louis River watershed -- 50 feet per mile -- elevations ranging from 2,900 feet to 1,000 feet from the upper drainage basin to the Highlands area. Gradients into the Highlands area through the rock outcrop and cliff and ridge area can and do reach up to 300 feet per mile with steep waterflow areas in some places (50-70 foot drops) creating waterfalls and rapids. Elevations drop suddenly from the western edge of the Highlands area to Lake Superior from 1,100 to 1,200 feet to 602 feet at the Lake. These bedrock ridges of the Highlands area determine the flow of the streams and Beaver River in the vicinity of the proposed tailing disposal basin. The bedrock surfaces and valley moraine are covered in this area by glacial lake deposits, clays and silts. Falls of this kind appear on most North Shore streams in the Highlands area.

There are few surface bodies of standing water in the drainage basin (0.58 square miles as compared with 1.52 square miles in the Partridge River sub-basin of the St. Louis River) and much less of a surface area representation of swamps, and bogs than in the St. Louis River watershed (9.49 square miles compared with 32.17 square miles in the Partridge River basin).

The main bodies of surface water are an elongated section of river bed in the upper East Branch, several small lakes in the main branch of the Beaver River off Kit Creek and the West Branch, Lax Lake, Beaver and Bean Lakes, and Bear Lake in the Highlands.

The areas of peat and bog deposits, and thus, of surficial water impoundments in the Beaver River watershed, are noticeably more sparse for the Beaver River watershed than for the St. Louis River watershed. This lack of significant surface water impoundment is possible because of a generally more rapid runoff; rock outcrops, ridges, and hillocks in the watershed; and a shallower surface cover of glacial till. Thus, there is less depth of bedrock surfaces for the Beaver River watershed than for the St. Louis River watershed. These features will generally support less of a sustained overflow through major watercourses and will not provide for standing water bodies as a flat, more gentle drainage regime will.

Figures 2.1.4.1-B and 2.1.4.2-A and B show the alignment of the sub-basins within the Beaver River watershed; streams, rivers and lakes, and bogs and swamps, respectively. Though no USGS or state monitoring station is located within the drainage basin, Reserve has kept records from their monitoring program (commencing September, 1974). Records generally show that flows of the Beaver River above the juncture with the East Branch are greater than those of the East Branch itself and, in turn, flows from the Beaver River downstream of the juncture of the two rivers were greater than either of the individual river flows. In September, 1974, average flows for the three branches ranged from 1.89 to 4.99 cfs. Portions of the streams and rivers draining glacial till soils range in width from several feet to 15 to 20 feet in places. Stream bottoms are generally of a gravel-like character because of rapid streamflow. In the steep drop from 1,100 feet at the western edge of the Highlands area to the 602 feet at Lake Superior, the stream flow varies from sluggish in swamp or impoundment areas in the Highland bedrock to very rapid over the rapids and falls in this area. Where there are pools, they are generally separated by riffles, bottoms in these areas varying from rock, to stony, to sandy. The main course of the rivers generally have rapid waterflows with bottoms of glacial boulders, rocks and rock fragments.



Source: E.A. Hickok & Associates

FIGURE 2.1.4.1-B BEAVER RIVER DRAINAGE BASIN

The Milepost #7 site itself is an elongated basin occupying a depressional area to the west of the Lake Superior Highlands and to the east of a rolling ridgeline running in a generally parallel alignment with the Highland area. Streams draining the upper central portion of the watershed drain to the southeast. The streams diverted from the tailing basin are the Big and Little Thirtynine Creeks. Little Thirtynine Creek is a shorter stream. Big Thirtynine Creek is a longer waterway running further to the south, but joining Little Thirtynine Creek at the west central side of the basin.

d. Details of Groundwater Conditions -- Klohn Leonoff

Water level observations and water tests performed in the overburden and in the bedrock indicate that the basin is exceptionally watertight and that seepage losses from the completed pond will be insignificant. The clay is the least pervious of the materials. The bedrock at depth in both formations is next in imperviousness. The glacial till and the near surface bedrock are about equal in permeability and, although not of such low permeability as the deep rock or the lacustrine clay, they are nevertheless relatively good water retaining materials. The sand and gravel deposits, particularly those within the glacial till blanket, are much more pervious. However, they were generally quite localized and these deposits were completely cut off with low permeability till deposits.

The east ridge rocks are dense and watertight and dam abutment areas were grouted. The relatively pervious coarse deposits along the east ridge were inconsequential and were removed in the dam abutment areas.

The water testing program has led to the following specific conclusions:

1) Although some isolated pervious zones were found near the bedrock surface, there are no potential high seepage zones at the till/bedrock contact.

2) The contact zone between the volcanic and the intrusive rocks is tight.

3) The higher permeability of the glacial till, as compared with the clay, results in development of a slight artesian condition which will be accentuated by the dams and the tailing pond. However, this can be easily remedied by judicious use of relief wells. Flows from the wells are small.

e. Natural Resource Sites -- Arthur D. Little

Site-Specific Wildlife Habitat--Milepost #7 Site

Moose: Table 2.2.2.2-A shows the preferred seasonal habitats and foods for moose in northeastern Minnesota. Table 2.2.2.2-B contains a seasonal rating of the moose habitats on the Milepost #7 site.

There was no open season on moose in Minnesota in 1974; i.e., hunting moose was not permitted.*

During the period from 1971 to 1973, there was at least one year when limited moose hunting was permitted. A specific number of permits were issued, each permit valid for shooting one moose and each permit issued to a party of four hunters.**

Prime moose habitat in northeastern Minnesota is typified by a high degree of interspersion of aspen-birch, dense conifer, lowland brush, wet meadows, and open water. This interspersion of key types is uncommon in the Milepost #7 site. Most conspicuous is the absence of lowland brush, so important in moose diet year-round. Also missing are adequate acreages of dense conifer needed for winter cover and wet meadows and open water.

Moose Rating: Fair to Poor

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*DNR, Division of Fish and Wildlife, 1974 Hunting and Trapping Regulations, State of Minnesota, 20 p.

**Personal Communication, Ron Cheetham, son of Minnesota moose hunter, March 7, 1975.

TABLE 2.2.2.2-A

Preferred Seasonal Habitats and Foods of Moose in Northeastern Minnesota

HABITAT	Spring	Selection of openings and aquatic types: ponds, streams, marshes with early snowmelt and green-up.
	Summer	Continued use of aquatic types in early summer. Shifting to upland aspen-birch, sparse to moderately stocked and relatively mature.
	Fall	Pre-rut, rut, and post-rut period. No clear preference but slightly more use of open-lowland brush types.
	Winter	Habitat usage dependent on weather conditions: Feed in open-lowland brush; bedding in upland spruce-balsam fir.
FOOD	Spring	Aquatic vegetation plus aspen, willows, white birch and hazel browse.
	Summer	Aquatic plants and aspen cherries, white birch, willows, hazel and mountain maple browse.
	Fall	Alder, willows, cherries, white birch, red osier dogwood, hazel and mountain maple browse.
	Winter	Willows, white birch, balsam fir, mountain maple, and Juneberry browse.

Source: New England Research, Inc.

TABLE 2.2.2.2-B

Ratings of Big Game Habitats on the Milepost #7 Site

Vegetation Type		Spring	Summer	Fall	Winter
			Season		
Aspen	Deer Moose		 4	2 2	3 2
White Birch	Deer Moose		1 1	2 1	2
Lowland Hardwood	Deer Moose				
Spruce	Deer Moose				2 2
Cedar	Deer Moose				3 4
Lowland Brush	Deer Moose	1 1	1 1	1 1	1 1
Openings and Deforested Areas	Deer Moose	4 2	4 2	 4	

Rating System: 1 = Poor, 2 = Fair, 3 = Good, 4 = Excellent.
(indicates the type used by deer or moose in that season)

Overall Deer Rating: Fair
Overall Moose Rating: Fair to poor

Source: New England Research, Inc.

TABLE 2.2.2.2-C

Preferred Seasonal Habitats and Foods of Deer in Northeastern Minnesota

HABITAT	Spring	Openings and trails plus snow free hillsides: i.e., types that green up early.
	Summer	Continued use of openings, shifting to herbs and browse species in younger Aspen-Birch and logging-clearcut types.
	Fall	Deciduous and conifer uplands moderately stocked and mature with edge openings.
	Winter	Upland or lowland dense conifer with browse available in surrounding upland habitats.
FOOD	Spring	Grasses, aquatics, strawberry, asters, and composites.
	Summer	Browse: Hazel, aspen, willow, white birch, red and mountain maple.
		Herbs: Aster, jewelweed, pea bracken fern, dogbone and clover.
	Fall	Aster, clover, grasses, bush honeysuckle, aspen, paper birch, wild cherries, maples, willows.
	Winter	Dogwoods, red maple, white cedar, cherries, Juneberry, mountain maple, hazel.

Source: New England Research, Inc.

Deer: Table 2.2.2.2-C contains the preferred seasonal habitats and foods for deer in northeastern Minnesota. Table 2.2.2.2-B contains the seasonal rating of the deer habitats on the Milepost #7 site.

About 75% of the area is in forest types (aspen, aspen-birch, white birch, and upland hardwood) which can be considered as summer range. These are mostly mature, fairly dense, second growth forests. Although they provide an adequate quantity of summer forage, they lack the desired species variety and presumably lack the quality found in younger growths. The meadow openings which are preferred in early spring and summer are nearly absent.

From the standpoint of fall and winter food and cover, the forest on Milepost #7 site has several deficiencies. The conifer types (cedar, cedar-tamarack, and spruce-fir), which comprise roughly 15% of the area, are very open stand which provide a minimum of cover. Further, they lack an adequate winter browse supply and are not interspersed with upland types which could act as a feeding area. Finally, much of the shrubs (hazel, red, sugar and mountain maple) have grown beyond the reach of deer and are not available for winter use.

Deer Rating: Fair

Ruffed Grouse: Table 2.2.2.2-D contains the preferred seasonal habitat and foods for ruffed grouse in northeastern Minnesota. See Table 2.2.2.2-E for the seasonal rating of game bird habitats on the Milepost #7 site.

Although aspen and birch, the prime habitat for ruffed grouse, are very abundant, there is little mixing of age classes of these species; since there has been virtually no recent disturbance. This forest type is quite old, about 60 years, which is not desirable for ruffed grouse. There has been virtually no disturbance of this forest which would stimulate aspen regeneration. Park-like nesting sites are in short supply because of the heavy alder and hazel understory. However,

TABLE 2.2.2.2-D

Preferred Seasonal Habitats and Foods of Ruffed Grouse in Northeastern Minnesota

HABITAT	Spring	Breeding Male - Drumming log in area providing vertical cover and open herb layer preferably with aspen food source nearby and no conifer. Female - Park like hardwood stands without brush and with aspen food source near.
	Summer	Adult Males - Lowland areas of aspen and alder in activity center near drumming log Females & Young - Early - young aspen stands; Later, lowland alder areas
	Fall	Remain in summer habitat until leaf fall, then move to upland areas of aspen and birch (10-25 years old)
	Winter	Areas of deep snow in hardwood areas with few obstructions to snow roosting.
FOOD	Spring	Buds, catkins of aspen, birch. Also ground vegetation (e.g., strawberry and wintergreen leaves).
	Summer	Ground vegetation, fruits of blueberry, cherry, Juneberry, blackberry.
	Fall	Diverse food habits, ground vegetation, fruits, berries shifting to aspen buds.
	Winter	Aspen and birch buds and twigs.

Source: New England Research, Inc.

TABLE 2.2.2.2-E

Ratings of Game Bird Habitats on the Milepost #7 Site

Vegetation Type	Spruce Grouse				Ruffed Grouse				Woodcock			
	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Aspen	1	1	1	1	2	2	2	2	1-2	2	2	Not Present
White Birch	1	1	1	1	1	1	1	1	1-2	1-2	1-2	Not Present
Lowland Hardwoods	1	1	1	1	1	1	1	1	1	1-2	1-2	Not Present
Spruce	2	2	2	2	1	1	1	1	1	1	1	Not Present
Cedar	1-2	1-2	1-2	1-2	1	1	1	1	1	1	1	Not Present
Lowland Brush	1	1	1	1	1	1-2	1-2	1	1-2	2-3	2-3	Not Present
Openings and Deforested Areas	1	1	1	1	1	2	1	1	3	2-3	2-3	Not Present

Ratings: 4 = Excellent, 3 = Good, 2 = Fair, 1 = Poor

Source: New England Research, Inc.

brood cover is quite prevalent. In general, the aspen and birch areas of Milepost #7 site lack the mixing of age classes necessary for the life cycle of the ruffed grouse.

Other areas such as spruce-tamarack and white cedar types are poor ruffed grouse habitat. The lowland brush type was very limited, but could serve as brood cover. The lowland hardwood type contained many fallen trees and conifer cover which is undesirable for grouse because of the advantage predators have in this situation. The open area (meadow type), consisted primarily of several abandoned fields which were rated poor for ruffed grouse use.

Ruffed Grouse Rating: Fair to Poor

Spruce Grouse: Table 2.2.2.2-F shows the preferred seasonal habitat and foods for spruce grouse in northeastern Minnesota. See Table 2.2.2.2-E for the seasonal rating of game bird habitats on the Milepost #7 site.

This site contained very little black spruce and was rated as poor spruce grouse habitat. The acreage of this type lacked a mix of tall, dense, black spruce, black spruce with a dense understory, and dense black spruce of lesser heights. The white cedar types was poor to fair habitat. Aspen-birch, white birch, lowland brush, lowland hardwood, and meadow are not preferred spruce grouse habitats. The areas of dense shrub and herb cover could possibly be of some importance in nesting and brood rearing, but again, the lack of any major black spruce component in the area reduces this potential.

No spruce grouse or any evidence of their presence were observed.

Spruce Grouse Rating: Poor

American Woodcock: Table 2.2.2.2-G contains the preferred seasonal habitat and foods for migratory American Woodcock which are in northeastern Minnesota from April to October. See Table 2.2.2.2-E for the seasonal rating of game bird habitats on the Milepost #7 site.

The aspen-birch and scarce lowland brush areas provide cover and the major food, earthworms, which were found at several locations on this site. Those areas in white birch and lowland hardwood types which have suitable shrub cover and soil moisture would also provide food and cover. However, the entire site lacked suitable openings for breeding purposes. Male woodcocks need openings, proportional to the height of the surrounding trees, with slumps of shrubs for breeding displays. Very few open areas were observed, and this could be a contributing factor to limiting the woodcock population. Suitable openings were observed at an abandoned farm and an old railroad camp. Another opening was observed on a rock outcrop. The black spruce and white cedar types are not preferred woodcock habitats.

No woodcocks were observed, but signs (probe holes and droppings) were observed at several sites.

American Woodcock Rating: Fair

Rare and/or Endangered Species: The list of "Minnesota Animals and Plants in Need of Special Consideration" as recently issued by the Department of Natural Resources Division of Fish and Wildlife (Special Publication No. 104) has been reviewed in relation to the Arrowhead Region and the Milepost #7 site. Of the "Rare and Endangered Species" on this list, only the peregrine falcon might occur here. Preferred nesting sites are ledges in the face of a cliff; the ridge along the east edge of the Milepost #7 site might possibly serve as a nesting site for the species, but there was no evidence of nesting there at the time of Arthur D. Little, Inc.'s 1974 survey. They have been observed migrating along the North Shore near Duluth. Discussions with local hunters and outdoorsmen indicate that they have never seen the peregrine falcon in this area. This view is also coroborated by the University of Minnesota Department of Wildlife.

Although listed only as a specified of changing or uncertain status by Minnesota's Division of Fish and Wildlife, the eastern timber wolf is listed as an endangered species by the U.S. Department of the Interior. The

TABLE 2.2.2.2-F

Preferred Seasonal Habitats and Foods of Spruce Grouse in Northeastern Minnesota

HABITAT	Spring	Prebreeding Male - dense black spruce Female - dense black spruce Breeding Male - tall, dense black spruce with few shrubs Female - young, black spruce with high shrub and ericaceous herb cover.
	Summer	Black spruce with blueberry, cranberry, lichen understory. Also mixed young spruce-fir-jack pine. Broods Stunted black spruce borders with high herb canopy .
	Fall	Black spruce with blueberry, cranberry, lichen understory and lowland black spruce.
	Winter	Coniferous trees of several species (e.g., black spruce, white spruce, balsam fir, jack pine) that provide food and cover.
FOOD	Spring	Spruce and pine needles, blueberry leaves and buds, and cranberry.
	Summer	Ground vegetation and berries (blueberry, cranberry).
	Fall	Berries, blueberry and cranberry leaves, larch and jackpine needles.
	Winter	Black and white spruce needles, jackpine needles.

Source: New England Research, Inc.

TABLE 2.2.2.2-G

Preferred Seasonal Habitats and Foods of American Woodcock in Northeastern Minnesota

HABITAT	Spring	Male - openings for singing grounds, cover of dense young aspen, shrubs that enhance earthworm populations. Female - Diverse, nesting cover - second growth mixed hardwoods, aspen-birch-fir, young open ground cover.
	Summer	Alluvial soils with alder, dogwood, and other shrubs. Also damp aspen - birch and mixed conifer deciduous.
	Fall	Alder lowlands, second growth hardwoods with dense shrub cover and litter covered ground (e.g. birch), also some upland conifer with dense shrub understory.
	Winter	Not Present in Minnesota
FOOD	Spring	Primarily earthworms but other soil and litter invertebrates also, occasionally small seeds.
	Summer	Similar to Spring
	Fall	Similar to Spring
	Winter	----------------

Source: New England Research, Inc.

primary wolf range in Minnesota occurs in the northernmost portion of the region as generally outlined by the southern border of the Superior National Forest. Examination of Figure 2.2.2.3-A shows that the Milepost #7 site is south and east of known wolf pack ranges, and that it lies at the periphery of the range where individual wolves dispersing from packs will occasionally be observed.

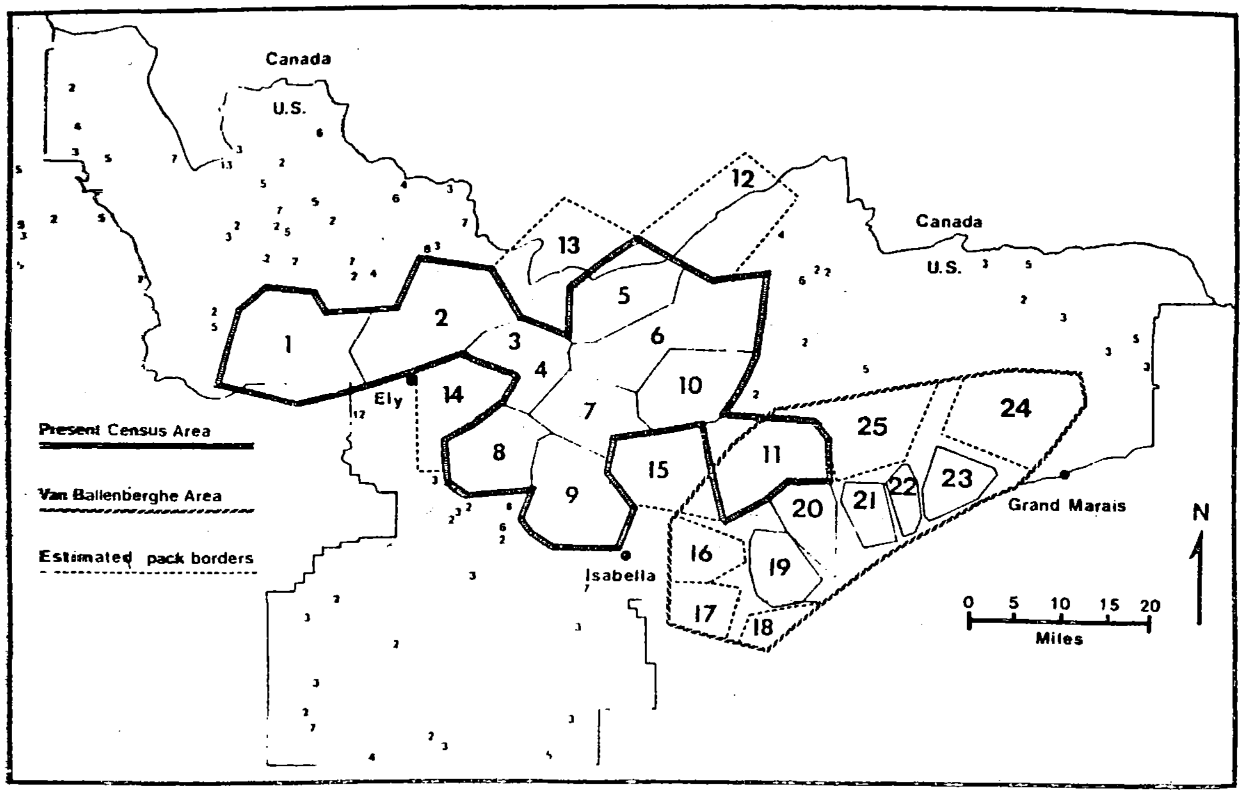
The next most important category on the Minnesota list is the "Threatened Species." Of this group, only the pine marten may have reinvaded this far south, but this is unlikely.

The third most important category is the "Species of Changing and Uncertain Status." This includes the fisher, bald eagle, Canada lynx and osprey, all of which may occur in this area. The two birds probably do not nest in the site because of lack of suitable aquifer habitats. The Canada lynx may occur occasionally in this area, but the habitat will not support significant numbers of snowshoe hare, their major food. Good fisher habitat does exist in this area, and the fisher is relatively common in the area. However, a density of one fisher per square mile would be high for this species.

The lack of suitable aquatic habitats would suggest that the three birds of "Special Interest," the least important category on the Minnesota list, are not commonly found in this area. These are the great blue heron, American egret, and common loon. On this list also is the pileated woodpecker, which undoubtedly occurs in low numbers because of lack of large decaying trees.

<u>Other Important Species</u>

<u>Furbearers</u>: Furbearing animals found in this region include the beaver, muskrat, mink, otter, weasel, fisher, and red fox. Because of the maturity of the aspen stands and lack of open water, the beaver population is probably in a low and static condition. Populations of the other furbearers in this region are also limited by the lack of interspersion of habitats. Beaver cuttings and dams were observed on



Source: USDA Forest Service Research Paper NC-97, 1973

FIGURE 2.2.2.3-A SUPERIOR NATIONAL FOREST WOLF PACK TERRITORY

the site, but were at least 2-3 years old -- no recent evidence of beavers was seen.

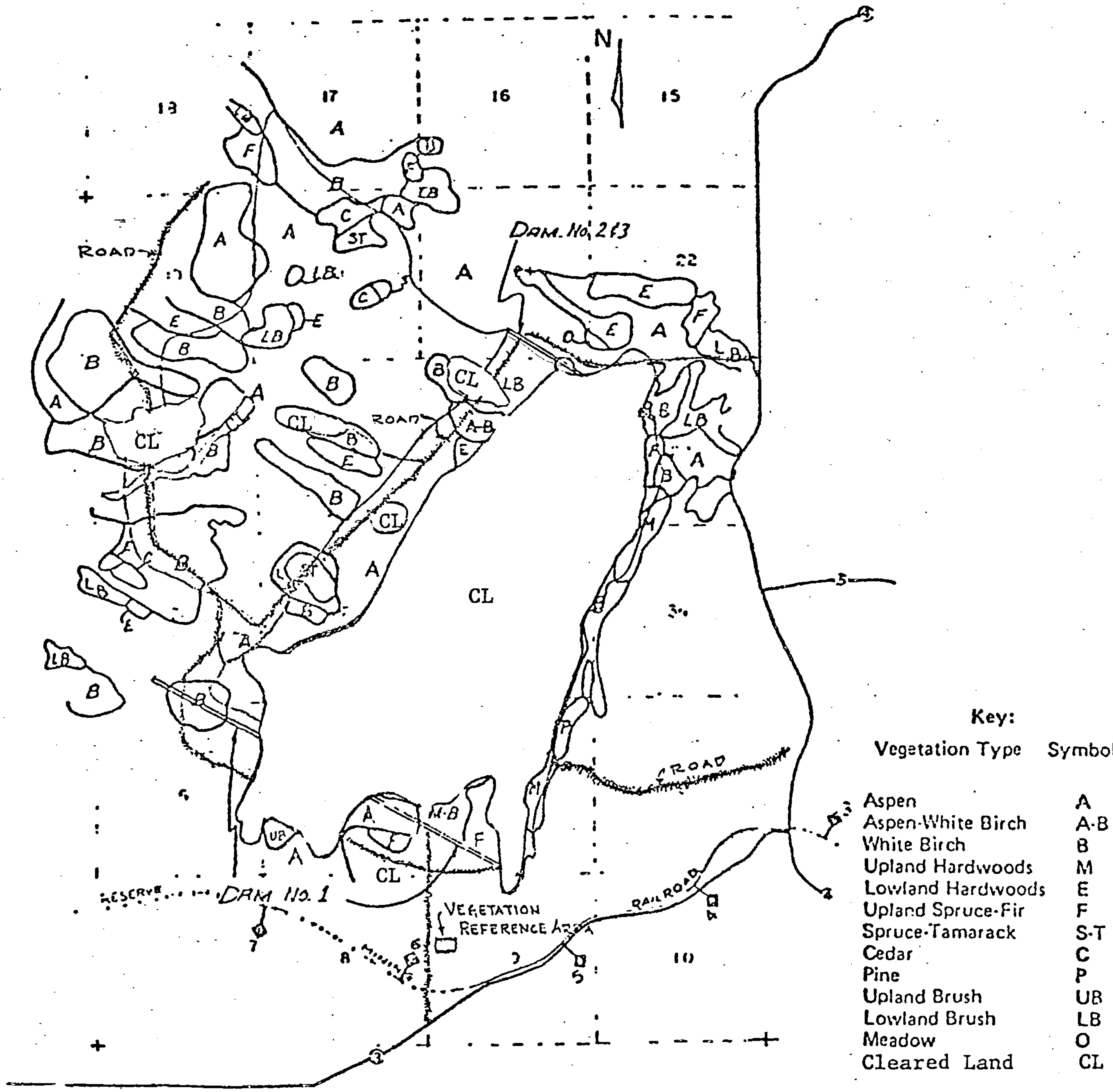
Song Birds: A recent list of "Birds of the Superior National Forest" issued by the Forest Supervisor lists 207 birds for this area. Twenty-one of these are residents. Of these, the common loon, cormorant, great blue heron, bald eagle, osprey, peregrine falcon, and pigeon hawk are noted to be threatened or unique to the forest as a whole. The extent and types of habitats near the Milepost #7 site suitable for these seven species is certainly minimal.

Hawks: Along the North Shore of Lake Superior in the fall there is a concentration of migrating hawks that is one of the most impressive in North America. The hawks are reluctant to cross Lake Superior and are funneled down the North Shore and concentrated along the bluffs in Duluth. Seventeen species of hawks with over 60,000 individuals have been observed in "good" years.

Fisheries: The diversions have been vegetated and riprapped where necessary to control the erosion of sediment into the Beaver River. Strict control of runoff is necessary to meet water quality conditions required by the Minnesota Pollution Control Agency. At the request of the DNR, the diversions were built in a meandering configuration with stratically located riffle and pool areas. Large rocks to serve as hiding places and shade areas for fish were also put into the streambed. Minnows and small brook trout have been observed in the diversions. The DNR fisheries Department has made surveys of the impacted areas in 1979 and 1980.

f. Forest Inventory -- Arthur D. Little

Area-Specific Vegetation Characteristics - Milepost #7 Area -- The Milepost #7 area has been investigated to determine the vegetative communities and wildlife that it currently supports. The regional literature, on-site investigation, and aerial photographs were used for this assessment. The following vegetation types were determined for the



Source: Reserve Mining Company

FIGURE 2.2.1.2–A VEGETATION TYPES – MILEPOST =7 SITE

Milepost #7 area: aspen-white birch, white birch, upland hardwoods, lowland hardwoods, upland-spruce-fir, spruce-tamarack, cedar, pine, upland brush, lowland brush, and meadow. Each of these types is described below and delineated in Figure 2.2.1.2-A. No evidence of virgin timber was found.

Vegetation present on the Milepost #7 area has resulted from a combination of significant influences: site conditions, fire, and early logging. Sites vary from dry rock outcrops with little soil to deep moist clay soils or wet organic bog conditions. Fires have burned parts of the area repeatedly, particularly following the heavy cutting of pine, cedar, and tamarack logs and their removal by railroad during the period 1900-1919.* There was no indication of major fires occurring on the site within the last 40-50 years.* The vegetation present is the result of natural regeneration following the fires and timber removal.

Aspen and Aspen-White Birch Types (Symbols A and A-B, 51% of the area) -- The aspen types include relatively pure stands of trembling aspen and aspen in combination with white birch, with white birch and balm-of-Gilead, and with black ash and balm-of-Gilead. (The A-B symbol indicates areas where aspen and birch occur in roughly equal proportions.) The stands range in age from 50-70 years and are mature to over-mature. Some groups of aspen are disintegrating badly while the birch tends to be in generally better condition. Site quality for aspen and birch in these types ranges from medium to good.

The understory includes small areas of balsam fir and occasionally poor aspen reproduction, and more generally an abundant shrub cover. The most commonly occurring shrub species were American hazel (ranging from 5-75% of ground cover and averaging 30% at heights of 4-10 feet), speckled alder (ranging from 0-100% cover, averaging 20% at heights of 5-20 feet), and mountain maple (ranging from 0-75% cover, averaging 20%, at heights of 3-7 feet). Other shrub layer species occurring with less frequency and coverage were bush honeysuckle, red osier dogwood, thimbleberry, raspberry, wild cherries, low juneberry, red maple, sugar maple, trembling aspen, red elderberry, and balsam fir.

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*Personal Communication, Donald Ferguson, September 25,1974.

Sample plots showed that the ground was 50-100% litter covered in this type. The dormant herbs were large-leaved aster whose percent cover ranged from 0-75%, but was most frequently in the 0-25% class, bristly dewberry, sedges, grasses, and ferns. Other herbs contributing significantly to that layer were clintonia, bunchberry, and mosses. Remaining herbs of lesser consquence were clubmosses, blueberry, strawberry, wild current, meadow rue, voilets, horetail, and sarsaparilla. These herbs were most commonly in the 0-25% cover class.

White Birch Type (Symbol B, 74% of the area) -- White birch type is generally nearly pure white birch, sometimes having a minor component of aspen or red maple. The stand condition of the birch is good, but the high density of these stands tends to keep the stems in a smaller diameter class and may tend toward growth stagnation. Stand ages are estimated at 50-70 years. The sites on Milepost #7 tend to be medium to good although the pure birch stands tend to be on drier sites than the birch with aspen.

There is generally no tree understory because of the dense canopy. The next layer is shrubs which are dominated by mountain maple (ranging in coverage from 0-75%, averaging 25%, at heights of from 2-8 feet), thimbleberry (ranging in cover from 5-100%, averaging 15%, at heights of 2-4 feet), and American hazel (ranging from 5-50% cover, averaging 15%, at heights of 3-8 feet). Red maple and sugar maple were found occurring on west-facing steep slopes in concentrations of 50% cover and heights of 6 inches to 7 feet. Other shrubs were bush honeysuckle, raspberry, and wild cherry.

The herb composition in this type is very similar to that of the aspen-birch type. The ground is more than 90% litter covered, but the litter is quite thin. Bristly dewberry, strawberry, sedges, fern, and violets were other herbs recorded. These remaining herbs were in the 0-25% cover class.

Upland Hardwood Type (Symbol M, 9% of the area) -- This type consists of various combinations of sugar maple, red maple, basswood, white and yellow birch, white spruce, balsam fir, white cedar, and occasionally red oak, black ash, and aspen. The condition of these stands is generally good.

The maple will maintain a cover indefinitely while the spruce and birch are generally mature. The age of trees in this type is mixed and ranges from 40-100 years.

The understory may be dense sugar and red maple reproduction up to 100% cover while in areas of less dense overstory, mountain maple, thimbleberry, and hazel may cover up to 50% of the area. The litter layer is thin but extensive with large-leaved northern aster and violet in the herb layer.

Lowland Hardwood Type (Symbol E, 4% of the area) -- This type is composed of pure stands of black ash, pure stands of balm-of-Gilead, and mixtures of these two species with white birch. In some places, this type has a component of balsam and cedar. The forests in the lowland type range in age from 50 to 70 years with some black ash of all ages up to 100 years. The condition of the trees is generally good except that the balsam is often overmature and falling. This type occurs in moist lowland areas in an organic soil or wet mineral soil with a layer of muck on the surface. Sites range from good to poor depending on the degree of flooding.

The understory generally has some ash reproduction and some balsam reproduction. The dominant shrubs are hazel and green and speckled alder. The hazel is in the 0-50% cover class while the alders are higher, in the 50-75% cover class. Other shrubs are wild cherrys, red-berried elder, and maple. All of these fall into the 0-25% cover class.

The ground is 50-100% litter covered. The dominant herbs are grasses, raspberries, fern, and large-leaved aster. Others of lesser importance are raspberries, sedge, violet, and horsetails. Each of these are in the 0-25% cover class.

Upland Spruce-Fir Type (Symbol F) -- This type generally has a mix of species composed of white spruce, balsam fir, white birch, white cedar, trembling aspen, red maple, and black ash. The age is variable up to 100 years. The white spruce and the larger birch are generally mature while the balsam fir is generally over-mature and falling. The stands are generally not well stocked. Good sites for this type are those which are moist while the high dry areas provide rather poor sites.

The understory has varying degrees of balsam fir and spruce regeneration from I to 20 feet high. The shrub layer has a variable cover of speckled alder, hazel, and mountain maple. On the drier sites, lichens compose the herb layer.

Spruce-Tamarack Type (Symbol S-T) -- Black spruce dominates this type with tamarack as a minor component. The organic soils supporting these specified provide a medium for good site, but may grade to poor in wetter spots. The stand condition is good at an age of 50-70 years.

The shrub layer in this type is very sparse. Labrador tea is the most abundant shrub and averages less than 5% cover. It is a low shrub, ranging from 6 inches to 18 inches in height. The herb layer is a thick mat of moss, lichens, and clubmosses with sphagnum moss predominating. Sedges may cover up to 5% and blueberries only I to 2%.

Cedar Types (Symbol C) -- White cedar in pure stands makes up only a small portion of this type. Most of the type is a mixture of white cedar and black spruce or mixtures of white cedar, balsam firm, tamarack, and black spruce. The density of the tree cover ranges from scattered trees to about 75% cover. The generally low densities make the stand condition good for survival, but poor for product quality. Trees may range in age from 5-100 years. The sites are generally wet organic soil with a poor site quality.

The understory vegetation generally bars reproduction of all the tree species present. The shrub layer is dominated by alders (ranging in ground cover from 5-75%, averaging 40%, with a height of 5-20 feet) and Labrador tea (cover ranges 5-75%, averaging 25%, height is I-2 feet). Red osier dogwood averages about 5% cover at heights of 2-4 feet. The ground cover is similar to the spruce-tamarack type with a thick moss-lichen-clubmoss layer covering up to 100%. Sedges are important components in some areas along with bunchberry and grasses (cover ranges 0-25%). Clintonia, bristly dewberry, and goldthread were other important members of the herb layer. Of lesser importance were horsetail, blueberry, cranberry, sarsaparilla, strawberry, bedstraw, and ferns.

Pine Type (Symbol P) -- The pine type is represented by one small area of pure white and red pines which mix with balsam fir and white birch at the edges of the type. The 50-70 year old stand is in good condition on a hillside site that ranges from medium to poor quality.

Upland Brush Type (Symbol UB) -- Upland brush type is dominated by shrub species although there may be scattered white birch, trembling aspen, and balsam fir trees included. Hazel, alder, mountain maple, and cherry are the major shrub species that cover up to 100% of this type.

Lowland Brush Type (Symbol LB) -- This type is characterized by dense thickets of one or more shrub species. Speckled alder (5-15 feet), willows (5-10 feet), bog birch (2-4 feet), and Labrador tea (1-2 feet) are the dominant species occurring in pure and mixed stands. Red osier dogwood frequently occurs as a secondary shrub understory (5-10% cover) and in isolated small clumps (2-4 feet in height). The herb layer composition is similar to that in the spruce-tamarack and cedar types. In addition, bullrush, strawberry, aster and goldenrod were occasionally found.

Meadow Type (Symbol 0) -- The meadow type surrounds an abandoned farm and is composed of sedges, grasses, and goldenrod interspersed with lumps of spirea, alder, and wild cherry.

Timber Resource on Milepost #7 Site -- The hardwood types on Milepost #7 (aspen, aspen-white birch, white birch, upland hardwoods, and lowland hardwoods) contained generally mature to over-mature stands of timber ranging in volume from 5 to 30 cords per acre. These stands within the tailing basin area were cut for pulpwood and a portion opened by Reserve for firewood cutting. Relatively few saw timber size trees were present.

The softwood types in general are also over-mature and suited for pulpwood. The pine type is very limited in areas, the cedar type is non-commerical.

g. Soils Inventory -- Arthur D. Little

Site-Specific Soil Characteristics - Milepost #7 Site -- This section is based on sources from the Soil Conservation Service soil series mapping for this area of northeastern Minnesota. For further details and raw data, the reader is referred to "General Geology of the Milepost #7 Site" by E. A. Hickok & Associates, dated January, 1975, and Klohn Leonoff Consultant's "On-Land Tailing Disposal Study - Milepost #7, " April, 1975.

Figure 2.1.2.2-A illustrates the soil types represented on the Milepost #7 site and contiguous areas.

Glacial Till -- The Superior lobe of the Wisconsin glaciation period swept to the west-northwest through the Lake Superior Highlands depositing glacial till, a non-stratified heterogeneous mixture of mineral materials related to materials in this area (basalts, gabbro/diabase rocks, rock sediments). The Lake Superior drainage basin is covered to a large extent by these glacial tills, which in addition to the bedrock outcroppings determined the character of the landscape existent in this area of northeastern Minnesota. Glacial tills consist of three basic types in this area--gravelly sandy loam, sandy loam till, and fine sandy loam.

Gravelly Sandy Loam (#9) -- This series consists of gently sloping to steep well-drained soils formed in 20 to 40 inches of dark brown, medium acid, gravelly sandy loam glacial till that is underlain by bedrock. The dominant bedrock is gabbro and granite. Surface stones typically occupy less than 5% of the surface and vary locally to 30%. Subsurface coarse fragment content typically is 25%. These soils occur on sloping to hilly terrain in the Laurentian Shield country of northeastern Minnesota. These tills cover approximately 10% of the site.

Fine Sand Loam, Clay Loam Till (#2) -- This series consists of nearly level, somewhat poor and poorly drained soils formed in loam or clay loam till. These soils are on concave and convex slopes on moraines. Native vegetation is forest. The surface layer is very dark gray silt loam about 11 inches thick. The subsurface layer is fine sandy loam about 4 inches thick. The subsoil is reddish brown, loam about 40 inches thick. The underlying material is reddish brown loam. Permeability is slow. The available water

LEGEND:

1 Lake Superior Clays

2 Fine Sandy Loam, Clay Loam Till

4 Sandy Loam Till

9 Gravelly Sandy Loam

P Peat Soils

Source: U.S. Soil Conservation Service.

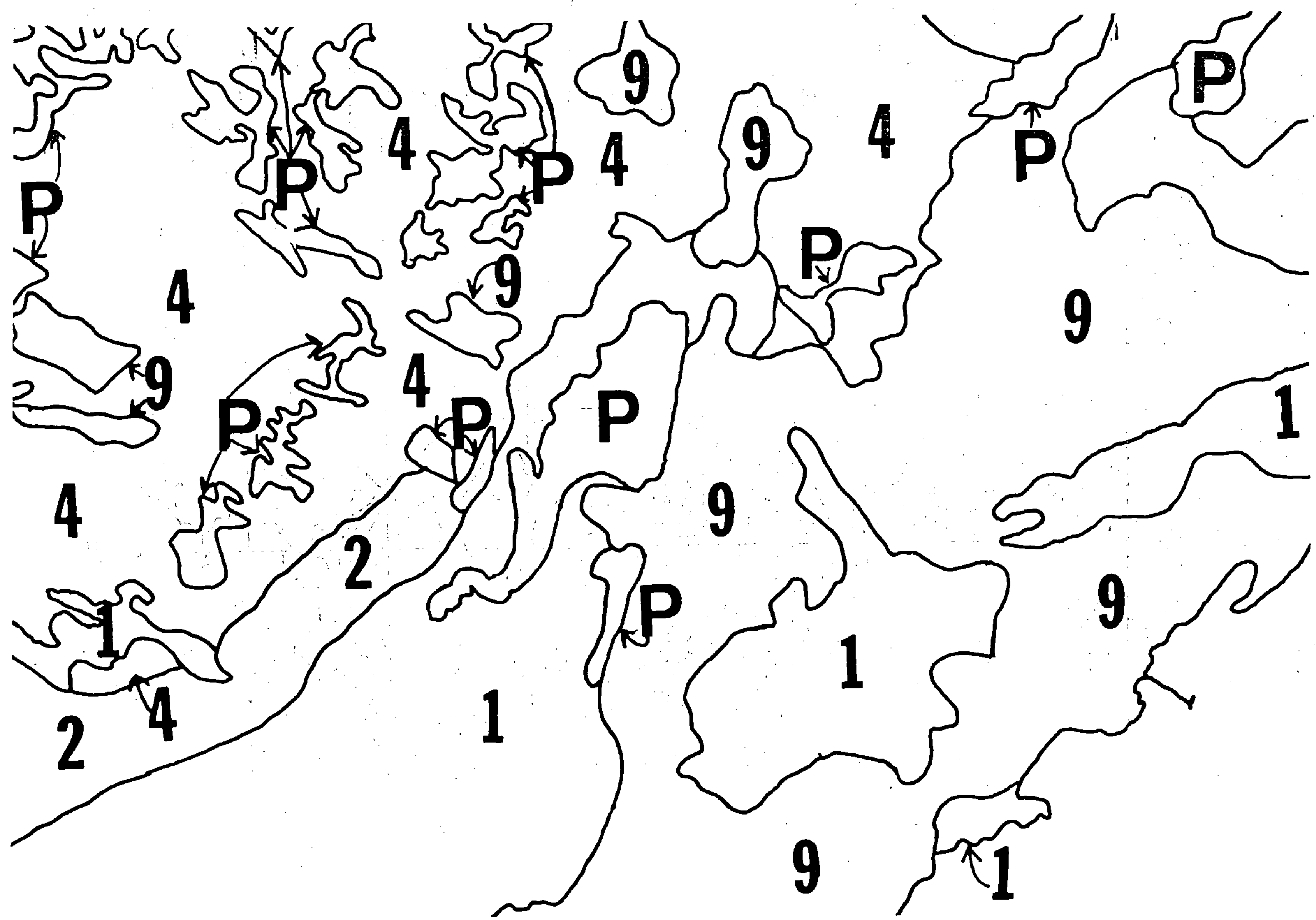

FIGURE 2.1.2.2-A SOIL TYPES – MILEPOST #7 SITE

capacity is high and organic matter content is high. The availability of phosphorus and potassium is low. The major limitation to use is wetness. These soils cover approximately 10% of the site.

Sandy Loam Till (#4) -- This series consists of nearly level to steep, well and moderately well-drained soils formed in sandy loam till. These soils are on moraines and broad drumlins. Native vegetation is forest. The surface layer is very dark brown silt loam about 2 inches thick. The subsoil is dark brown, very friable, fine sandy loam about 14 inches thick in the upper part. The lower part is reddish brown firm sandy loam about 44 inches thick. The underlying material is reddish brown fine sandy loam. Permeability is moderately slow. The available water capacity is low and organic matter content is low. The availability of phosphorus and potassium is moderate. These soils have very dense lower subsoil and underlying material. Cobbles are common throughout the profile. The wet soils in this association are called Pickford Soils, the well-drained Ontonagon. These tills cover approximately 20% of the site.

Lake Superior Clays (#1) -- After the glaciers retreated, a lake was formed in what is now known as the Lake Superior drainage basin (Glacial Lake Duluth). Outlets to the lake at that time were blocked so lake levels were 1,165 feet as compared with 602 feet at present in Lake Superior. Lacustrine clays were deposited on the lake bed during this time and with the withdrawal of the ice lobes, these clays ("Ontonagon Rock Outcrop" soil type) were deposited along the entire Lake Superior coastline area, 3 to 10 miles inland depending on the extent of Glacial Lake Duluth.

According to Dell (1973), the red varved clays which overlie red till or red non-varved lacustrine sediments were deposited as the ice retreated northward across the Lake Superior basin. The gray varved clays overlying the red varves represent a very widespread unit in the lake and more probably deposited soon after the whole lake became free of ice and glacier was close to the North Shore. Massive gray clays overlying the gray varves were derived from the northern part of the basin and were laid down under conditions of slow sedimentation in post-glacial time. The brown silty sediment is a common sediment type in the southern half of the lake overlying the red sediments or gray clays. The surface sand occurs in littoral areas in the lake at the present time. The soils are over 80% clay being finer than 2 micrometers in grain size. The following test results were achieved by Dell in tests of the Lake Superior clays. The most abundant clay materials in the Lake Superior sediments are illite ranging from 10-41% less than 2 micrometers fraction. Other clay minerals were expandable clay minerals 3-20%, chlorite 2-13%, kaolinite 1-11%, and vermiculite 0-17%. Non-clay minerals in the less than 2 micrometers fraction are quartz 3-28%, plagioclase feldspar 4-21%, potash feldspar 3-9%, calcite 0-26%, and dolomite 0-15%. She found that tills in the drainage basin were generally the same minerals as lake sediments but show more stability. She also found a higher percentage of expandable clay minerals and sediments to the west of the basin than in the east and a higher percentage of coarse in some easternmost samples. These clays cover approximately 30% of the site.

Peat Soils ("P") -- This area of northeastern Minnesota though not having large groundwater basins, has a high percentage of standing waters that either were left as glacial lakes from melt waters or were formed from runoff in depressions created by glacial scour - either as lakes or ponds. There are many such lakes, ponds, and standing water bodies throughout the Lake Superior drainage basin. Where the water is found very close to the surface in other depressional areas, large bodies of peat soils have been formed in this area. These soils are formed from the accumulation of undecomposed vegetation material in these wetland-like areas. In other areas of Minnesota, peats are so extensive that they are used as an extractable resource. These soils vary greatly in vegetation composition, thickness, fertility, and water quality.

The vegetation types vary from sedimentary algae to very acid, unfertile sphagnum moss types. Reed-sedge with a high percentage of wood-fiber is the most common type peat composition. Numerous small mineral islands are located in these boggy areas. The islands are rocky and bouldery with brown acid sandy loam. Glacial till is the main mineral soil parent for these soils. These soils are generally low in fertility and usually very acidic in character. These peat soils and associated perched water tables cover approximately 30% of the site.

h. Past Mining Facilities -- There are no past mining facilities known to exist in the Silver Bay operation area.

i. Surface Ownership and Severed Mineral Ownership in Mining Areas or Areas Which will be Ecavated or covered with Waste -- B-11 and B-12

j. Exclusion, Avoidance, and Setback Areas --This map is not needed since the regulation does not apply to this operation.

4. ENVIRONMENTAL SETTING ANALYSIS - BABBITT OPERATIONS

No environmental reports are available which specifically relate to the mining operations at Babbitt. An explanation of the basis for siting those parts of the operation in the Babbitt area is as follows:

a. Mine Expansion and Development of Gravel Borrow Areas -- At the time when these rules became effective, most of the area to be developed for mining purposes in the Reserve operation had been developed. This included the removal of vegetation and the stripping of surface overburden from much of the mining area. Pit expansion, as shown on C-3 and C-4, which will be completed after the establishment of these rules, will be conducted largely on a strip on the south side of the mine. In addition, a small borrow area will be developed in Sec. 21 of T60N, R12W. Because the expansion into new areas is very minimal, the impact of this expansion will also be minimal. Vegetation to be removed will mainly be the aspen-birch, timber type. This timber is of low value, in oversupply and, therefore, the withdrawal of these areas will have little or no effect on the timber resource of the Babbitt area. Soils that will be removed are of low productivity, tend to be very rocky, and therefore, not in high demand for anything other than timber production and wildlife habitat. During operations and deactivation, runoff waters from these operations will be returned to their normal watershed wherever this is possible. The impact on these or other resources shown in the environmental setting maps will be of little or no consequence.

b. Waste Stockpiles and Access Roads -- The siting of the various waste stockpiles and access roads to these areas have been sited using the following criteria: 1) minimizing haul distance from the mining areas, 2) located so they will not incumber future mineral reserves, 3) minimize the undisturbed land needed to develop these waste disposal areas, and 4) maximize the use of past, present and future mining areas.

When analyzing the effects of developing new stockpile areas on the resources present, we can draw the following conclusions.

1) Bedrock Geology - A few of the overburden stockpiles will be located on the Biwabik Iron Formation. Due to lease requirements, some stockpiles will also be placed on the Biwabik Iron Formation. However, in most instances where this happens, the iron formation is very thin and of little or no value.

2) Water Basins, Watercourses, and Wetlands - Stockpiles will be designed so as to minimize the effects of stockpiling on watercourses or waterbodies. In some cases, the swampy area south of the mine will be covered with overburden stockpiles. These stockpiles will be designed by a qualified engineer and built in such a manner that they will be stable and protect watercourses and water quality.

3) Watershed - When constructing these facilities, they will be designed and constructed in such a manner so as to make no major changes in watershed boundaries.

4) Ground Water - It is not anticipated that the construction of these stockpiles will have any appreciable effect on the ground water in this vicinity.

5) Natural Resource Sites - The only natural resource sites designated by the DNR in this area are Iron Lake and the Partridge River. All facilities will be designed to protect these natural resource sites.

6) Forest Inventory - No high value forest stands will be disturbed by the construction of these waste stockpile areas. The timber stands which will be disturbed are mainly aspen-birch, some balsam-spruce,

and swamp conifers. The aspen-birch timber types are in great supply, much of the balsam-firm have been weakened by spruce bud worm attack, and the swamp conifers are of very low productivity. For these reasons, the impact on the forest resources is very minimal. Wherever possible, the merchantable timber will be salvaged prior to the construction of waste disposal areas.

7) Soils - The soils in this area are of very low productivity. The upland soils are generally rocky, in the lowlands, covered with peat and muskeg. For this reason, the development of these waste disposal areas will have little effect on the productivity of the area for forest products. When constructing waste stockpiles in low areas, a layer of surface and rock overburden will be laid down prior to the construction of the stockpile.

8) Past Mining Facilities - The only past mining facilities in this area were those developed by Mesabi Iron Company in the 1920's. They now consist of a plant site located north of the present mining area with its inactive tailing basin. Within the area of present operations, the Cliff Quarry and Argo Lake (reservior) were also developed by Mesabi Iron in the 1920's

9) Ownerships - All stockpiles will be constructed on lands which are either owned or leased by Reserve Mining Company at the time that they are utilized for this purpose.

10) Exclusion, Avoidance and Setback Areas - These requirements do not apply to this operation.

5. MINING AND RECLAMATION MAPS

The following maps and cross-sections, which are required by the regulations, can be found in Appendix C.

a. The map showing the shape and extent of the ore body, which is capable of supporting the operating life of the mine -- Figure C-1.

b. The map identifying the inferred mineral reserves -- Figure C-1.

c. The map identifying and locating the proposed vegetative reference areas. At this time a preliminary selection of vegetative references areas has been made. Prior to the time that elements of the mining operation are deactivated, a final selection will be made of reference areas --Figure C-2.

d. The map detailing drainage patterns for water which may contact leachable materials -- Since it is not anticipated that surface water will come in contact with leachable materials, no map is submitted for this purpose.

e. A series of maps and cross-sections are required which will depict mining the ore body, watershed modifications, construction of mining facilities, and reclamation activities. These maps and cross-sections are shown as Figures C-3 through C-19. Lean Ore Surge Pile on C-14 is shown on Sections C-8, C-9, C-10, and C-11. Lean Ore Surge Pile on C-15 is shown on Section C-8. Waste Rock Stockpile on C-15 is shown on Sections C-3, C-4, C-5, and C-6.

6. MINING AND RECLAMATION PLAN

a. Operation Life of the Mine

1) Rate of Mining -- The rate of mining is shown in the table below:

RATE OF MINING

Period	Ore (Million Tons)	Lean Ore (Million Tons)	Waste Rock Million Tons)	Surface (Million) C.Y.)	Tailing (Million Tons)
1	310.0	75.6	64.4	11.0	207
2	310.0	99.5	40.5	8.3	207
3	310.0	31.4	25.8		207
4	310.0	4.1	0		207

There are no anticipated changes in mining, however, should the demand for steel change, the mining rates would follow.

2) Factors Used to Determine Reserves -- Taconite considered ore has the following characteristics:

Magnetic Iron Content Greater than 19%.

Concentratability Greater than 62.5% (Davis Tube Analysis).

Grindability Index Greater than 29.0%.

In 1968, Reserve Mining Company adopted a plan to deplete the Peter Mitchell ore body based on its average quality with the low limits noted above. The future reserves are as follows:

3) The Potential Future Reserves are:

Ore	526.6 Million Tons
Lean Ore	159.0 Million Tons
Waste Rock	233.5 Million Tons
Surface	27.9 Million Cubic Yards

b. Mining Activities to be Conducted

1) Mining the Ore Body -- The Biwabik Iron Formation is an ancient sedimentary deposit. Deposition probably took place in shallow water.

It consists of chemical precipitates of iron silicates, carbonates, silica and magnetic and non-magnetic (iron oxides). The iron oxides occur as thick banks and minute crystals or grains. Minor quantities of other minerals are also prsent. Mud layers were interbedded with the precipitates and now form the slate layers.

This series of sediments, Biwabik Iron Formation, which lies on the Pokegama Quartzite was covered by a great thickness of Virginia Slate. Consequently, the aggregate was firmly compressed and cemented together.

The layer of sediments was raised by movements in the earth. Warping and cracking occurred allowing the entrance of water-bearing dilute chemical solvents. The solvents in the water attacked the ferrous iron compounds and oxidized them. Water also leached out a great amount of silica. The processes of oxidation and leaching left the iron concentrate in place. This residual material now consistutes the ore bodies of the Central and Western Mesabi Range.

However, in the Babbitt area on the Eastern Mesabi Range, the Duluth Gabbro intruded the Biwabik Iron Formation. The taconite was heated but not melted. This heating converted ferrous iron oxides to magnetite. The baking effect rendered the formation impervious to water so the iron compounds were not oxidized, and the silica was not leached out. Consequently, the enriched ores of the Western and Central Mesabi Range are absent in this area.

In comparatively recent times, a glacier covered the Mesabi Range. It cut down softer rocks and removed much iron ore. It deposited the rocks and soil which constitute the overburden.

Prior to mining, in the Biwabik Iron Formation, diamond drills produce core samples which are analyzed for quality of ore in the determination of future mining areas and mining limits.

After the mining areas have been determined, and merchantable timber harvested, clearing of the existing vegetation is done with tractors equipped with rakes. The trees are piled into windrows and burned when conditions are suitable. With this surface vegetation removed, the overburden (sand, gravel, etc. over the iron bearing ore) can then be removed.

The existing overburden, which varies in depth from 2 feet to 25 feet, is removed with electric power shovels and loaded into end dump trucks. This material is used to build roads and stockpile pads and the remainder placed in overburden piles.

To aid in proper clean-up of overburden, track and rubber-tired dozers and front end loaders are sent into the area. This is done to remove the remaining overburden which the shovels could not get. Leaving this waste material would dilute the ore and hamper the jet drilling program.

Blast hole drilling is accomplished primarily by jet piercing machines. These drills combine fuel oil and oxygen to produce a high temperature flame (4,400°). A three-port burner, located at the bottom of a 55 foot rotating stem, directs the flame against the taconite, causing the rock to spall off in small chips. Water, which serves to cool the burner, flashes into steam upon contacting the hot taconite. The rapidly expanding steam rushes upwards carrying the taconite chips out of the hole. Ten of these machines are located throughout the mine.

An average blast consists of approximately 150 holes, 38 feet in depth, and breaks 500,000 tons of taconite. A 16-inch diameter hole is made by making multiple passes with the jet flame. Hole size varies considerably due to the layering of the rock.

Some blast holes are drilled using a rotary drill which pushes a 15-inch diameter tri-cone roller bit into the rock. The cones contain tungsten carbide inserts which cause the rock to chip. High pressure air carries these chips out of the hole.

The holes are loaded by pumper trucks with a bulk ammonium nitrate based slurry explosive. The upper part of the hole is loaded with the pumped slurry if water is present or with ammonium nitrate prills and fuel oil if the hole is dry.

The blasted waste rock and lean ore is loaded by 11- to 13-cubic yard capacity electric shovels into end-dump haulage units varying in size from 80 tons to 120 tons. The waste rock is deposited in stockpiles outside the pit area. The lean ore is stockpiled on pads near the crusher or in the pit on similar quality material called footwall.

The blasted ore is loaded by 11-yard to 13-yard capacity electric shovels into 90-ton capacity side dump tractor-trailer units. Approximately 90,000 tons of taconite per day are hauled an average of 1.9 miles to the primary crushers. Nine ore shovels are located in the two pits with normal operations using six of them to achieve the required production. Annual production from the mine is 31,000,000 tons of taconite from which about 10,000,000 tons of concentrated pellets are produced by the plant located at Silver Bay.

At both crusher locations, an electric hoist at the crusher pocket dumps the ore into a 60-inch gyratory primary crusher. The ore is then fed to four 30-inch gyratory crushers and the pan feeder which loads the conveyor belt. A weightometer and a magnetic induction coil, located near the lower end of the belt, read and record the tonnage and the magnetic iron analysis of the ore as it passes.

The ore is conveyed up a 1,000 foot incline to the top of the loading bins. It is then fed by gravity into 85 long-ton capacity railroad cars. About 160 cars are made up into a train for shipment to Silver Bay over a 47 mile long company-owned railroad. At Silver Bay, two cars at a time are emptied by a rotary car dumper to begin the final processing from crude ore to pellets.

a) Distinction Between Ore, Lean Ore, and Waste Rock. Taconite of the Peter Mitchell Mine is divided into the following categories:

Cagetory	Magnetic Iron Content	Concentratability	Grind Index
Ore	19.0%-30.0%	61.5%-68.0%	29.0%-85.0%
Lean Ore	16.0%-23.0%	57.5%-65.5%	37.0%-56.0%
Waste Rock	Less than 16%		
Footwall Ore	16.0%-19.0%	64.9%-66.5%	32.0%-51.0%

Lean ore is placed in surge piles in anticipation of changing economic conditions and/or technological improvements. When favorable conditions occur, the following material may be cycled into the mill.

Lean Ore	300 Million Tons

Technological advances and changing economic conditions could also permit stripping more material to the south and would create an additional 15 years of ore as shown on page 31.

The factor that will affect our reserves is mill feed quality. Should the mill be able to process a different quality material, our reserve could change.

b) In-Mine Disposal. Reserve's plan exposes footwall as rapidly as possible. However, the material on top of the footwall is very hard to mill and must be blended with better ore to produce an acceptable mill feed. This fact limits the available area and the amount of lean ore that can be stockpiled in the pit. The lean ore stockpiles placed in the mine will be constructed in such a manner so as to maximize the amount stored in the mine and thereby minimize the amount of undisturbed land needed for this purpose.

c) Physical and Chemical Characteristics of Mine Waste.

Surface Overburden - The superficial geology of the Iron Range area is described in the Geological Survey Bulletin 1331-C as follows:

The red clayey till is characterized by a red or reddish-brown color and a clayey matrix. Pebble content consists of a large percentage of granitic and metamorphic rocks. The till contains minestone, dolomite, and shale (rocks indicating a northwest source) and basalt, felsite, and gabbro (rocks indicating a northeast source, by way of the Lake Superior Basin). The till contains a wide variety of heavy minerals, but hornblende, limnoite, and magnetite predominate. The clay fraction consists largely of mixed-layered montmorillonite and illite. Percentage of soluble material is generally between 5 and 15 percent.

The brown silty till is characterized by a medium to light brown color and a sandy matrix. Its pebble content is much like the red clayey till, but generally consists of slightly more limestone. Heavy-mineral content, clay-mineral content, and percentage of soluble material are similar to the red clayey till.

Bouldery Till - The bouldery till is characterized by large numbers of cobbles and boulders, largely of granite, in a sandy matrix. The till displays various shades of orange, red, brown, yellow, and gray. Pebble lithology is largely granite, but metamorphic rocks are also abundant. Pebbles of gabbro, felsite, and balsalt occur in nearly all samples. Pebbles of northwest origin are rare. Only three samples contain shale, and in two of these, shale constitutes about 2 percent of the total pebbles counted. Percentage of heavy minerals is higher in the bouldery till than in the other till units. Limonite, magnetite, and hornblende are common, and augite and diopside contents are higher in the bouldery till than in the other tills. Montmorillonite is the most common clay mineral in the bouldery till. Percentage of soluble material is lower (generally less than 8 percent) in the bouldery till than in the other tills.

Basal Till. The basal till is characterized by dark colors of gray, greenish gray, and brownish gray. The matrix is calcareous and consists of sand and gravel but includes much silt and clay, especially in the central and western part of the study area. Cobbles and some boulders are also present. The till contains indicator rocks from both northeastern and northwestern sources, but the most common pebbles are granitic and metamorphic rocks of local origin. Heavy-mineral content is much like that of the other till units; magetite, limonite, and hornblende predominate. The basal till in the eastern part of the area contains more epidote than the other till units. Illite is the predominant clay mineral in the basal till. The percentage of soluble material is generally between 5 and 15 percent.

Waste Rock Description - The material Reserve Mining Company refers to as waste rock includes varying thicknesses and volumes of the Virginia Formation, the Biwabik Iron Formation, and intrusive dikes and sills.

Virginia Formation - The composition of the Virginia Formation varies with the distance from its contact with the Duluth gabbro. Close to the gabbro it can be described as essentially a fine-grained, biotite, quartz, anorthoclase hornfels. Banded pyrrhotite may occur as a trace constituent of this rock type.

Farther away from the gabbro contact, recrystallization has produced a fine-grained hornfels consisting of chlorite, muscovite, quartz, and orthoclase.

The Virginia Formation at its greatest distance from the contact generally consists of a slightly recrystallized light gray, laminated, fine-grained quartz graywacke.

The lime-silicate, calcite marble zone occurs within the three types of Virginia Formation. Wollastonite is probably the most common lime-silicate present. Trace amounts of hisingerite, nontronite, and sulfides occur throughout the formation in the Babbitt area.

All of the above material is waste rock.

<u>Biwabik Iron Formation</u> - This formation which ranges in thickness from 350 feet to 450 feet in the eastern Mesabi district contains the varying grades of crude taconite mined and treated in this operation.

The waste rock portion of the Biwabik Iron Formation includes the uppermost member of the formation, 5 to 10 foot layer of calcite-marble. In the western part of our mining area, it is a white to light-bluish-gray rock and to the east, a medium gray to gray-black marble. Lime silicates (Wollastonite) occur within the horizon, along with minor to trace amounts of diopside, quartz, idiocrase, andradite, and hisingerite.

Waste rock also includes the 10 to 20 foot layer of light green diopside chert underlying the calcite marble member. Lesser amounts of darker-green hedenbergite are sometimes associated with the diopside. Minor to trace amounts of magnetite, hornblende, cummingtonite, actinolite, sulfides, and hisingerite are present.

An intrusive diabase sill in the upper horizons of the Biwabik Iron Formation, generally below the diopside chert layer, has reduced a rock layer with marginal magnetite content to a waste rock horizon.

Basically, it is characterized by zones of interlaminated magnetite (minor) and ferro-hypersthene or interlaminated magnetite and cummingtonite. Quartz is the dominant interlayer mineral with minor to trace quantities of hedenbergite, fayalite, sulfides, hisingerite, and nontronite.

Diabase Dikes and Sills - The diabase dikes and sills which intrude both the Virginia and Biwabik Formations are also included as waste rock layers to be removed in our stripping operations. In hand specimen the diabase has been described as containing a vague diabasic texture with small plagioglase laths (labradorite) and interstitial fine-grained augite anhedra. Some of the augite has been altered to a yellow-green amphibole and rod-like grains of ilmenite have been superimposed on the rock texture. Minor to trace amounts of sulfides, hisingerite and biotite are also found within the diabase.

Physical Characteristics - The above-described waste rock layers, upon drilling and blasting, generally yield chunky (1 to 3 feet) to blocky (greater than 3 feet) pieces for digging, hauling and stockpiling.

Tailing - The following list itemizes the typical chemical composition of the Reserve Mining Company tailings.

Typical Chemical Analysis of
Reserve Mining Company Tailings

	%
Iron	14.93
Silicon	33.03
Aluminum	.35
Calcium	1.67
Magnesium	2.55
Manganese	.37
Titanium	.030
Phosphorus	.026
Sodium	.20
Potassium	.08
Sulfur	.03
Lead	.005
Zinc	.004
Nickel	.002

Molybdenum	.001
Vanadium	.001
Cobalt	.002
Chromium	.004
Cadmium	.0003
Carbon	.11
Hydrogen	.10
Oxygen	46.40
Total	99.90

Figure A shows typical grain size analysis of the Reserve Mining Company tailing.

c. Ore Beneficiation Process

The 3½ inch taconite is conveyed to fine crusher storage bins on one of two parallel conveying systems. The 10 fine crusher bins provide 32,000 long tons storage ahead of the fine crushing plant. There are 10 fine crushing lines. Each line consists of a 6 x 12 foot double deck screen, followed by a heavy duty 7-foot short head crusher, followed by another 6 x 12 double deck screen and another heavy duty 7-foot short head crusher. All screen undersize material bypasses the crushing lines. This results in an open circuit crushing process. The fine crusher product is approximately 98 percent minus 3/4-inch, 80 percent minus ½ inch and 50 percent minus 3/8-inch in diameter. Each fine crusher line processes approximately 400 LTPH of crude taconite.

Dry Cobbing -- The dry magnetic separation step is between the fine crusher and the concentrator. Approximately 20 percent of the fine crusher product is rejected as a tailing in the dry cobbers and the magnetic iron content of the taconite is raised from 24 to 29 percent iron.

The fine crusher produce is conveyed on one of two parallel conveying systems into the dry cobbing building. There, the crushed ore is discharged by shuttle conveyors into one of two 30-minute capacity surge bins. The crushed ore is withdrawn from the two bins by twelve, 10-foot wide, constant speed conveyor belts. Each belt discharges 500 LTPH of crushed taconite into a dry cobbing machine. Each dry cobbing machine consists of

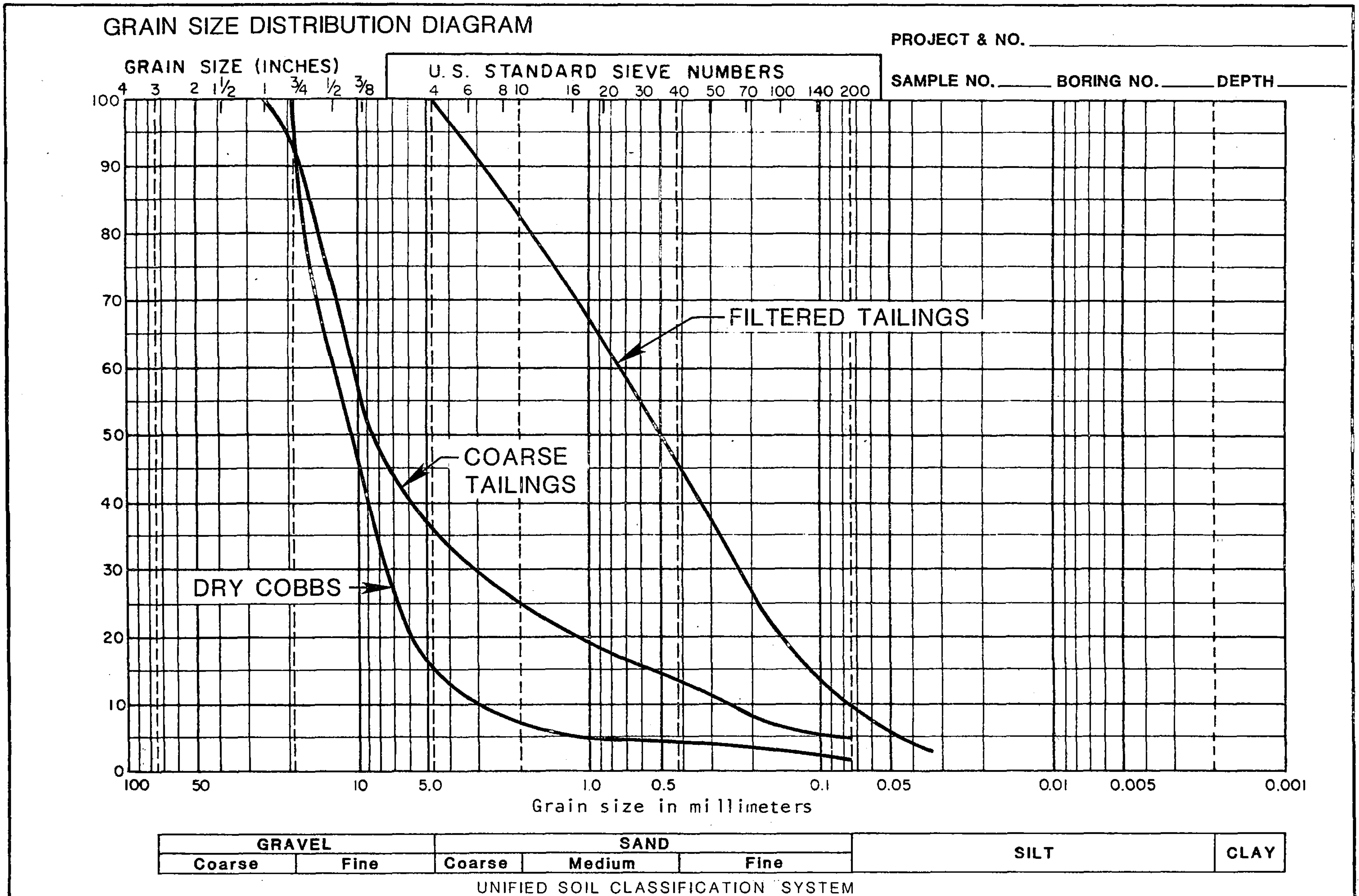

FIGURE A

BARR ENGINEERING CO.
Minneapolis, Minnesota

a 10-foot long riffle splitter and two 10-foot long, 36-inch diameter, permanent magnet separators operating in parallel. Dry cobber concentrates are conveyed on two parallel conveying systems to 44 rod mill feed storage bins having a storage capacity of 84,000 long tons. Dry cobber tailing are conveyed 4,500 feet to two coarse tailing loadout bins with a 7,000 long ton capacity. There, coarse tailing are loaded into trains for movement to the tailing basin.

Dry cobbing serves two major purposes in the new process. Its principal function is to provide large volumes of dry coarse aggregate for use in construction of the tailing dams. These tailing are free draining and have high frictional shear strengths, two key requirements for the dam building aggregates.

Dry cobbing has also made possible a substantial reduction in rod mill feed rates while not seriously reducing the iron unit production of the concentrating process. That is, fewer tons of high-grade dry cobber concentrate are required to produce equivalent concentrate tonnages. The 20 percent reduction in rod mill feed rate also decreases the quantity and size analysis of coarse tailings generated in the concentrating process. This favorably affects tailing disposal activities since it increases the quantity of minus 65 mesh tailing. All tailing coarser than 65 mesh are rail-hauled to the disposal site, while the minus 65 mesh tailing are pumped to the basin.

Concentrator -- The new concentrating flowsheet will process approximately 2,900 LTPH of dry cobber concentrates and produce 1,100 LTPH of concentrate. Concentrate grade will be 68 percent iron, 4.7 percent silica and 92 percent minus 325 mesh with a surface area of approximately 9,500 cm^2/cm^3.

In each section, the 10½ foot diameter by 18 foot long rod mill discharge is combined with the discharge of two 10½ foot diameter by 16 or 18 foot long ball mills. That slurry stream feeds four 10 foot long by 3 foot diameter rougher magnetic separators operating in parallel. Rougher magnetic separator tailing flow to a hydraulic sump for further treatment. Rougher magnetic separator concentrates are pumped by a variable speed pump to eight 10 inch diameter cyclones operating at 13 psi. Cyclone underflow is split and feeds two ball mills. Cyclone overflow flows to two 16 or 18 foot diameter primary hydroseparators for further upgrading. The primary hydroseparators are equipped with water injection systems to maximize tailing rejection. Concentrates are raked to the hydroseparator underflow and flow into the screen feed sump. The screen feed sump feeds a two-stage fine screen bank. Sump make-up water rates are varied to control fine screen performance.

The oversize from the first stage fine screens is rescreened on the second stage. Fine screen oversize is pumped back to the ball mills for further grinding. Each section is equipped with eight first-stage and eight second-stage fine screens. The screen panels have 2 foot by 4 foot flat decks with 0.004 inch openings. Mechanical rappers are used on the screens.

Screen undersize feeds a single 16-foot diameter finishing hydroseparator. It is equipped with water injection systems and a rake withdrawal system for concentrates. Finisher hydroseparator concentrate feeds two 8-foot long by 36-inch diameter double drum flotation feed magnetic separators. Flotation feed magnetic separator concentrate is diluted and pumped to the primary flotation cells. Each section is equipped with two 500 cubic foot primary flotation cells operating in series.

There is a 35 percent recirculating load in the flotation middlings circuit. In it, the middlings froth from the primary cells is pumped to a single drum 10-foot long by 36-inch diameter dewatering magnetic separator. The separator concentrate gravity flows to a regrind mill. Regrind mill discharge is pumped to the secondary flotation cells. Each section is equipped with two 500 cubic foot secondary cells operating in series. The froth from the first secondary cell reports to tailing. The froth from the second secondary cell is combined with the froth from the primary cells and is recycled in the regrind circuit. The secondary cell concentrate joins the primary cell feed. Primary cell concentrates are washed in a 16-foot diameter flotation hydroseparator and pumped to the new central concentrate filter building.

Flotation -- The cationic flotation flowsheet produces pellet silica of 5 percent by weight. The present 5 percent silica target is based on current blast furnace technology. The silica target may change in the future since the flotation process allows the silica level of concentrates to be changed on demand.

It is desirable to run the process at its natural basic pH since this reduces water treatment requirements. The objective is to float the quartz and silicate particles and to discharge the magnetite in the cell undeflow. Therefore, a cationic collector is used to float the negatively charged particles.

The presence of cummingtonite complicates the separation. Studies at the University of Minesota have shown that cummingtonite and magnetite have similar electrokinetic characteristics, indicating that one can expect some magnetite flotation in the process. In actual practice, as much as 60 percent of the cell froth is free magnetite.

A minimal amount of conditioning is required. Reagent is fed directly to sumps feeding the flotation cells providing less than 1 minute of conditioning.

Reagents used are amines or diamines of 13 to 15 chain length in the flotation process. Most of those amines require neutralization to enhance their dispersion in water when added to the flotation cells. Collector consumption will be approximately 0.2 lbs/ton concentrate. Methyl isobutyl carbonal (MIBC) is used as a frother. It will be added at a rate of 0.05 lbs/LT of concentrate. The reagent preparation system automatically batches, mixes, and feeds predetermined quantities of the various flotation reagents to the process several times each shift. Iron recovery in the flotation process is adjusted to maintain the desired pellet silica. Reagent addition rates are controlled by four neutron activation silica analyzers which measure the silica content of the concentrates from the 22 sections. The four, time-shared assay systems each analyze 12 slurry samples per hour. Each section is sampled once every 20 to 30 minutes. Silica analysis is accurate to $\pm$0.2 percent by weight.

The sodium carbonate or blowdown water is added directly into the rod mill where the chemical concentrations, temperatures, and pH are higher than the rest of the circuit, and violent mixing occurs. It is possible to reduce the calcium concentration to a level of 7 mg/l in the rod mill discharge waters, if desired. The sodium that replaces calcium remains in solution when the calcium carbonate precipitates. Sodium has not had a measurable effect on the performance of the flotation circuit.

Concentrates from the 22 sections are pumped to one of four transfer pumphouses. Each pumphouse receives the concentrates from five or six sections. Each concentrate slurry is automatically sampled for silica content using neutron activation analyzers at the pumphouse. Then the slurry streams are combined in a sump and pumped to concentrate filter building. There, concentrates are dewatered in two 40-foot diameter hydroseparators, stored in two 40-foot diameter by 40-foot high slurry storage tanks, and filtered with 10 new 9-foot diameter external tube concentrate filters. Each filter is equipped with its own vacuum pumps to minimize friction losses that would occur in a common vacuum system. A common snapblow air supply is supplied to all filters. Filter cake is conveyed to the pelletizer concentrate storage bins.

Coarse Tailing Disposal -- Rougher magnetic separator tailing are washed in a hydraulic sump to remove fines from those coarse tailing. The sump overflow feeds the main tailing launders. The sump underflow is pumped to a tailing cyclone. Tailing cyclone overflow feeds the main tailing launders. Tailing cyclone underflow, averaging about 8 percent minus 200 mesh is distributed on a 4-foot wide horizontal belt filter for dewatering. There, the tailing are dried to a 6 to 8 percent moisture range. The filtered tailing are discharged into the coarse tailing conveyor system for transportation to the tailing loadout bins.

Dry cobber tailing and filtered tailing are conveyed to the tailing loadout bins at rates of 790 and 260 LTPH, respectively. The 1050 LTPH of coarse tailing are then rail transported 12 miles to the basin. Three 25 to 30 car trains powered by three 2,000 HP locomotives are required to move the coarse tailings to the basin. Four train loads of coarse tailing are carried to the basin each 8-hour shift.

The dam design and construction specify that certain portions of the dam will be constructed totally from either filtered or dry cobber tailing. Therefore, the conveying and rail-haul system is designed to transport either mixed or separate streams of dry cobber and filtered tailing, depending on the tailing dam building specifications in effect at any given time. The normal ratio of dry cobber to filtered tailing is three parts dry cobber tailing to one part filtered tailing.

The coarse tailing are used in dam construction during the summer months and are used for splitter dike construction in the basin during freezing weather. The splitter dikes subdivide the basin into a series of cells.

The coarse tailing storage bins have a capacity of 7,000 tons or 6 hours operation. The concentrator plant feed is automatically shut down if the bins are filled to capacity since the operating permits prohibit any outdoor surge storage of coarse tailing. This restraint imposes rather severe operating requirements on the railroad department since anything that stops the rail movement of coarse tailing will result in a total plant shutdown.

Fine Tailing Disposal -- Fifteen hundred LTPH of minus 65 mesh tailing along with 275,000 gpm of water, flow by launder to four 400-foot diameter tailing clarifiers. Liquid cationic long chain polymers are used for flocculating the tailing. Clarified water is recycled back to the process for reuse. The thickened tailing are lifted approximately 675 feet and travel approximately 5½ miles by pipeline to the nearest edge of the tailing basin. An additional 10 miles of pipeline is used in the basin area to distribute the fine tailing. The pipeline transport system consists of two 24-inch diameter pipelines, one operating and one spare. There are two pumphouses. One is at the start of the pipeline system, and the other is located approximately 3 miles along the line. Each pipeline requires three pumps running in series in each pumphouse, or six pumps for each line.

The slurry is transported to the basin at the highest possible density to reduce power requirements. The design objective is to transport at approximately 5 feet per second the 60 percent solids by weight. Pipeline transport times between the plant and the basin will vary between 2 and 3 hours depending on the location of discharge in the basin.

Our operating permits require the pipeline operation to be highly automated. Each pipeline has automatic start-up, operating, and shutdown systems and an extensive leak-detection system which will shut down the operating line in the event of a pipeline failure.

Our operating permits essentially prohibit spigotted tailing beaches. Therefore, the tailing dam construction design allows the storage of free water at the dam face. This requires that the water balance be managed to maintain an average 20 feet of water over the fine tailing in the 5.8 square mile basin. A series of splitter dikes and 16-inch diameter ultrahigh density plastic floating pipelines is used to distribute fine tailing throughout the basin. Each floating pipeline may be up to 1,500 feet long. The fine tailing discharge points will be moved at frequent intervals to ensure that the tailing are discharged directly into water.

Pelletizing -- Moist concentrate is conveyed to 9-foot by 30-foot concrete-lined steel balling drums, each with a capacity of 50 long tons per hour. Bentonite is added at the rate of 20 pounds per long ton of concentrate to add strength to the pellets below firing and to control the release of moisture during firing. Pellets are fed to a roll screen with undersize pellets being returned to the head of the balling drum while finished pellets (plus 11/32 inch) go to product. The product of the balling drums is fed to horizontal-grate pelletizing machines where the pellets are fired at 2350°F, converting the magnetic iron to the hematite form. The sequence of operations as the pellets travel on the horizontal grate of the pelletizing machines is as follows:

- Updraft drying
- Downdraft drying
- First downdraft heating
- Second downdraft heating
- Ignition
- Burning

- Recuperation of heat returned to the updraft stage
- First cooling stage
- Second cooling stage

In this process, heat generated by the combustion of natural gas is carefully conserved and recycled to the various addition points listed above. Pellets then go over a shaking screen where they are quenched. Exhaust air passes through wet wall electrostatic precipitators to remove particulates.

After the pellets have been quenched, they are conveyed on two conveyor belts to the loading and storage areas at the rate of 27,000 tons per day, where they are stored in ten bins, each with 6,000 ton capacity. These pellets contain 65.5% iron and 5.0% silica.

The auxilliary loading facilities are:

a) Boat loaders. Twenty conveyors (2 to each bin) feed two boat loaders, each containing a 60-inch conveyor with a capacity of 3,800 long tons per hour.

b) Pellet storage bridge. The main span is 465 feet and the cantilever span is 200 feet. The bridge houses a 42-inch conveyor with a capacity of 1,550 long tons per hour.

c) Pellet storage area. This area has a capacity of 5.4 million long tons.

d. Methods, Sequence and Schedules of Reclamation

1) Buffers and Barriers - Since there is neither habitation or public highways immediately adjacent to the operations, no buffers or barriers are required.

2) Sloping and Land Form Designs - Reserve Mining Company may be in the future requesting a variance from the design requirements for rock, lean ore, and surface overburden stockpile requirements as they

relate to lift heights, benching, and slope requirements. Until such time, stockpiles will be constructed according to these rules.

At deactivation, the top and benches of waste rock stockpiles will be covered with surface as required and they will be designed to be stable and capable of withstanding a 100-year frequency, 24-hour duration storm. Should lean ore stockpiles be present at the time of mine deactivation and have no foreseeable use as ore, tops of these will also be covered with surface material as required.

When the mine is deactivated, it will be managed so as to minimize watershed modifications.

The rock, lean ore, or coarse tailing stockpiles contain no decomposable material and therefore require no special treatment.

Surface overburden portions of the pit walls will be designed and built to be in compliance with the requirements thereto.

The closure map, C-16, shows a number of items, as follows:

a) The location of the five cross-sections are shown in C-12 and C-13 and define the ore body. They are 2E, 18, 24, 34, and 42.

b) The red line defines the final surface bank created after August 21, 1980. After mining has receded from this bank a feasible distance, the bank will be sloped to a 2.5 to 1 slope and seeded with vegetation.

when completed

c) Stockpiles of surface are shaded in orange. The tops, slopes and benches of these piles will be seeded with vegetation when they are completed.

d. Stockpiles of waste rock are shaded in yellow. The top and benches of these piles will be covered with 2 feet of surface material and be seeded with vegetation.

e. Stockpiles of lean ore are shaded in green. The final disposition of these stockpiles will be dealt with in the final deactivation plan.

The design construction of the tailing basin is also covered in great detail in other permits and reports submitted to the DNR and other agencies.

When the project nears the end of the mine life, special efforts will be made to raise the tailing level in some of the cells above the average level of the settled tailing, to heights equal to or slightly below the average level of the ultimate pond area. A coarse tailing cap several feet deep will then be worked out over the cells to provide a firm and stable final surface. Seeding and reforestation will proceed concurrently.

Fine tailing produced during this final period will continue to be dumped in cells that will be deliberately left low for that purpose. These cells will also comprise the final lakes or ponds. Coarse tailing beaches will be placed around the lakes to provide safe footing.

As discussed previously, the free water pond will be reduced in volume and area concurrently with placing the seeding of the coarse tailing topping layer. The result will be a large meadow with one or more small ponds, and the entire area protected at the extremities by the tailing dams standing several feet above the general level. The average level in the ultimate tailing pond area will be about elevation 1305 while the dam crests will be elevation 1315.

The 10 feet of freeboard above the average pond level is about double the volume required to store the runoff from a 96-hour maximum probable storm on the 8.7 square mile catchment. Consequently, the ultimate spillway will not be required to handle peak flows, and need only be sufficient to cope with normal flows and to restore water levels in the ponds to normal within a reasonable period of time after unusual floods.

The final spillway location has as yet to be determined, but it is expected to be at one of several suitable points in the east ridge rock area. The site chosen will be such that the outlet end of the spillway channel is in sound rock to protect against erosion. A low concrete weir will serve to provide a positive control level. The aim is to minimize maintenance to the maximum extent possible.

A nominal width of channel, 12 to 15 feet, should suffice to cope adequately with any conditions that can be conceived. Average annual flows will be in the order of 10 cfs and the peak flows following an extreme storm should not exceed 500 cfs. Crest level for the concrete weir will be in the order of elevation 1303. That level will, of course, also be the minimum level for the small ultimate free water pond or ponds.

A somewhat more elaborate spillway control facility may be adopted if it is found necessary to limit the maximum discharge rates. This might take the form of a pipe or port set in the weir so as to throttle the flow more than would be possible with just a free crest and open channel. The need for such measures can only be resolved when the site has been selected and hydraulic studies have been done on downstream channel characteristics.

3) Vegetation - Vegetation will be established so as to conform with the requirements of the Rules Relating to Mineland Reclamation. Because of the active nature of the mine and tailing basin, it will be many years before much vegetation can be established in these areas. A significant portion of the tailing basin dams will, however, be vegetated much earlier. As the mine reaches ultimate limits, and surface banks are no longer subject to being disturbed by fly-rock, they will be shaped to a 2½:1 slope and revegetated with a combination of herbaceous and woody plants. The amount of each and species used will depend upon the post-mining use of a particular area, and the type of plants that will best fulfill the objectives of revegetation. As haul roads outside the mine are deactivated, they will be

revegetated. The tops of the waste rock stockpiles will also be revegetated after they are covered with surface. The top and banks of the surface overburden stockpiles will also be revegetated as required. Vegetative reference areas are shown in C-2.

It is difficult to know what new reclamation techniques will be developed prior to the time when these mining facilities will be deactivated and available for revegetation. It now appears that the following techniques might be used.

a) Timing - In order to maximize the success of revegetation, it should follow the deactivation of a mining area as soon as possible. This is especially true of surface overburden slopes. Vegetation will be established as required by the Rules Relating to Mineland Reclamation.

b) Grading - Surface banks in the mine will be shaped just prior to seeding to minimize the possibility of erosion prior to plant establishment.

c) Chisel Plowing and Discing - Where the surface overburden has become greatly compacted and thereby limiting root growth and stabilization by plants, it will be loosened using only one of the above mentioned practices.

d) Fertilization - If required, due to extreme infertility of the mine waste, they will be fertilized to hasten stabilization and thereby decrease the possibility of erosion.

e) Seeding and/or Planting - The objective of plant establishment is to minimize erosion, provide future use of the mineland and develop a vegetative cover that will be compatible with the surrounding vegetative cover. This will be achieved by using plant species (both herbaceous and woody) that will meet the above objectives. It is anticipated that the major future use for reclaimed minelands will be for forestry and wildlife habitat development. It is anticipated that most seeding will be done by broadcast or hydroseeding techniques. Woody plants will be hand planted in rough rocky areas and machine planted wherever possible. Trees and shrubs may consist of bare-root seedlings, cuttings and containerized trees where needed.

f) Mulching - On severe sites it may be necessary to mulch seeded areas to achieve required results. Mulch will probably consist of hay/straw or wood pulp.

g) Irrigation - Since precipitation is quite dependable at both the Babbitt and Silver Bay operations, no irrigation is expected to be needed to obtain desired results.

The above mentioned are general since they cover a long time period. As it becomes possible to carry out the required revegetation, the methods and techniques will be covered in more detail in the Operating Plans.

7. 1981 OPERATING PLAN

Reserve Mining Company plans to mine approximately 27.0 million tons of crude ore during 1981. This will produce approximately 18.0 million tons of tailing to be deposited in our basin at Silver Bay.

The stripping that goes along with this production is shown on a map called the "1981 Stripping Plan", C-17. It amounts to 4.3 million tons of waste rock, 7.9 million tons of lean ore, and 1.0 million cubic yards of surface.

Stripping materials will be used to construct pads and access roads for future surface, waste rock and lean ore stockpiling as required to meet our mining schedules.

Waste rock materials stripped will be used to cap the above mentioned pads and access roads.