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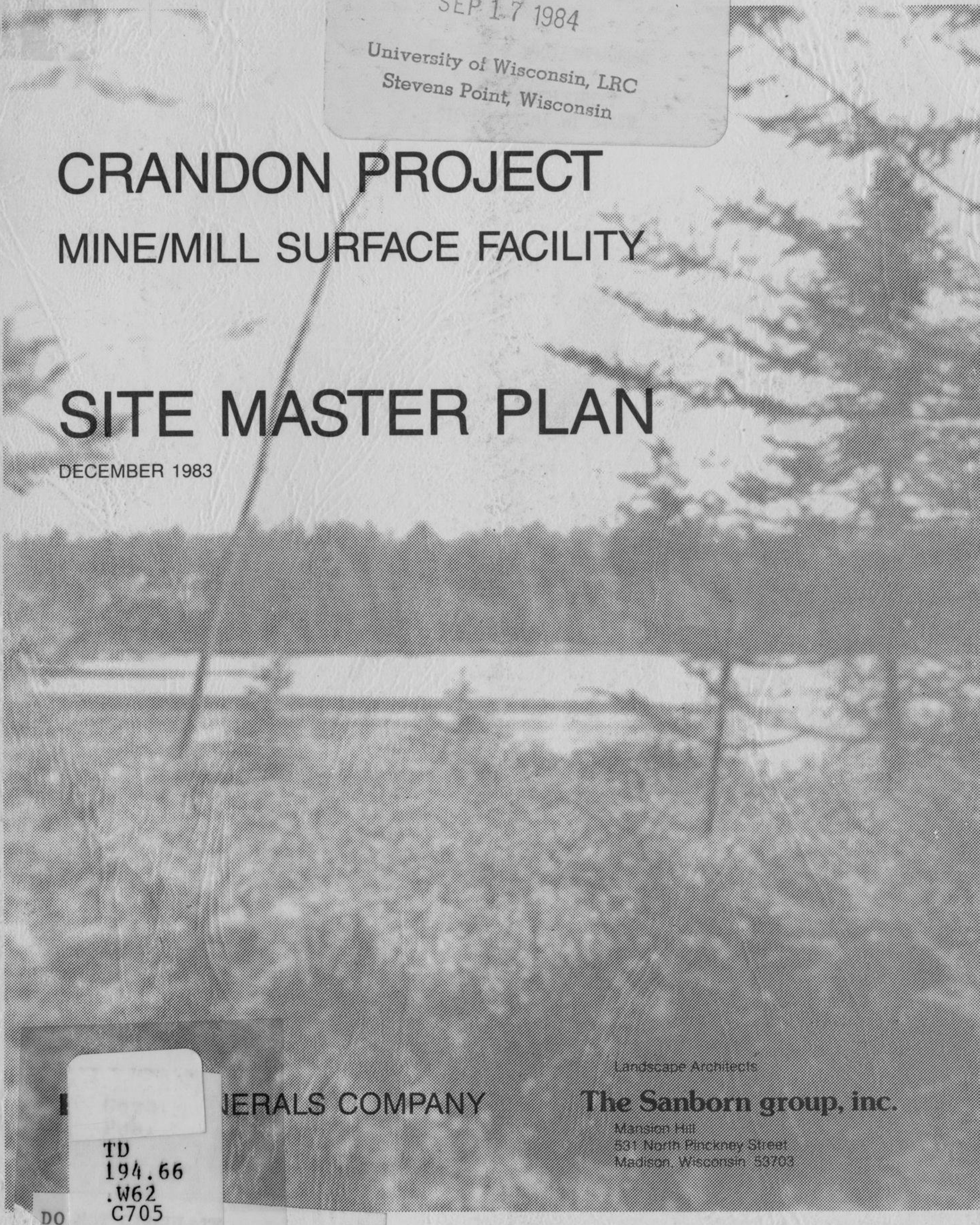
CRANDON PROJECT

MINE/MILL SURFACE FACILITY

SITE MASTER PLAN

DECEMBER 1983



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Landscape Architects
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CRANDON PROJECT

MINE/MILL SURFACE FACILITY

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1.0 INTRODUCTION

Exxon Minerals Company, a division of Exxon Corporation, is conducting studies and work to evaluate the feasibility of developing a mine/mill complex to mine and process zinc, copper and lead bearing ores from a sulfide deposit located in Forest County, Wisconsin. This work is known as the Crandon Project. This report presents a discussion of the Site Master Plan development for the Crandon Project mine/mill surface facilities to be used by the Exxon Minerals Company.

The Crandon Project mine/mill surface facilities referenced in this report include those facilities required on the surface for the support of the underground mine operation; ore handling, storage and crushing facilities; the concentrator where minerals are separated from the ore to produce concentrates; and those ancillary facilities, including transportation and utility services required to support the operation of the mine/mill process. Chapter 1.0, Description of the Proposed Action in the Crandon Project Environmental Impact Report (Exxon Minerals Company, 1982a) supplements the Site Master Plan report to provide a detailed description of these facilities. The scope of the Site Master Plan report does not include the access road, railroad spur and powerline corridors to the mine/mill surface facilities or the mine waste disposal facility and the adjacent water reclaim ponds located southeast of the mine/mill site.

This section of the work focuses on the mine/mill site situated around the Crandon ore deposit. The location of the site (Figure 1.0-1) is 8 km (5 miles) south of Crandon, Wisconsin and 3 km (2 miles) east of State Highway 55. Swamp Creek is approximately 1.6 km (1 mile) to the north of the site and Little Sand Lake is 0.4 km (0.25 mile) to the south. Sand Lake Road forms the southern boundary of the site.

An access road will connect the mine/mill site to State Highway 55 at a point about 4.8 km (3 miles) northwest of the site. A railroad spur will connect the mine/mill site to the Soo Line Railroad at a point about 4.3 km (2.7 miles) northeast of the site.

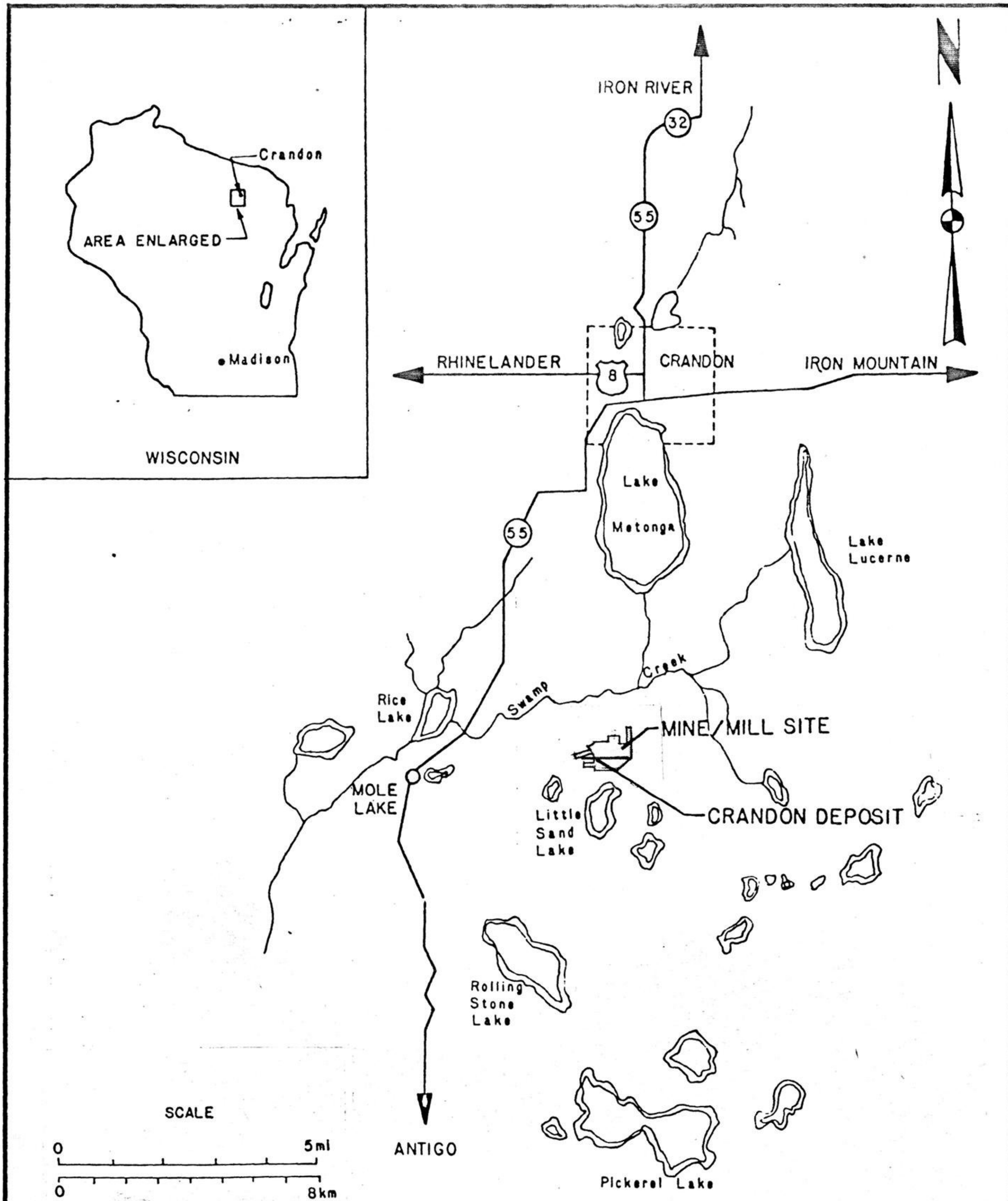
The principal objectives in this section of the work are to document a Site Master Plan that:

1) Provides assurance that the mine/mill surface facilities are arranged for aesthetic compatibility with the local area, the existing topography, and the environment; and

2) Provide a landscape massing plan utilizing indigenous species to initiate the reclamation of the site to its natural state during the construction phase.

Toward the achievement of this objective, the Site Master Plan focuses on locating the boundaries of the complex outside the 305 m (1,000 feet) shoreline zoning boundary around all lakes, minimizing infringement into wetlands, preserving the existing landform and vegetation to the maximum extent possible, reducing the total surface area occupied by the facilities and containing the complex within a controlled perimeter to the extent possible.

The Site Master Plan was the product of a logical and comprehensive site development process. Factual data compiled in the Crandon Project environmental baseline studies and engineering reports, extensive aerial site mapping and detailed background information documented in other technical resources served as the foundation for decision-making during the site development process. The landscape architect also worked with the Exxon engineering and environmental technical staff during various



Geographic location of the Crandon Project and ore deposit

EXXON MINERALS COMPANY
CRANDON PROJECT

PROJECT LOCATION MAP

The Sanborn group, inc.

Fig. 1.0-1

phases of Project design to ensure that considerations were given to the aesthetic and environmental characteristics of the mine/mill site and the surrounding landscape in the arrangement of facilities. Thorough graphic communication, including models, renderings, plans, sections, and perspective sketches was used to document observations and illustrate design conclusions.

This report is divided into six sections reflecting the stages of the site development process:

1) Inventory and Analysis. The Inventory and Analysis is the initial step in the Site Master Plan development in which regional and site-specific information is assembled, recorded and interpreted for the purpose of gaining a comprehensive understanding of the Project site;

2) Functional Program. The Functional Program follows the Inventory and Analysis to define the basic functional scope of the mine/mill complex including interrelationships of facilities and constraints dictated by the mine/mill process and operations;

3) Concept Development. The Concept Development section defines the optimum relationships of the mine/mill surface facilities to the Project site based on natural design potentials and constraints identified in the Inventory and Analysis and the relationships and guidelines established in the Functional Program;

4) Site Master Plan. The Site Master Plan section includes a description of the proposed layout of the mine/mill complex in terms of organization and spatial pattern, circulation layout, aesthetic appearance and building design and landscape massing;

5) Landscape Plan. The Landscape Plan section contains a discussion of selection and location of plant associations for the revegetation of the landscape masses depicted in the Site Master Plan; and

6) Landscape Implementation. The Landscape Implementation section provides documentation for the implementation of the Landscape Plan during the construction of the mine/mill surface facilities and the maintenance of the Landscape Plan during the mine/mill operations.

2.0 INVENTORY AND ANALYSIS

2.1 INTRODUCTION

The initial step in developing the Site Master Plan involved the collection, recording and interpretation of pertinent information that describes the existing environment encompassing the site for the mine/mill surface facilities.

The purpose of this work was to develop an overall familiarity with the environmental and aesthetic character of the natural landscape and to assess existing natural features as potential design determinants to be used to structure the organization of the mine/mill surface facilities. This was an essential first step toward accomplishing the basic planning objective of compatibly integrating the facilities into the landscape.

2.2 METHODS

2.2.1 Data Collection

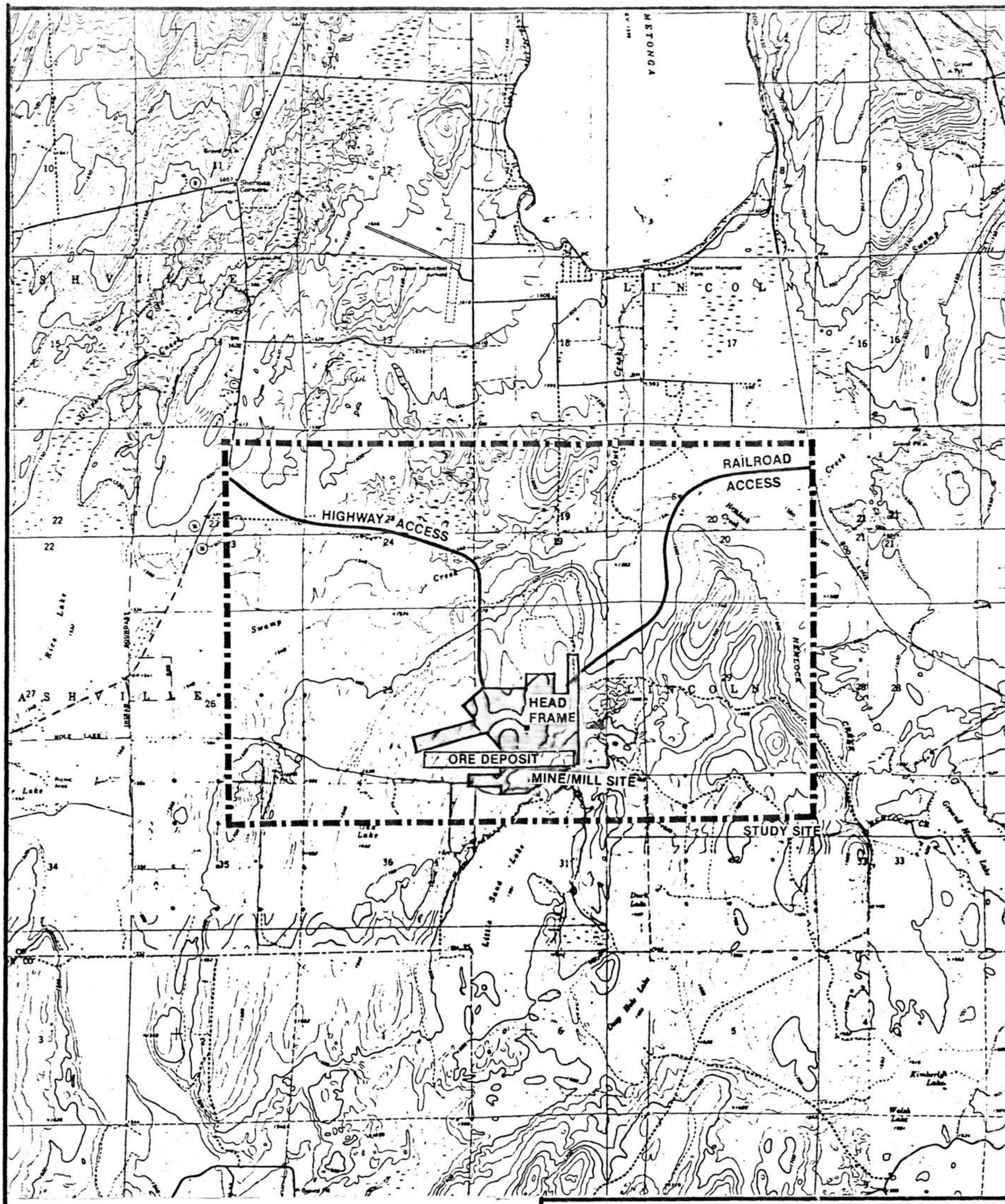
The inventory and analysis were initiated by gathering and documenting key data about the Project site to serve as the basis for subsequent decision making. Environmental baseline studies (Exxon Minerals Company, 1982a) and aerial photography, aerial photogrammetric mapping and planimetric mapping were the principal sources of information for this work. Data collected from field inspections of the mine/mill site, USGS surveys, USDA-SCS interpretations of local soil conditions and a forest inventory by E.F. Steigerwaldt (1982) were used to supplement these information resources.

2.2.2 Graphic Overlay Mapping

Natural resource base conditions including topography, surface drainage, vegetation, climatic factors of orientation and exposure and perceptual characteristics such as key aesthetic features and view potentials were distilled from the maps, studies and planning documents identified in subsection 2.2.1 and recorded on individual maps to overlay either an aerial photogrammetric or planimetric base sheet. The succession of overlays, as presented in Appendix A, Figures A-1 through A-8, provided a composite record of the systems that collectively comprised the natural landscape encompassing the mine/mill site. Interpretation and analysis of the information synthesized in this process led to conclusions regarding planning directions for the development of the mine/mill site.

Prior to recording information and formulating conclusions with respect to the immediate mine/mill site, the graphic overlay mapping process was used to inventory an expanded study area surrounding this site. This expanded view was necessary to gain a comprehensive understanding of the natural characteristics specific to the immediate environment of the mine/mill site.

The expanded study area is defined on the north by the Swamp Creek drainage basin; on the east by Hemlock Creek; on the northwest by Highway 55; on the southwest by the Hoffman Creek drainage basin; and on the south by Little Sand Lake and Oak Lake. This study area encompasses the mine/mill site and the proposed routes for the access road and railroad spur from the main lines to the site. Figure 2.0-1 locates this study area.



EXXON MINERALS COMPANY

CRANDON PROJECT

STUDY AREA LOCATION MAP

The Sanborn group, inc.

Fig. 2.0-1

2.3 KEY OBSERVATIONS AND CONCLUSIONS

2.3.1 Topography

A general southwest trend of ridges and intervening lowlands characterizes the southern portion of the study area while the Swamp Creek drainage system, also a southwest trend, dominates the northern portion.

The immediate mine/mill site is situated in a upland area owing to the position of an elongated, elliptical landform which bisects the site. Elevational changes range from 515 m (1,690 feet) to 488 m (1,600 feet) while slope conditions vary from 0 to 35 percent. General slope orientation is in a southwest trend.

The central landform exhibits strong potential as an organizing element for the mine/mill site development. Its proximity to the ore body and the main shaft and its slope characteristics offer a siting opportunity that can facilitate the operational requirements of gravity flow of materials. This landform can also positively affect the microclimate of the mine/mill complex by buffering prevailing northwest winter winds.

2.3.2 Surface Drainage Patterns

The topographic ridge systems within the study area act as major drainage divides channelling surface water to two predominant drainage basins, Swamp Creek and Pickerel Creek.

Within the immediate mine/mill site, a ridge system and its corresponding saddles divide drainage patterns and channel surface water with the predominant pattern toward the south and the Pickerel Creek basin. This existing natural condition will assist in accomplishing a planning objective of directing the majority of surface water run-off from the mine/mill complex to the Pickerel Creek basin.

A series of terraced landforms characterizes the southerly slope of the ridge dividing the mine/mill site. Pockets of closed drainage or areas having ephemeral drainage have created wetland conditions within the southeastern corner of the mine/mill site and outside the mine/mill site to the north and west. The mine/mill surface facilities are organized to avoid disturbances to these areas.

2.3.3 Vegetation

Variations in topography, soil types, soil moisture and slope orientation result in three general vegetative groupings within the study area:

1) Upland Forest - This vegetative group is subdivided into three plant associations: northern xeric forest occupying dry, sandy soil conditions and characterized by red, jack, and white pine dominants; northern dry-mesic forest occurring on well-drained soils with typical white pine, red maple, red oak, paper birch, and quaking aspen dominants; and northern mesic forest, the climax successional community occupying rich soils on non-extreme topography and supportive of sugar maple, hemlock, yellow birch, and basswood;

2) Lowland Forest - This vegetative group is subdivided into two plant associations: wet-mesic forest, commonly referred to as Cedar Swamp, occupying poorly drained lowland soils dominated by white cedar and balsam fir; and northern wet forest, known as the bog forest, characterized by black spruce and tamarack; and

3) Edge Zone - This is a transition zone represented by a gradational change between the upland and lowland forests resulting in greater species diversity.

The upland forest characterizes the vegetation in the majority of the mine/mill site due to the morraine-like landform system upon which the site is located. Lowland forests and edge zones occupy the north, west and southeast portions of the site at the base of this landform. These lower areas with their greater diversity of vegetation and wildlife habitat are planned for minimal development.

2.3.4 Perceptual Character

The natural landscape encompassing the study area is characterized by topographic variety and vegetative diversity. The approach sequence for the access road to the mine/mill site is planned to promote an awareness of this landscape and its changing visual character by alternating views to key natural features in both upland and lowland areas.

The upland zone that occupies the majority of the mine/mill site is visually monotypical consisting of northern hardwoods represented by aspen and birch. Wetland drainage corridors supporting conifer stands of balsam fir and black spruce penetrate the perimeter of the mine/mill site. These lower areas provide visual relief to the predominant upland vegetation and are therefore planned for minimal development.

3.0 FUNCTIONAL PROGRAM

3.1 INTRODUCTION

The basic functional planning criteria for the mine/mill complex are identified in this section of the Site Master Plan report including required interrelationships of facilities and constraints of the process and operations. These functional criteria were identified through interactions with engineers and environmental scientists for the Crandon Project and serve as the basis for planning an optimum, efficient and aesthetic arrangement of facilities.

The scope of this section focuses on the mine/mill surface facilities including those facilities required for support of the underground mine; those required for handling, storing, and crushing ore; the concentrator where the minerals will be separated from the ore to produce concentrates; and the ancillary facilities, including parking, transportation and utility services required to support the mine/mill operations. The surface facilities complex occupies about 46 ha (114 acres). A portion of this area will be covered by buildings, roadways, parking lots and ancillary facilities. The remaining area will be landscaped for erosion control and general aesthetics.

3.2 FUNCTIONAL REQUIREMENTS

3.2.1 Operations Center

The nucleus of the mine/mill surface facilities consists of three basic components: the main shaft and headframe, the single point of transport for personnel and supplies to the underground mine and conveyance of mined ore to the surface; the ore handling (conveyors), storage and crushing facilities; and the concentrator.

The locations of these facilities are fixed to form a tight operations center for the mine/mill complex. The headframe is fixed according to its relationship to the ore body and the underground mine. The concentrator is fixed in close proximity to the headframe and in relation to an existing landform to assist the operational requirement of gravity flow of materials. The ore handling, storage and crushing facilities are fixed to minimize the number and length of conveyors necessary for required material flow. In addition, the mine air heater and ventilation air shaft, the collar house and change facilities for the underground mine are all located according to their required relationship to the headframe.

3.2.2 General Arrangement Criteria

The remaining mine/mill surface facilities are located as close as possible to this core to accomplish the primary planning objective of minimizing the total surface area occupied by the mine/mill complex. These facilities are also located to achieve the following arrangement criteria:

1) Observe the 305 m (1,000 feet) shoreline zoning boundary around all lakes and minimize infringement into wetlands;

2) Minimize surface disturbance to the environment;

3) Provide a safe, healthy environment for all operating personnel;

4) Minimize noise and particulate emissions during mine/mill operations;

5) Provide well-organized and direct vehicular circulation including service and emergency access; minimize the extent of roadways;

6) Provide direct personnel access to facilities along the shortest possible routes;

7) Minimize in-plant rail trackage while accommodating essential service access and convenient flow of materials;

8) Provide direct piping runs and consolidate piping wherever possible within corridors;

9) Consolidate facilities that can potentially contaminate ground and surface water within drainage control zones;

10) Mitigate local climatic conditions;

11) Achieve the best overall visual aesthetics with materials and colors selected for compatibility with the surrounding environment.

3.2.3 Facility Interrelationships and Operation Constraints

The arrangement of surface facilities is also based on the following criteria reflecting facility interrelationships and operation constraints:

1) Approach road is positioned for direct, tightly controlled access to the mine/mill complex;

2) Parking area is arranged to accommodate personnel and visitor parking within minimum area requirements and smooth ingress and egress of vehicles during shift changes;

3) Gatehouse is centrally located with respect to the parking for direct employee and visitor access;

4) Main electrical substation is centrally located with respect to the concentrator and the underground mine;

5) Services building, including the administrative offices, warehouse, and maintenance and mechanical repair shops, is centrally located with respect to the headframe and concentrator for direct service to mine and mill operations;

6) Water storage tanks are located adjacent to the water treatment facility for the storage of reclaim water and in close proximity to the concentrator where large volumes of reclaim water will be used;

7) Water treatment facility is located adjacent to the concentrator where reclaim water will be reintroduced to the mill process;

8) Tailings thickener is located adjacent to the concentrator to handle the by-products of the concentrate process;

9) Reagent storage is located for direct rail access and in close proximity to the concentrator;

10) Timber and steel storage is located for direct rail access and in close proximity to the headframe for convenient flow of materials to the underground mine;

11) Bentonite storage is located for direct rail access and adjacent to the access road to the mine waste disposal facility;

12) Sanitary sewage treatment facility is located adjacent to the soil absorption field;

13) Explosives storage area is located in an area remote from all other facilities; and

14) Preproduction ore storage is located close to the mine/mill operations zone for convenient transport of ore collected during the construction of the underground mine and for recycle back to the concentrator operations.

4.0 CONCEPT DEVELOPMENT

4.1 INTRODUCTION

In the concept development phase of the site master planning process, the diagrammatic relationship of the mine/mill surface facilities (Fig. 4.0-1) to the Project site has been established in a manner compatible with the aesthetic and environmental character of the surrounding landscape. Natural design potentials and constraints identified in Section 2.0, Inventory and Analysis, and the relationships and guidelines identified in Section 3.0, Functional Program, of this report served as the basis for this phase of the planning process.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N 36 000
N 35 800
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N 35 400
EXPLOSIVE STORAGE
SURFACE DRAINAGE BASIN NO. 3
PRE-PRODUCTION ORE STORAGE
SURFACE DRAINAGE BASIN NO. 2
ACCESS ROAD
RAILROAD SPUR LINE
CONCENTRATE THICKENERS
WATER TREATMENT PLANT
WATER TANKS
TAILINGS THICKENER
CONCENTRATOR
PUMP HOUSE
PUMP CHAMBER
FUEL STATION
HAUL ROAD
REAGENT BULK STORAGE
BENTONITE STORAGE
FINE CRUSHING
WASTE ROCK
COARSE ORE STORAGE
COVERED STORAGE
LUBE STORAGE
COMPRESSOR BUILDING
COMPRESSOR COOLER
SUBSTATION
COLD STORAGE
TOPSOIL STORAGE AREA
TO MINE WASTE DISPOSAL FACILITY
COLLAR HOUSE
MINE AIR HEATER
NATURAL GAS METER STATION
SERVICES BLDG.
HEADFRAME
CORE PROCESSING & STORAGE
STATIC VAR COMPENSATOR
TRUCK SCALE
GATE HOUSE
WEST EXHAUST RAISE
VENTILATION AIR SHAFT
MULCH STORAGE AREA
PARKING
BACKFILL HOLE NO. 1
BACKFILL HOLE NO. 2
SURFACE DRAINAGE BASIN NO. 1
EAST EXHAUST RAISE
BULK FUEL STORAGE
FUEL TANKS
SEPTIC TANK
FUEL DELIVERY BORE HOLE
POTABLE WATER SUPPLY WELL & PUMP HOUSE
REPLACEMENT AREA
INITIAL AREA
SOIL ABSORPTION FIELD
0 50 100 150
SCALE IN METERS
EXXON MINERALS COMPANY
CRANDON PROJECT
GENERAL ARRANGEMENT SURFACE FACILITIES PLOT PLAN
SHOWN
WISCONSIN
FOREST
DR SPRINGBORN
FIGURE 4.0-1

4.2 OVERALL SITE ORGANIZATION

The basic site organization for mine/mill surface facilities has been conceived as a well-organized industrial complex that combines an aesthetically-pleasing entrance, a central circulation system, and a center of operations. The following points summarize the environmental, aesthetic and functional parameters for the organization of this industrial complex within the mine/mill site:

1) The mine/mill site development area is established to observe the 305 m (1,000 feet) shoreline zoning boundary around all lakes and to minimize infringement into wetlands;

2) A ridge running through the approximate center of the site divides the mine/mill complex into two basic development zones: an operations zone on the east side of the ridge consisting of the mine/mill process and ancillary facilities; and an entrance zone on the west side of the ridge including the mine/mill main approach drive. This general organization will be reinforced by the location of the rail access serving the operations zone from the northeast and the road access serving the entrance to the mine/mill complex from the northwest.

   Locating the mine/mill complex with respect to this ridge system will confine development to a predominantly upland area and, subsequently, will minimize the potential for disturbance to the lowlands areas and associated wetlands in the north, west, and southeast portions of the site;

3) Rail lines are located to define the physical limits of the operations zone and prevent encroachment into the surrounding natural areas during construction as well as confine site drainage during construction and operations. The rail corridors will establish a fire break for the mine/mill complex and a barrier for the invasion of the surrounding natural vegetation into the mine/mill complex;

4) The entrance zone is developed to provide an aesthetically-pleasing approach to the mine/mill site. The alignment of the access road will be varied to direct views toward natural features in the surrounding landscape and the facilities within the entrance zone will be sited to preserve the character of the existing topography and

vegetation. These considerations, in addition to the visual focus on the headframe as the orientation point for the entire mine/mill complex, contribute toward establishing a strong entrance for the facility;

5) The perception of a natural setting for the mine/mill complex will be enhanced by the design of an irregular perimeter which permits the surrounding natural landscape to penetrate the site;

6) An efficient central circulation system has been planned to consist of an entrance drive that will provide smooth ingress and egress and tightly controlled access to the operations zone and a main circulation corridor that will provide direct service and emergency access throughout the operations zone;

7) The principal component of the industrial plan is the center of operations consisting of the headframe, concentrator and ore handling, storage and crushing facilities and including the services building and main electrical substation. The entrance and operations zone and central circulation system are tightly organized around this center to provide for efficient flow of materials, direct service and emergency access throughout the mine/mill complex, as well as the direct distribution of piping, utilities and personnel travelways; and

8) The operations center and central circulation system provide a basic organizational framework that will minimize the extent of roadways and effectively reduce the total surface area required for the mine/mill complex.

4.3 LANDSCAPE MASSING

The landscape massing plan for the mine/mill site facilities has been developed on the basis of preserving the aesthetic and environmental character of the surrounding landscape and providing for the ultimate reclamation of the mine/mill site to a natural state. The following points summarize the parameters for the development of the landscape plan:

1) Large landscape masses are incorporated within the operations and entrance zones to reduce the perception of the overall scale of the facilities and establish a compatible visual transition between the natural environment and the scale of buildings and open spaces within the mine/mill complex;

2) The incorporation of indigenous landscape masses within the complex and the massing of native landscaping on the perimeters promotes the perception of the mine/mill complex integrated within the surrounding landscape;

3) Landscape masses are located to reinforce the basic framework of the industrial plan including main approach drive, the mine/mill operations center and the main circulation corridor;

4) Landscape masses are incorporated within the entrance zone to assist in visually screening the parking area, powerline corridors and the concentrator building;

5) Landscape masses are located to facilitate erosion, noise, and climate control; and

6) The landscape plan will promote the use of native vegetation as the basis for reclaiming the developed site to a natural state. Edge zones, comprising a variety of plant species, will be vegetated to promote natural landscape invasion and the reclamation of the mine/mill site perimeter from the start of construction. Large landscape masses will be located within the mine/mill complex to serve as colonies for the natural invasion and reclamation of the site upon the conclusion of operations.

4.4 GRADING AND DRAINAGE AND EROSION CONTROL

The considerations given to grading and drainage and erosion control in the development of the mine/mill complex emphasize the preservation of existing topography and natural drainage patterns. These considerations are summarized below:

1) The organization of facilities within the mine/mill complex promotes the preservation of the natural topography to the maximum extent possible. The entrance zone is developed to retain the character of the existing landform. The process and ancillary facilities are tightly organized to reduce the overall surface area of the operations zone and minimize the extent of disturbance to the natural topography;

2) The grading plan has been designed to maintain a cut and fill balance during construction of the mine/mill surface facilities;

3) The organization of the mine/mill complex promotes surface drainage within existing drainage patterns. Surface drainage of the operations zone is channelled to the extent possible toward the south and the Pickerel Creek drainage basin;

4) Surface drainage basins are located to the north and southeast to collect run-off for evaporation, percolation and dispersal into the natural drainage system. These retention areas will also serve as filtering basins to protect the surrounding natural areas from sediment run-off; and

5) The organization of the mine/mill complex promotes erosion control by preserving large existing landscaped areas and minimizing hard surfaces.

4.5 CLIMATE, NOISE AND DUST CONTROL

The site development plans for the mine/mill complex have given consideration to building placement, vegetative massing and landform location in order to facilitate climate, noise and dust controls. These controls are summarized below:

1) The concentrator in conjunction with the north-south ridge system and the landscape massing in the area of the main entrance will buffer the operations zone from prevailing winter winds;

2) The concentrator will be set into the existing landform to add mass to its south wall and assist in reducing noise transmission from the crushing facilities;

3) The incorporation of large landscape masses within the mine/mill complex will aid in mitigating the reflection and transmission of noise; and

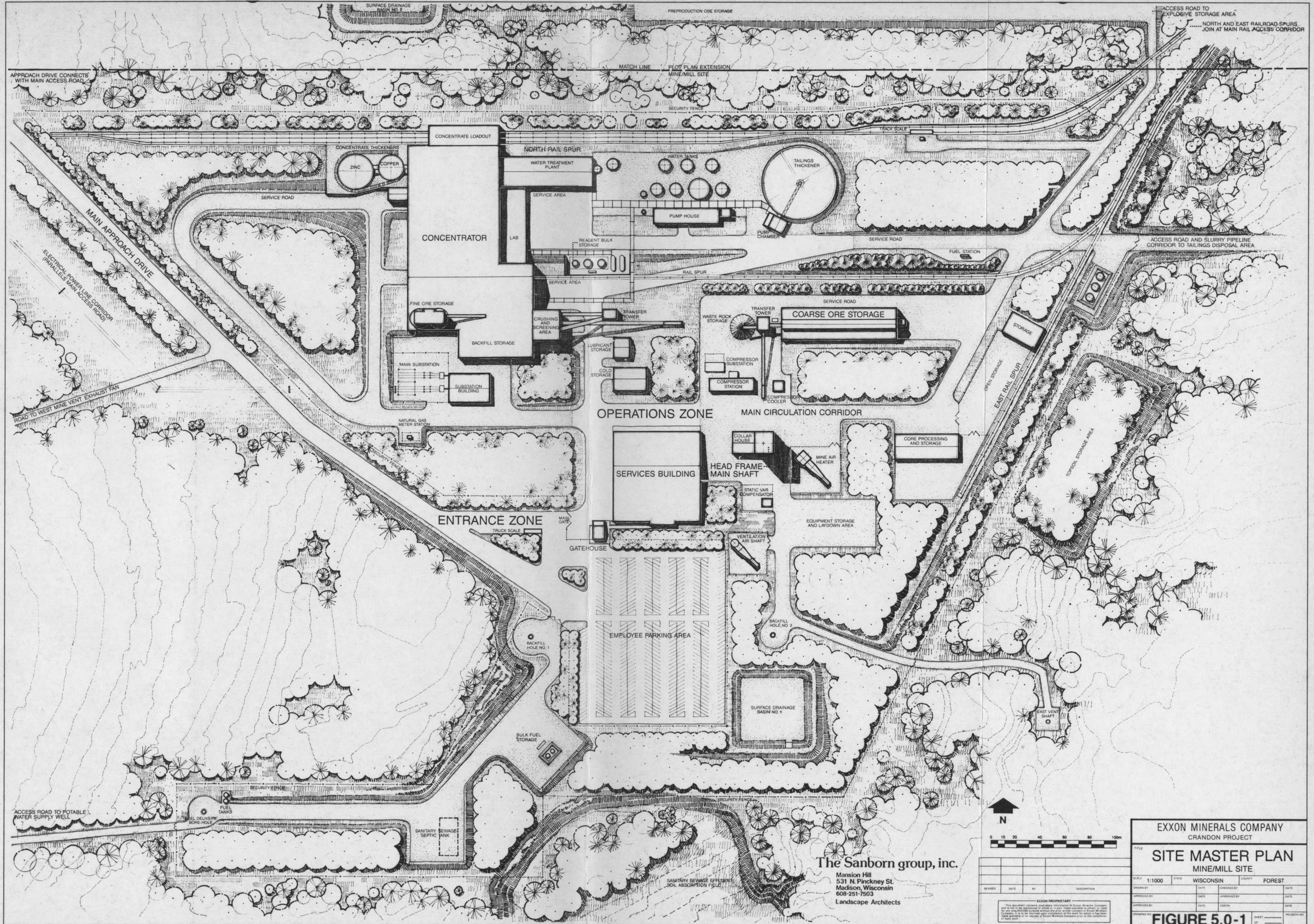
4) The incorporation of large landscape areas within the mine/mill complex will aid in mitigating the transmission of dust.

5.0 SITE MASTER PLAN

5.1 INTRODUCTION

This section of the report focuses on the Site Master Plan. This plan culminates the site development process by integrating the arrangement of facilities, site grading and drainage, and selected landscape massing into a final physical layout within defined boundaries and in the context of the surrounding natural landscape. The Site Master Plan for the immediate mine/mill complex is illustrated in Figure 5.0-1 whereas Figure 5.0-2 shows the arrangement of facilities located north of the main plant. Figure 5.0-3 is an artist's rendition depicting a three-dimensional aerial view of the overall mine/mill surface facilities.

The following discussion describes the layout of the mine/mill complex in terms of organizational and spatial pattern, circulation layout, aesthetic appearance and building design and landscape massing. This discussion divides the mine/mill complex into three components: the entrance zone, operations zone, and the perimeter zone. Following a description of these three zones, the discussion will focus on the aesthetic design of the mine/mill surface facilities. The Facilities Description section, Chapter 1.0 of the Proposed Action in the Crandon Project Environmental Impact Report (Exxon Materials Company, 1982a), supplements this report by providing a detailed description of all facilities referenced in this discussion.


SURFACE DRAINAGE BASIN NO. 2
PREPRODUCTION ORE STORAGE
ACCESS ROAD TO EXPLOSIVE STORAGE AREA
NORTH AND EAST RAILROAD SPURS JOIN AT MAIN RAIL ACCESS CORRIDOR
APPROACH DRIVE CONNECTS WITH MAIN ACCESS ROAD
MATCH LINE
PLOT PLAN EXTENSION MINE/MILL SITE
SECURITY FENCE
TRACK SCALE
CONCENTRATE LOADOUT
CONCENTRATE THICKENERS
ZINC
COPPER
NORTH RAIL SPUR
WATER TREATMENT PLANT
WATER TANKS
TAILINGS THICKENER
SERVICE ROAD
SERVICE AREA
PUMP HOUSE
PUMP CHAMBER
MAIN APPROACH DRIVE
ELECTRICAL POWER LINE CORRIDOR (PARALLELS MAIN ACCESS ROAD)
CONCENTRATOR
LAB
REAGENT BULK STORAGE
RAIL SPUR
FUEL STATION
ACCESS ROAD AND SLURRY PIPELINE CORRIDOR TO TAILINGS DISPOSAL AREA
FINE ORE STORAGE
CRUSHING AND SCREENING AREA
TRANSFER TOWER
WASTE ROCK STORAGE
COARSE ORE STORAGE
STORAGE
BACKFILL STORAGE
LUBRICANT STORAGE
COLD STORAGE
MAIN SUBSTATION
SUBSTATION BUILDING
COMPRESSOR SUBSTATION
COMPRESSOR STATION
COMPRESSOR COOLER
OPEN STORAGE
EAST RAIL SPUR
ROAD TO WEST MINE VENT EXHAUST FAN
OPERATIONS ZONE
MAIN CIRCULATION CORRIDOR
NATURAL GAS METER STATION
COLLAR HOUSE
CORE PROCESSING AND STORAGE
MINE AIR HEATER
TOPSOIL STORAGE AREA
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ENTRANCE ZONE
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TRUCK SCALE
GATEHOUSE
EQUIPMENT STORAGE AND LAYDOWN AREA
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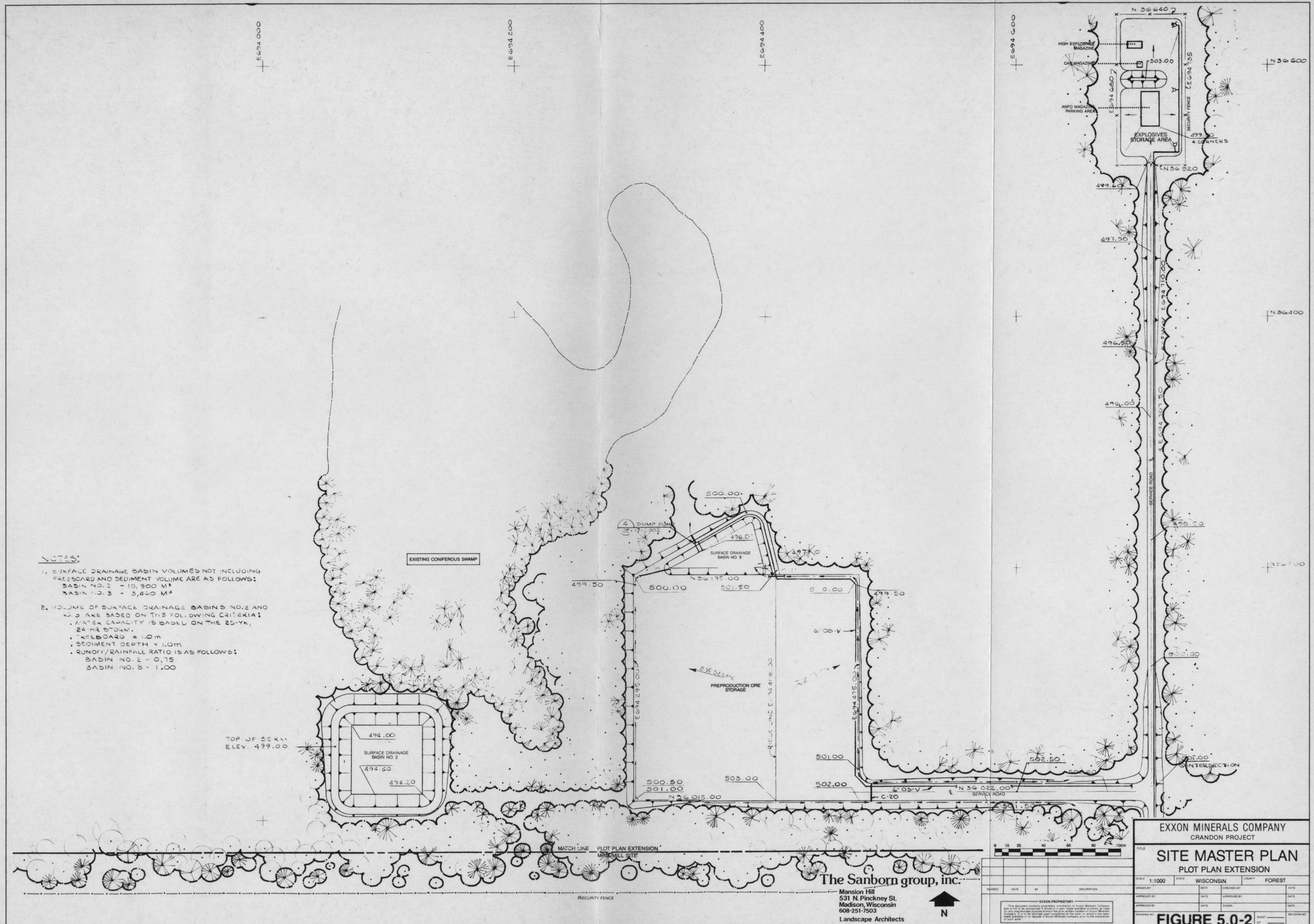
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N 36640
N 36600
N 36400
HIGH EXPLOSIVES MAGAZINE
CAP MAGAZINE
ANFO MAGAZINE PARKING AREA
EXPLOSIVES STORAGE AREA
503.00
SECURITY FENCE
499.50 4 CORNERS
N 36 620
499.60
497.50
496.50
496.00
SERVICE ROAD
EXISTING CONIFEROUS SWAMP
NOTES:
1. SURFACE DRAINAGE BASIN VOLUMES NOT INCLUDING FREEBOARD AND SEDIMENT VOLUME ARE AS FOLLOWS:
BASIN NO. 2 - 10,900 M³
BASIN NO. 3 - 3,460 M³
2. VOLUME OF SURFACE DRAINAGE BASINS NO. 2 AND NO. 3 ARE BASED ON THE FOLLOWING CRITERIA:
. WATER CAPACITY IS BASED ON THE 25-YR, 24-HR STORM.
. FREEBOARD = 1.0m
. SEDIMENT DEPTH = 1.0m
. RUNOFF/RAINFALL RATIO IS AS FOLLOWS:
BASIN NO. 2 - 0.75
BASIN NO. 3 - 1.00
SUMP PUMP
500.00
496.00
SURFACE DRAINAGE BASIN NO. 3
N 36 135.00
499.50
500.00
501.50
PREPRODUCTION ORE STORAGE
2% SLOPE
RIDGE LINE
6" OS-V
TOP OF BERM ELEV. 499.00
494.00
SURFACE DRAINAGE BASIN NO. 2
494.50
494.20
500.50
501.00
N 36 015.00
503.00
501.00
502.00
502.50
N 36 022.00
SERVICE ROAD
C-20
501.50
INTERSECTION
MATCH LINE PLOT PLAN EXTENSION
MINE/MILL SITE
SECURITY FENCE
0 10 20 40 60 80 100m
The Sanborn group, inc.
Mansion Hill
531 N. Pinckney St.
Madison, Wisconsin
608-251-7503
Landscape Architects
N
REVISED
DATE
BY
DESCRIPTION
EXXON PROPRIETARY
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
SITE MASTER PLAN
PLOT PLAN EXTENSION
SCALE 1:1000
STATE WISCONSIN
COUNTY FOREST
DRAWN BY
CHECKED BY
APPROVED BY
EXXON
DRAWING NO
FIGURE 5.0-2
SHEET
OF
REVISION NO

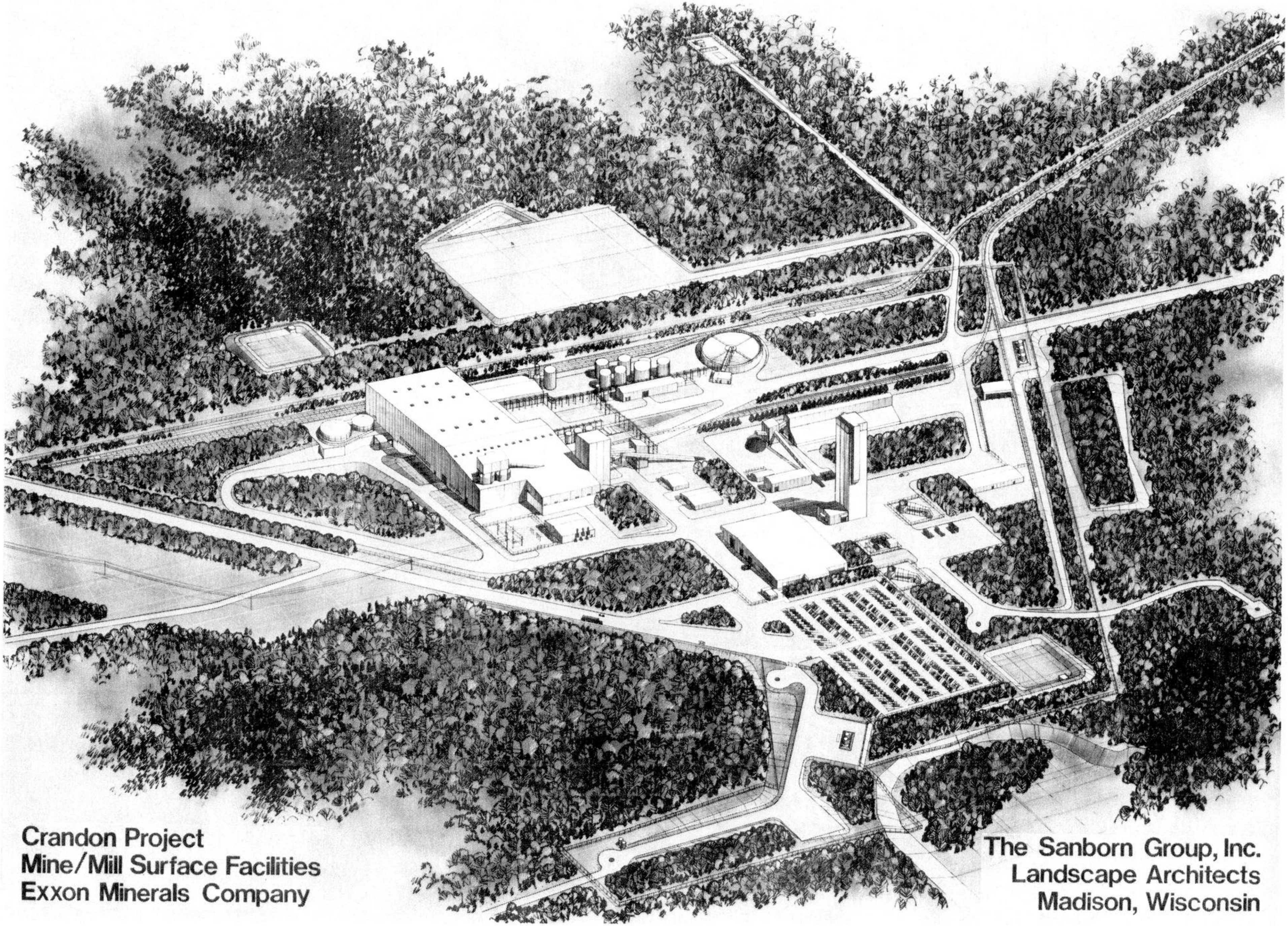

Crandon Project
Mine/Mill Surface Facilities
Exxon Minerals Company
The Sanborn Group, Inc.
Landscape Architects
Madison, Wisconsin

FIGURE 5.0-3

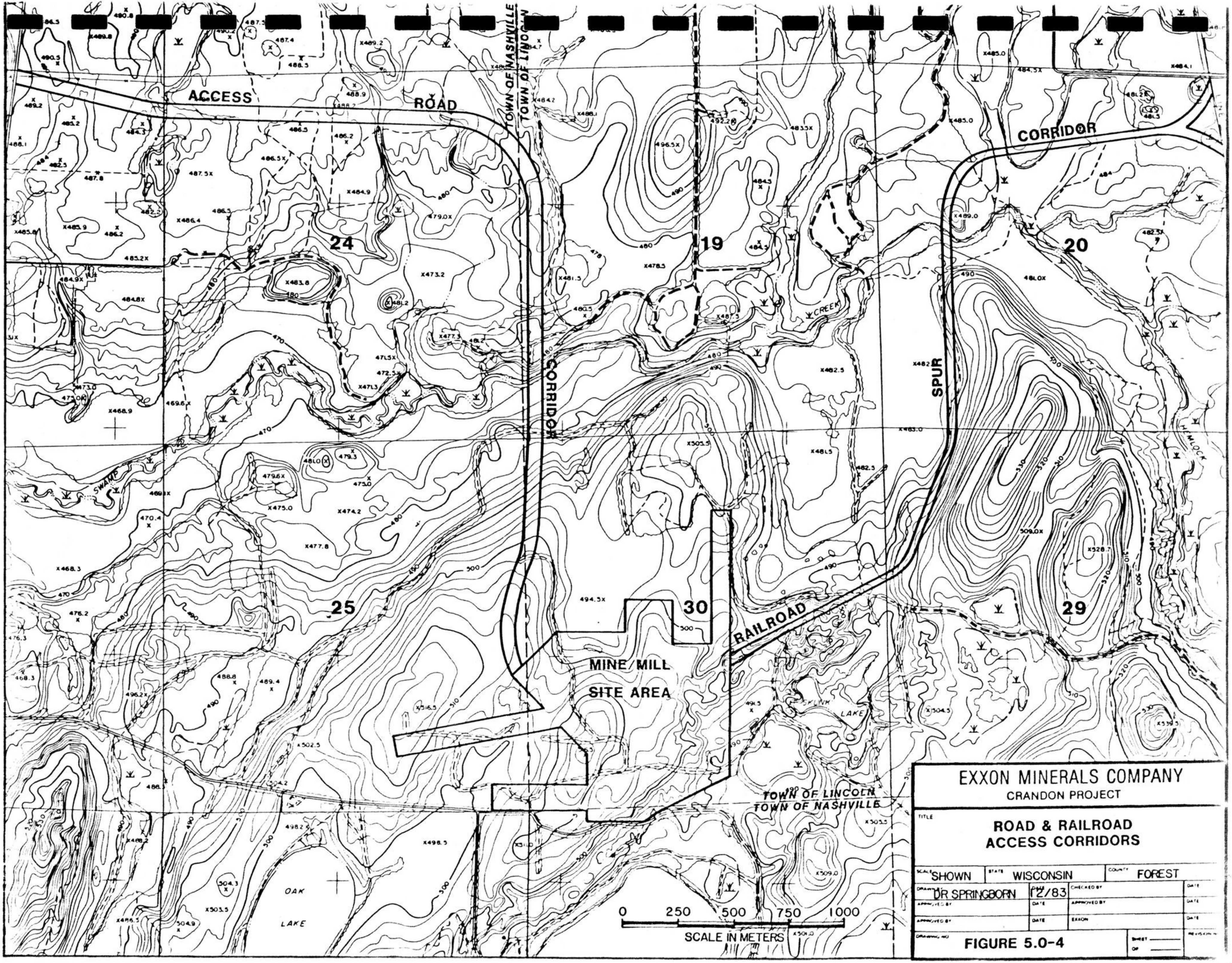
5.2 ENTRANCE ZONE

The entrance zone will be developed to provide both an aesthetically pleasing approach and a tightly controlled entrance to the mine/mill complex. The natural topography and vegetation will be preserved to the maximum extent possible with the existing ridge contributing spatial definition to the area. The development within the entrance zone will include the main approach drive to the mine/mill complex, the parking area, the gate area comprising gatehouse and truck weigh-in and the main powerline corridor.

5.2.1 Vehicle Circulation Layout

An access road will connect the mine/mill site to State Highway 55 at a point about 4.8 km (3 miles) northwest of the site (Figure 5.0-4). The alignment of this roadway will be varied along the final approach to the mine/mill site to provide a changing view orientation. A varied horizontal alignment presents alternating views between features in the surrounding landscape and intermittent focus on the headframe to maintain a sense of directional reference to the mine/mill complex.

The access road enters the mine/mill site from the northwest crossing a lowland area along a divide between two drainage corridors. From this low area, the final diagonal approach ascends the rising landform to the mine/mill entrance and gate control located just beyond the ridge dividing the entrance and operations zones. Vehicle circulation splits in the area of the main gate with truck traffic entering the truck scale to the north and employee and visitor traffic proceeding southeast to the parking area.



EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
ROAD & RAILROAD ACCESS CORRIDORS

SCALE SHOWN | STATE WISCONSIN | COUNTY FOREST
DRAWN BY DR SPRINGBORN | DATE 12/83 | CHECKED BY | DATE
APPROVED BY | DATE | APPROVED BY | DATE
APPROVED BY | DATE | EXXON | DATE
DRAWING NO

FIGURE 5.0-4

SHEET ___ OF ___

A linear massing of vegetation frames each side of the main approach drive to enhance the directional focus and assist in visually screening the powerline corridor and the concentrator building.

5.2.2 Parking

The employee parking area, located at the termination of the main approach drive, will accommodate approximately 480 vehicles. The overall size of the parking has been determined on the basis of efficient shift scheduling to maximize utilization and minimize the total surface coverage to limit disturbance to the environment. The parking area will be centrally located with respect to the gatehouse to minimize personnel travel distances. The parking area will be drained to surface drainage basin No. 1 located to the east. Landscape masses will be situated at the perimeter of the parking to visually screen this area from the entrance zone.

5.2.3 Gatehouse

The gatehouse has been located to effectively control the multiple circulation patterns to the mine/mill complex, both vehicular and pedestrian, for minimal conflict. The position of the gatehouse will provide good visual control over truck scale activities and all vehicle movement to and from the mine/mill complex. In addition to monitoring activities at the main gate to the operations zone, the gatehouse will also control access to the fuel storage and sanitary sewage treatment facilities to the south.

5.2.4 Powerline Corridor

Primary electrical power will be brought to the mine/mill site in a 60 m (200 feet) wide corridor parallel to the access road. Upon entering the site, the powerline corridor will follow the diagonal approach drive until it changes direction toward the east near the concentrator to connect with the main electrical substation.

The visual impact of the powerline corridor upon the entrance zone will be mitigated through the use of single, aesthetically designed poles to support the powerlines and the preservation of existing landscape masses along the main approach drive to partially screen the powerline corridor from view.

5.3 OPERATIONS ZONE

The operations zone will be organized to achieve an aesthetic, orderly, compact and functional arrangement of facilities while minimizing the extent of disruption to the existing terrain. The development within the operations zone will include the basic ore processing facilities, including the main shaft and headframe where mined ore is conveyed to the surface, the ore handling (conveyors), storage and crushing facilities, and the concentrator where the minerals will be separated from the ore to produce concentrates. The development will also include the process and ancillary facilities, including road and rail circulation and piping and utility distribution required to support the mine/mill operations.

5.3.1 General Organization

The operations zone will be organized on the basis of a centralized plan in which all process and ancillary facilities are tightly arranged around an operations center and an organized circulation system. This centralized plan ensures a compact arrangement of facilities and a minimum surface area coverage.

The operations zone will be contained within a controlled perimeter defined by rail lines, roadways, and a perimeter security fence. The controlled perimeter will minimize the potential for disturbance to the surrounding natural areas.

Unlike the development within the entrance zone where the character of the natural landform will be preserved to the extent possible, reconstruction of the topography will be required within the operations zone.

A new grade level at approximately +508 m (+1666 feet) will comprise the majority of the operations zone representing the main service platform for the supply of materials and equipment on the surface to the mine/mill operation. A secondary level at the approximate elevation of +500 m (+1640 feet) will be confined to an area at the northern portion of the operations zone where the final products and by-products of the mine/mill process are distributed. A sloping landscaped strip will divide these two platform levels. A perimeter slope system will provide a transition between the grade levels at the outer limits of the operations zone and the surrounding natural topography.

The general arrangement of facilities within the operations zone will be characterized by a predominantly east-west linear organization. This organizational pattern will be established in response to the basic process flow of mined ore to the crushing facilities and the distribution of tailings from the concentrator to the tailings thickener and by pipeline to the mine waste disposal facility. The main rail line forming the northern perimeter of the operations zone reinforces this pattern.

Site drainage will be designed to allow surface run-off wherever possible. The majority of the operations zone will be surface drained to surface drainage basin No. 1, located in the southeast corner of site, for dispersal into the Pickerel Creek drainage system. The northern portion of the operations zone will be surface drained to surface drainage basin No. 2, located outside the security fence north of the concentrator. Water collected in this basin will be dispersed into the Swamp Creek drainage system. These retention areas will also serve as filtering basins to protect the surrounding natural areas from sediment run-off. Drainage control zones will be established within the operations zone where potential spills could contaminate ground and surface water. Drainage in these areas will be collected and transported through an underground sewer system to treatment facilities or to the tailings thickener overflow.

Climatic control for the operations zone will be promoted through building placement, vegetative massing and landform buffers. The concentrator in conjunction with the north-south ridge system and the landscape massing in the area of the main gate will buffer prevailing northwest winds during the winter months. Additional buffering will also be accomplished with the arrangement of landscape masses along the northern perimeter of the complex as well as through the general arrangement of landscape masses within the operations zone.

The operations zone will be revegetated with landscape masses composed of low maintenance, indigenous plant associations. These masses, located for minimum interference to mine/mill operations and future facilities demolition, will serve as colonies that will aid in reclaiming the site through natural invasion at the conclusion of operations. In addition, these landscape masses will visually extend the surrounding natural landscape into the mine/mill complex and assist in perceptually reducing the physical scale of the operations zone.

5.3.2 Operations Center

The headframe, concentrator and ore handling, storage, and crushing facilities will form the nucleus and operations center of the mine/mill surface facilities. In addition to these three basic facilities, the operations center will include the services building and the main electrical substation with several other small ancillary buildings.

The services building will be centrally located to facilitate personnel movement from the gatehouse to the changing areas. This building will also house the central administrative offices, warehouse and maintenance and mechanical repair shops for both the mine/mill surface facilities and the underground mine.

The main electrical substation will be located near the concentrator and underground mine, the principal users of electrical power within the mine/mill complex. This facility will receive primary power from the above ground powerlines and distribute it to the mine/mill facilities via utility duct systems.

The entrance and operations zone will be tightly organized around the operations center to accommodate direct service, emergency access and efficient flow of materials throughout the mine/mill complex. This central core will also ensure distribution of piping and utilities along the shortest possible routes.

5.3.3 General Arrangement of Support Facilities

The following discussion describes the arrangement of process and ancillary facilities that will be organized around the operations center to comprise the remainder of the operations zone.

The reagent bulk storage, water treatment plant, water storage tanks and tailings thickener will be located adjacent to the concentrator to facilitate the mill process. The water treatment plant and tailings thickener will also be located for direct pipeline connection to the reclaim ponds and mine waste disposal facility.

The lubricant storage and cold storage facilities will be positioned adjacent to the concentrator to support its continuous operation.

The bentonite storage and timber and steel storage facilities will be located on the eastern perimeter of the operations zone for direct rail access. The bentonite storage facility also requires a direct roadway access to the mine waste disposal facility and the timber and steel storage requires a close relationship to the headframe for the transport of materials to the underground mine.

The mine air heater, ventilation air shaft, compressor station, and static VAR compensator will be clustered around the headframe because of their required connection to the main shaft.

A storage and laydown area will be located adjacent to the headframe for the temporary storage of equipment to be transported to the underground mine or to the services building for repair. The core processing and storage facility will also be located in close proximity to the headframe.

The mine backfill holes and the fuel delivery bore hole have been fixed according to the organization of the underground mine.

The bulk fuel storage will be located southwest of the operations center in a remote location to minimize fire hazard to other facilities.

The sanitary sewage treatment facility will be positioned for proximity to the soil absorption field located outside the operations zone to the south.

5.3.4 Vehicle Circulation Layout

The vehicle circulation system within the operations zone will be organized around a main circulation corridor that interconnects the surface plant facilities: headframe, coarse ore storage, concentrator, services building and electrical substation. This corridor is routed to the northeast beyond the operations zone and will terminate at the explosives storage area. In addition to this east-west corridor, a principal north-south roadway will link the main gate with the center of the operations zone. This roadway will extend to the north to service the east side of the concentrator, the water treatment plant, water tanks and the tailings thickener. It will extend to the south to service the bulk fuel storage facility, sewage treatment facility and fuel delivery borehole. Other secondary circulation corridors will extend from this basic east-west and north-south system to link all other process and ancillary facilities to the operations center.

The organization of vehicle circulation within the operations zone will allow for the efficient flow of materials, direct service and emergency access throughout the mine/mill complex.

5.3.5 Rail Circulation Layout

The primary rail access for the mine/mill surface facilities will originate at the Soo Line Railroad about 4.8 km (3 miles) northwest of the mine/mill site. The layout of this corridor is shown in Figure 5.0-4.

Rail access will divide at the point of entry into the mine/mill site in order to service several different facilities within the operations zone. The main railroad spur will travel west to the north side of the concentrator where materials and supplies will be off-loaded and where concentrates will be on-loaded for shipment. This rail line will form the entire northern perimeter of the main plant terminating at the northwest corner of the site. A smaller spur will form the east boundary of the operations zone, travelling southwest to service the bentonite storage and timber and steel storage facilities. An additional rail spur will separate from this line and travel west to supply the reagent storage area and the primary grinding section of the concentrator.

These rail lines will define the north and east physical limits of the operations zone. The grading of these edges will include the construction of berms and swales to confine and channel site drainage to the surface drainage basins.

5.4 PERIMETER ZONE

The perimeter zone encompasses the ancillary facilities and their respective access roads located outside the security fence enclosing the main mine/mill complex.

Facilities to be located north of the main plant (Figure 5.0-2) will include the surface drainage basin No. 2, the preproduction ore storage area and the explosives storage area. Surface drainage basin No. 2 will be designed to collect surface water and sediment run-off from the northern portion of the mine/mill complex. The preproduction ore storage facility will be designed to handle the ore collected during the construction of the underground mine prior to the operation start-up for the surface facilities. This facility will also include a drainage basin for the collection of precipitation within this area. The explosives used in the construction and operation of the underground mine will be stored in the explosives storage area in an approved location remote from all other facilities.

An area for the storage of topsoil collected during the construction of the mine/mill surface facilities will be located directly east of the main plant. Topsoil stockpiled in this area will be used in landscaping at the completion of construction activities and for reclamation of the site at the completion of mine/mill operations. Between these two periods, this area will be landscaped in a manner consistent with the surrounding natural environment.

The soil absorption field for the mine/mill sanitary sewage treatment system will be located directly south of the main plant. This area will be maintained as a clear zone throughout the life of the Project.

Mine vent shafts will be located east and west of the main plant in positions fixed according to the organization of the underground mine. Access roads will extend from the main plant to these facilities.

Potable water for use within the mine/mill surface facilities will be pumped from a well located southwest of the main plant. A separate access road will provide a connection to this facility.

The perimeter zone will also include the clear zone located immediately outside the security fence. This clear zone will be maintained for fire control as well as for security reasons and to restrict the invasion of the surrounding vegetation into the operations zone. During clearing of the mine/mill site, the forest edge will be maintained in an irregular pattern to add visual interest. Plant species will be added to this edge to enhance the landscape aesthetics and to provide wildlife habitat.

Construction of facilities within the perimeter zone will be accomplished with minimal disruption to the natural environment. Grading operations will maintain the existing topography to the extent possible and the clear zones surrounding these facilities will be kept to a minimum.

5.5 AESTHETIC DESIGN OF THE SURFACE FACILITIES

The mine/mill surface facilities will be designed to maintain the highest possible standards of engineering performance and to provide an aesthetically-pleasing appearance compatible with the surrounding environment. An artist's rendition (Figure 5.0-3) depicts a three-dimensional aerial view of the mine/mill complex for the purpose of describing its overall aesthetic appearance and organizational pattern within the context of the surrounding environment.

The color for the mine/mill surface facilities will be selected to promote aesthetic compatibility with the surrounding natural areas and achieve a strong, unified character and visual identity for the mine/mill surface facilities.

All facilities, with the exception of the headframe, will be designed for steel construction and exterior corrugated metal wall system. The exterior walls of these facilities will be designed to maintain a clean, aesthetic appearance.

The concentrator, the largest structure on the site in building height and surface area coverage, has been set into the existing landform to reduce its scale relative to adjacent facilities and surrounding vegetation. The vertical and horizontal mass of this structure has been broken up to reflect the diversity of its interior function.

The headframe, approximately 76 m (250 feet) in height from grade level, is designed as a simple rectangular, vertical shaft of slip-form poured-in-place reinforced concrete construction. Its contrasting materials and vertical scale with respect to adjacent facilities serve to make this structure a strong visual focus and orientation point for the approach into the mine/mill complex. At the same time, this structure, when seen from a distance, will blend into the surroundings due to its natural coloration and the fineness of its profile.

While the form, color and texture of the individual buildings contribute toward a positive visual perception of the mine/mill complex, the basis for an aesthetically-pleasing complex lies in the well-organized, efficient, environmentally compatible and visually pleasing arrangement of facilities. Preserving the natural landscape, varying the views along the approach drive, establishing a strong entrance with a sense of arrival and a visual focus, providing clear and direct circulation patterns, and mitigating the visual impact of dominant structures are all important considerations that will establish a strong aesthetic character for the Crandon Project mine/mill surface facilities.

6.0 LANDSCAPE PLAN

6.1 INTRODUCTION

The development of the Landscape Plan is an outgrowth of the organizational framework defined by the Site Master Plan which culminated the site planning process by integrating the facility arrangement, site grading, drainage and landscape treatment into a physical plan. Figure 6.0-1 describes the Landscape Plan for the immediate mine/mill site while Figure 6.0-2 describes the landscape massing for those facilities located north of the main plant. An artist's rendition (Figure 5.0-3) illustrates a three-dimensional view of the landscape massing for the overall mine/mill surface facilities.

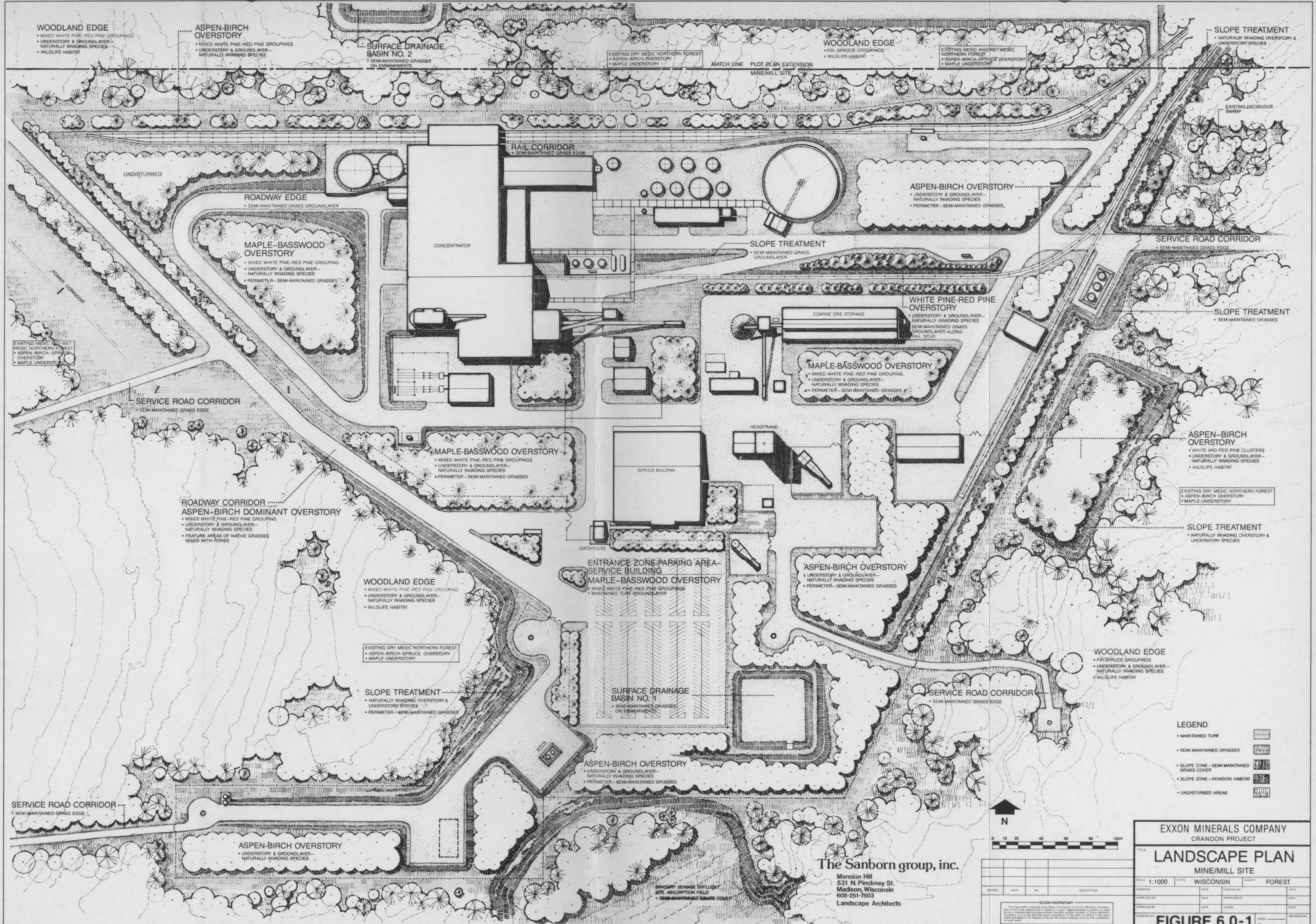
The Landscape Plan for the Crandon mine/mill surface facilities has been developed to meet the following objectives:

1) Development of a landscape plan for the revegetation of the mine/mill site that is compatible with the functional, aesthetic and environmental character of the surrounding landscape;

2) Utilization of indigenous plant communities to maintain the character of the surrounding environment; and

3) Inclusion of plant species which will aid in long-term reclamation of the mine/mill site to a natural state.

Revegetation of the mine/mill site will begin during the site construction phase and involve the installation of overstory, understory and groundlayer plantings. Concurrently, vegetative reclamation of the disturbed earth surface will control erosion and permit invasion of native plant species. At the conclusion of project operation, revegetation completed during construction of the mine/mill facilities will become the foundation for final site reclamation.



WOODLAND EDGE
• MIXED WHITE PINE-RED PINE GROUPINGS
• UNDERSTORY & GROUNDLAYER–NATURALLY INVADING SPECIES
• WILDLIFE HABITAT
ASPEN-BIRCH OVERSTORY
• MIXED WHITE PINE-RED PINE GROUPINGS
• UNDERSTORY & GROUNDLAYER–NATURALLY INVADING SPECIES
SURFACE DRAINAGE BASIN NO. 2
• SEMI-MAINTAINED GRASSES ON EMBANKMENTS
EXISTING DRY MESIC NORTHERN FOREST
• ASPEN-BIRCH OVERSTORY
• MAPLE UNDERSTORY
MATCH LINE PLOT PLAN EXTENSION MINE/MILL SITE
WOODLAND EDGE
• FIR-SPRUCE GROUPINGS
• WILDLIFE HABITAT
EXISTING MESIC AND WET MESIC NORTHERN FOREST
• ASPEN-BIRCH-SPRUCE OVERSTORY
• MAPLE UNDERSTORY
SLOPE TREATMENT
• NATURALLY INVADING OVERSTORY & UNDERSTORY SPECIES
EXISTING DECIDUOUS SWAMP
RAIL CORRIDOR
• SEMI-MAINTAINED GRASS EDGE
UNDISTURBED
ROADWAY EDGE
• SEMI-MAINTAINED GRASS GROUNDLAYER
CONCENTRATOR
ASPEN-BIRCH OVERSTORY
• UNDERSTORY & GROUNDLAYER–NATURALLY INVADING SPECIES
• PERIMETER–SEMI-MAINTAINED GRASSES
MAPLE-BASSWOOD OVERSTORY
• MIXED WHITE PINE-RED PINE GROUPING
• UNDERSTORY & GROUNDLAYER–NATURALLY INVADING SPECIES
• PERIMETER–SEMI-MAINTAINED GRASSES
SLOPE TREATMENT
• SEMI-MAINTAINED GRASS GROUNDLAYER
SERVICE ROAD CORRIDOR
• SEMI-MAINTAINED GRASS EDGE
POWER CORRIDOR
WHITE PINE-RED PINE OVERSTORY
• UNDERSTORY & GROUNDLAYER–NATURALLY INVADING SPECIES
• SEMI-MAINTAINED GRASS GROUNDLAYER ALONG RAIL SPUR
COARSE ORE STORAGE
SLOPE TREATMENT
• SEMI-MAINTAINED GRASSES
EXISTING MESIC AND WET MESIC NORTHERN FOREST
• ASPEN-BIRCH-SPRUCE OVERSTORY
• MAPLE UNDERSTORY
MAPLE-BASSWOOD OVERSTORY
• MIXED WHITE PINE-RED PINE GROUPING
• UNDERSTORY & GROUNDLAYER–NATURALLY INVADING SPECIES
• PERIMETER–SEMI-MAINTAINED GRASSES
SERVICE ROAD CORRIDOR
• SEMI-MAINTAINED GRASS EDGE
HEADFRAME
MAPLE-BASSWOOD OVERSTORY
• MIXED WHITE PINE-RED PINE GROUPINGS
• UNDERSTORY & GROUNDLAYER–NATURALLY INVADING SPECIES
• PERIMETER–SEMI-MAINTAINED GRASSES
SERVICE BUILDING
ASPEN-BIRCH OVERSTORY
• WHITE AND RED PINE CLUSTERS
• UNDERSTORY & GROUNDLAYER–NATURALLY INVADING SPECIES
• WILDLIFE HABITAT
EXISTING DRY MESIC NORTHERN FOREST
• ASPEN-BIRCH OVERSTORY
• MAPLE UNDERSTORY
ROADWAY CORRIDOR
ASPEN-BIRCH DOMINANT OVERSTORY
• MIXED WHITE PINE-RED PINE GROUPING
• UNDERSTORY & GROUNDLAYER–NATURALLY INVADING SPECIES
• FEATURE AREAS OF NATIVE GRASSES MIXED WITH FORBS
SLOPE TREATMENT
• NATURALLY INVADING OVERSTORY & UNDERSTORY SPECIES
GATEHOUSE
ENTRANCE ZONE-PARKING AREA-SERVICE BUILDING
MAPLE-BASSWOOD OVERSTORY
• MIXED WHITE PINE-RED PINE GROUPINGS
• MAINTAINED TURF GROUNDLAYER
ASPEN-BIRCH OVERSTORY
• UNDERSTORY & GROUNDLAYER–NATURALLY INVADING SPECIES
• PERIMETER–SEMI-MAINTAINED GRASSES
WOODLAND EDGE
• MIXED WHITE PINE-RED PINE GROUPING
• UNDERSTORY & GROUNDLAYER–NATURALLY INVADING SPECIES
• WILDLIFE HABITAT
EXISTING DRY MESIC NORTHERN FOREST
• ASPEN-BIRCH-SPRUCE OVERSTORY
• MAPLE UNDERSTORY
WOODLAND EDGE
• FIR-SPRUCE GROUPINGS
• UNDERSTORY & GROUNDLAYER–NATURALLY INVADING SPECIES
• WILDLIFE HABITAT
SLOPE TREATMENT
• NATURALLY INVADING OVERSTORY & UNDERSTORY SPECIES
• PERIMETER–SEMI-MAINTAINED GRASSES
SURFACE DRAINAGE BASIN NO. 1
• SEMI-MAINTAINED GRASSES ON EMBANKMENTS
SERVICE ROAD CORRIDOR
• SEMI-MAINTAINED GRASS EDGE
ASPEN-BIRCH OVERSTORY
• UNDERSTORY & GROUNDLAYER–NATURALLY INVADING SPECIES
• PERIMETER–SEMI-MAINTAINED GRASSES
SERVICE ROAD CORRIDOR
• SEMI-MAINTAINED GRASS EDGE
ASPEN-BIRCH OVERSTORY
• UNDERSTORY & GROUNDLAYER–NATURALLY INVADING SPECIES
SANITARY SEWAGE EFFLUENT SOIL ABSORPTION FIELD
• SEMI-MAINTAINED GRASS COVER
LEGEND
• MAINTAINED TURF
• SEMI-MAINTAINED GRASSES
• SLOPE ZONE–SEMI-MAINTAINED GRASS COVER
• SLOPE ZONE–INVASION HABITAT
• UNDISTURBED AREAS
N
0 10 20 40 60 80 100m
The Sanborn group, inc.
Mansion Hill
531 N. Pinckney St.
Madison, Wisconsin
608-251-7503
Landscape Architects
REVISED
DATE
BY
DESCRIPTION
EXXON PROPRIETARY
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE
LANDSCAPE PLAN
MINE/MILL SITE
SCALE 1:1000
STATE WISCONSIN
COUNTY FOREST
DRAWN BY
DATE
CHECKED BY
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APPROVED BY
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EXXON
DATE
DRAWING NO
FIGURE 6.0-1
SHEET
OF
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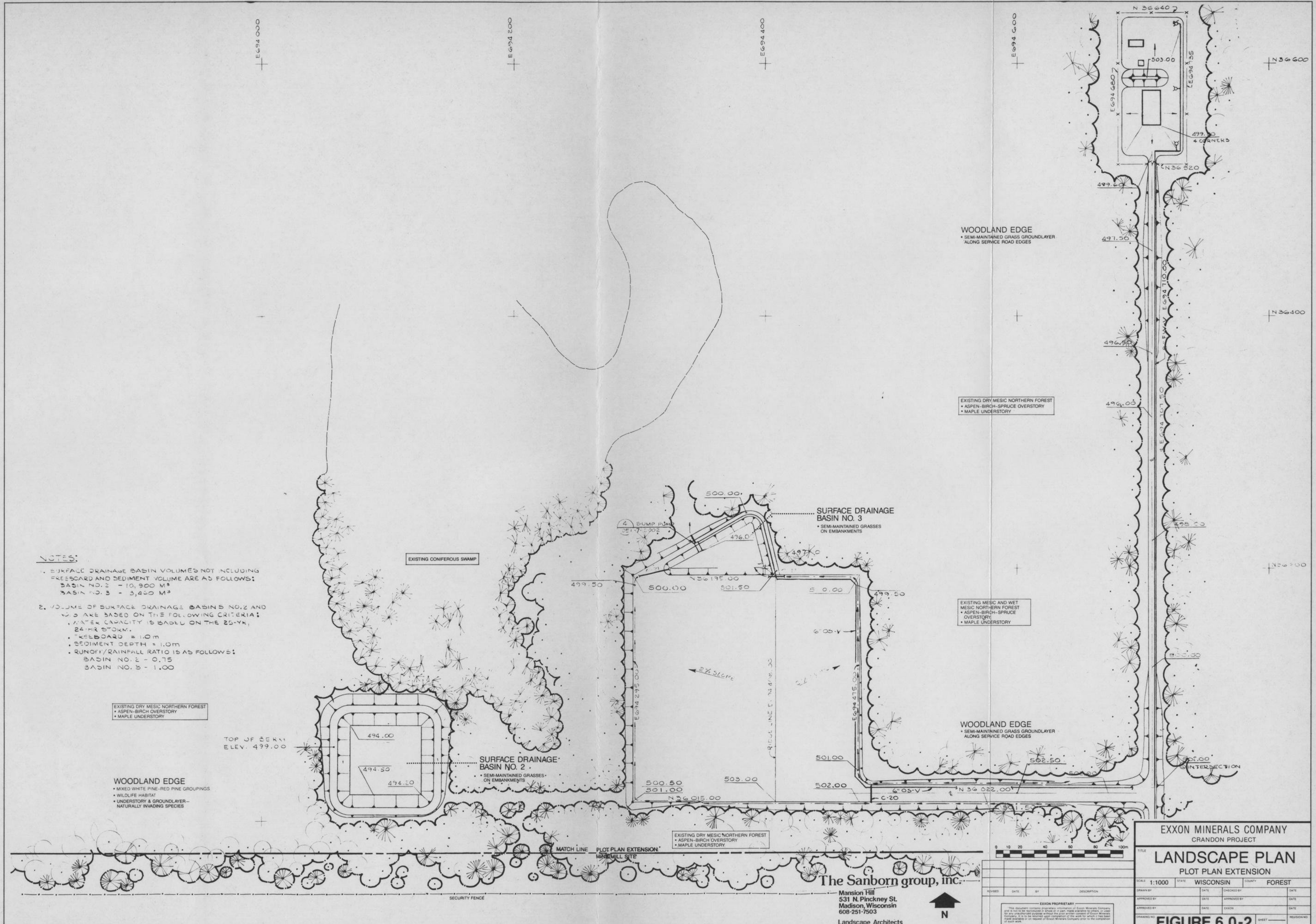

The Sanborn group, inc.
Mansion Hill
531 N. Pinckney St.
Madison, Wisconsin
608-251-7503
Landscape Architects

REVISED	DATE	BY	DESCRIPTION

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EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
LANDSCAPE PLAN
PLOT PLAN EXTENSION

SCALE 1:1000	STATE WISCONSIN	COUNTY FOREST

DRAWN BY	DATE	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY	DATE
APPROVED BY	DATE	EXXON	DATE

DRAWING NO. **FIGURE 6.0-2** SHEET ___ OF ___ REVISION NO.

Pre-operation and post-operation revegetation of the mine/mill site will utilize progressive plant succession: the staged evolution of a forest that is initiated by the invasion of next-generation species into the forest understory. Plants established as part of the landscape and reclamation programs and undisturbed plant communities will provide the necessary vegetative basis to initiate the successional process.

Development of a landscape compatible with the mine/mill site requires an understanding of ecological conditions including soils, topography, moisture and orientation present in the existing landscape. Native landscapes exhibit a species diversity and visual interest that result from variations in these ecological conditions (Curtis, 1959). By understanding these conditions, revegetation of the mine/mill site following construction can be accomplished in a manner compatible with the undisturbed portion of the site, can improve wildlife habitat and can provide for future site reclamation at the conclusion of mine/mill operations.

In addition to the supporting references that have been cited in this report, several others have been used in its preparation, including:

1) Deciduous Forests of Eastern North America by Lucy E. Braun, New York: Hafner Press, 1967.

2) R. Guries, 1983, Dept. of Forestry, University of Wisconsin-Madison, personal communication, Oct. 31, 1983.

3) E.R. Hasselkus, 1983, Dept. of Horticulture, University of Wisconsin-Madison, personal communication, Nov. 2, 1983.

4) E. Howell, 1983, Dept. of Landscape Architecture, University of Wisconsin-Madison, personal communication, Oct. 31, 1983.

5) C. Locey, 1983, Wisconsin DNR-Tomahawk, Silviculturalist, personal communication, Nov. 16, 1983.

6.2 EXISTING SITE CONDITIONS

Key ecological features of the natural landscape were identified through investigation of existing site conditions and are presented and discussed in Section 2.0, Inventory and Analysis, of this report. This investigation provided a comprehensive understanding of the natural landscape encompassing the mine/mill site and assisted the landscape architect in making planning decisions related to the arrangement of the facilities and the selection and placement of plant materials needed to restore the site.

6.2.1 Landform and Drainage

The regional landscape of the Crandon area was created by the most recent glaciation of Wisconsin, resulting in the various landforms and drainage corridors in the region. Landforms are typically morraines perched on outwash plains and interspersed with the old outwash channels of melting glacial waters. These present-day drainage corridors, basins and wetland plant communities define the morraine-like landform system upon which the site is located. Several sub-drainageways extend from the lowlands and penetrate the upland fringes of the mine/mill site. The wetland communities in these areas are described in The Wetlands Assessment Report (Normandeau Associates, Inc. and Interdisciplinary Environmental Planning, Inc., 1982). The site straddles a ridge system that is formed by a series of elongated, elliptical hills. The site drains to two major drainage basins, the Swamp Creek drainage system to the north and the Pickerel Creek system to the south.

6.2.2 Soils

Soils of the site region vary with the majority of the area being an upland loam and the lowlands composed of poorly drained loams, mucks and peats.

Soils of the immediate site have been identified as Iron River Stony Loam, a silt loam 71 to 107 cm (28 to 42 inches) thick developed from 61 cm (24 inches) of silty sediment over an acidic sandy loam glacial till (USDA, Soil Conservation Service, 1978). The potential exists for a perched water table because of a compacted, low permeable, silty soil layer. This condition, however, may be altered in areas that will be graded during site preparation and construction of mine/mill surface facilities. Iron River soils occur largely on uplands with the potential for native vegetation being maple/basswood forest. Poorly drained loams which extend up drainage corridors to the site perimeter are classified as Monico Stony Loam and occupy relatively small land areas. Little, if any, of this soil type occurs within the Project perimeter.

6.2.3 Vegetation

The mine/mill site is located north of the tension zone (Curtis, 1959), which divides Wisconsin into two major floristic provinces:

1) The northern hardwoods province of mixed conifers and hardwoods which are adapted to short, wet summers and long, cold winters; and

2) The southern prairie-forest province, a prairie-forest border community adapted to longer, drier summers and shorter, milder winters (Curtis, 1959).

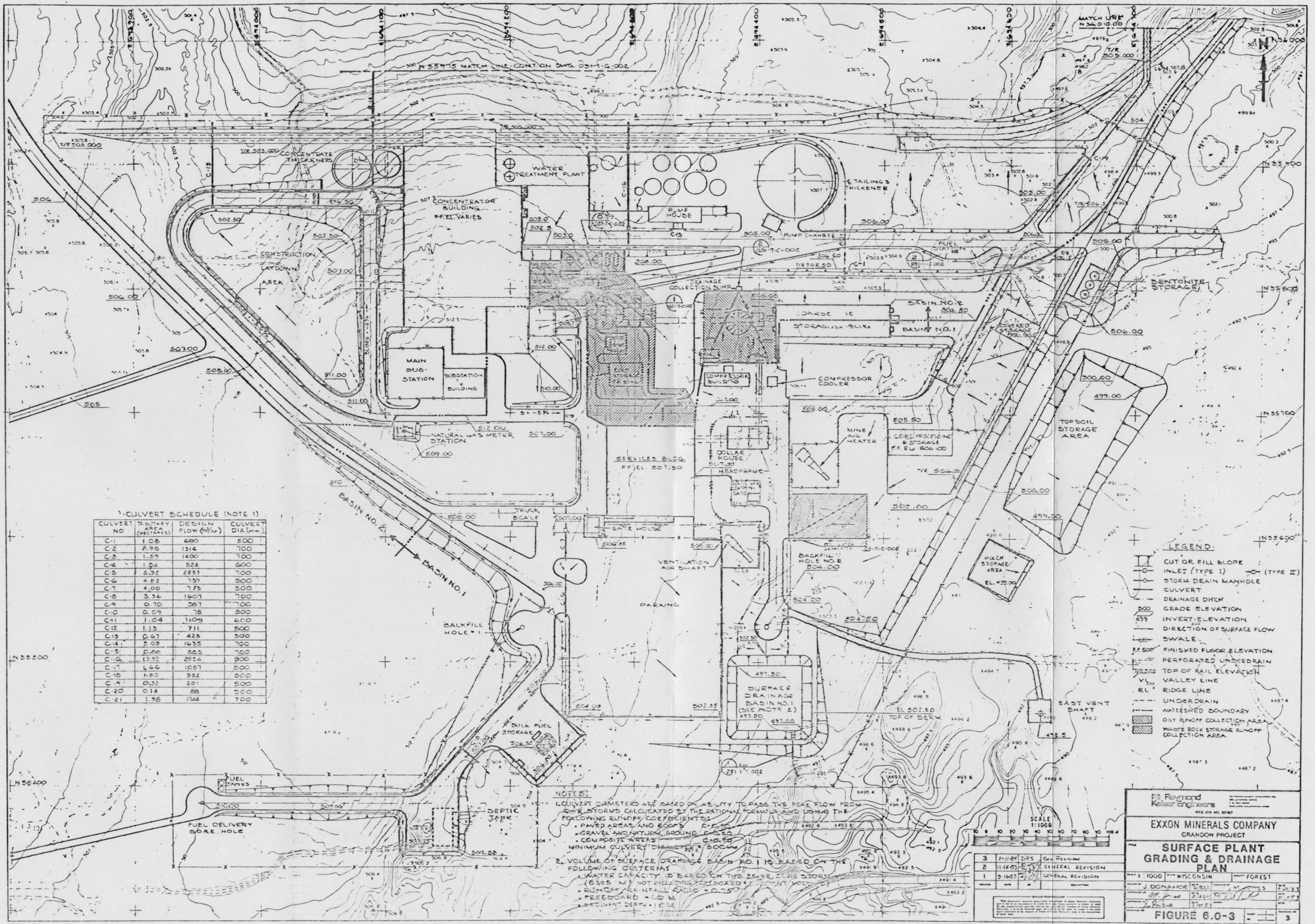
Early survey records of the state reveal that vegetation prior to the lumbering of the mid-1800's provided a relatively continuous vegetative cover of forest, savanna-like pine barrens or scrub lands. Vast stands of mixed conifers and hardwoods, dominated by hemlock, sugar maple, yellow birch and white pine, were prominent in the Project region (Finley, 1976) and generally corresponded to the heavier loamy soils of the region. Interspersed with the vast woodlands were a variety of wetland communities, generally dominated by tamarack and white cedar; and dry upland settings of thin soils occupied by jack pine and red pine. Because of lumbering operations in the area, little of the original vegetation presently exists. Currently, second-growth woodlands, including aspen, birch and red maple, have invaded the hillsides (Curtis, 1959).

The mine/mill site typifies this second-growth condition. Dominant deciduous species in the overstory consist of aspen and birch with an understory of sugar maple seedlings. Upland drainage corridors of black spruce, white cedar and fir penetrate the perimeter of the site and eventually channel run-off to Swamp Creek. These wet sites are often bog or coniferous swamp communities supporting stands of black spruce, balsam fir and white cedar (Exxon Minerals Company, 1982a; Steigerwaldt, 1982; and Normandeau Associates, Inc. and Interdisciplinary Environmental Planning, Inc., 1982).

6.3 CONSTRUCTED SITE CONDITIONS

The layout of the mine/mill facilities and grading of the site was determined by operational requirements of the surface facilities, a geometric approach to vehicular roadway alignment, run-off and erosion control measures, and aesthetic considerations concerned with maintaining visual continuity with the surrounding landscape. The purpose of the proposed site organization scheme is to integrate the site layout, constructed landforms and landscape plantings into the existing woodland environment. The proposed layout of mine/mill surface facilities minimizes the amount of vegetative clearing and grubbing that will be required during site development. The edges of the cleared site will be given an irregular perimeter which will be reinforced during the landscape process with forest edge plants and wildlife habitat to provide a smooth transition between forested and cleared areas.

In the mine/mill site approximately 46 ha (114 acres) of land will be cleared of existing vegetation. Marketable timber will be harvested for pulp and sawlogs. Slash and brush will be chipped, stockpiled, and used for mulch during landscape operations. Topsoil will be salvaged and stockpiled. The site will then be graded to accommodate roadways, structures and service areas. The entrance zone and drainageways will receive priority for reapplication of topsoil. The Surface Plant Grading and Drainage Plan prepared by Raymond Kaiser Engineers, 1983 (Figure 6.0-3) and the Erosion Control Program (Crandon Project Reclamation Plan, Exxon Minerals Company, 1982b) provide a description of grading operations and topsoil reapplication.



CULVERT SCHEDULE (NOTE 1)

CULVERT NO	TRIBUTARY AREA (HECTARES)	DESIGN FLOW (m³/hr)	CULVERT DIA (mm)
C-1	1.08	680	500
C-2	2.98	1314	700
C-3	1.59	1400	700
C-4	1.04	524	600
C-5	5.92	2237	700
C-6	4.82	737	500
C-7	4.00	713	500
C-8	3.36	1607	700
C-9	0.70	587	700
C-10	0.09	78	500
C-11	1.04	1109	600
C-12	1.13	711	500
C-13	0.67	425	500
C-14	3.09	1635	700
C-15	0.66	553	700
C-16	13.92	2954	800
C-17	4.66	1057	500
C-18	1.80	952	500
C-19	0.32	201	500
C-20	0.14	88	500
C-21	1.98	1744	700

6.3.1 Constructed Site Soil Conditions

Existing soils of the mine/mill site are coarse in texture and moderately well drained (USDA, Soil Conservation Service, 1978). In a natural state, these soils provide conditions favored by the dominant aspen/birch overstory and the maple/basswood understory. These natural soil conditions, however, will be disturbed when the site is regraded for the mine/mill facilities.

The constructed site will create changes in topography and soil moisture when compared to pre-construction conditions. Earthwork operations will disturb and intermix the soil profiles of the site, thereby modifying their climatic exposure, internal drainage, surface gradients and run-off characteristics. Excavated sandy loam subsoils supply much of the required earth for grading operations. Berms and embankments will be drier, especially where side slopes will be oriented south or west. Conversely, construction of drainage swales and surface drainage basins will create wet areas with soils that are periodically saturated.

Cuts in the existing subsoil up to 7 m (23 feet) will be made for the main approach drive and fills up to 7 m (23 feet) will be required where the rail line leaves the mine/mill complex. Throughout the site, subsoil conditions will be exposed as a result of cut and fill operations leaving a finished surface of sandy loam materials. Side slopes, cut embankments and new landforms will be maintained at a maximum 1.5:1 slope. In general, the constructed site will be drier, less fertile, and exhibit greater variation in slope and soil moisture conditions than what currently exists on the site.

6.4 LANDSCAPE PLAN DEVELOPMENT

The constructed site will exhibit differing physiographic conditions that favor distinct plant communities. The characteristics of plant communities indigenous to northern Wisconsin have been documented by Curtis (1959) who defines the existing plant structure in terms of a continuum of soil, moisture and physiographic conditions. Species representative of plant communities indigenous to the site area will be used to landscape the mine/mill site. Plant selection will be based on the adaptability of species to post-construction site conditions, and on commercial availability.

6.4.1 Overstory Plant Selection

In the Project site area, the most widespread overstory forest cover is the upland mixed hardwood forest (maple/basswood and aspen/birch), followed by smaller areas of forested and non-forested wetlands (Exxon Minerals Company, 1982a). Disruption of the maple/basswood (mesic) canopy by fire and lumbering has resulted in drier, more exposed forest floor conditions favoring the invasion of aspen/birch (dry-mesic forest) and pine (xeric forest). Once the aspen overstory has been established, species of the maple/basswood community will invade and become established in the understory. Over time, woodland succession will be completed as the aspen die out and are replaced with maple and basswood overstory (Curtis, 1959). This same process will be employed for overstory revegetation of the majority of the mine/mill site.

Plants of the pine community will be used in conjunction with other communities to screen mine/mill facilities, provide year-round color, moderate winds and provide wildlife habitat. This community can also invade drier and more exposed sites.

Plants of the aspen/birch community will comprise the majority of the overstory vegetation used throughout the site. This community is also well suited to dry, exposed sites. Large masses of these plantings will occupy a central location in the operations zone. Rapid growth and rapid maturity to seed producing age are characteristic of this community (Daniel et al., 1979; USDA, Forest Service, 1974a). Once established, members of this community will be the dominant invaders of the site's groundlayer and will ultimately restore the site's forest cover. In addition to a re-vegetating role, the aspen/birch community will create valuable wildlife habitat. This plant community and adjoining shrub and grassland edge will be attractive to upland game birds and small animals. Further improvements in wildlife habitat will occur with the use of understory plants selected for their food and cover value for wildlife (Appendix C). Other species and management alternatives that will be considered for use in landscape and reclamation planning for wildlife are presented in Barr Engineering Co., et al (1980).

The maple/basswood community will be planted in select locations in the entrance zone. In the existing forest setting, this community normally becomes established in an aspen/birch overstory. Because of the dry, exposed conditions of the site, species in this community will require more attention at the time of planting. These species will be planted near the services building, adjacent to the employee parking area, along the main approach drive, and along the main circulation corridor within the operations zone.

At the conclusion of mine/mill operations, the aspen/birch and maple/ basswood communities will provide an immediate seed source for reforesting the new open spaces left by the mine/mill surface facilities, roadways, and rail corridors.

Appendix B of this report provides a list of native plant communities indigenous to the Project site and lists specific overstory plants in each community which would be suitable for use in revegetating the site. The individual plants on the list have been selected because of their dominance in the regional landscape (Curtis, 1959), potential adapatability to the constructed site, and commercial availability (USDA, Forest Service, 1979; USDA, Forest Service, 1981; Wisconsin Nurserymen's Association, 1983).

6.4.2 Groundlayer Vegetation Selection

Establishment of groundlayer vegetation will immediately follow site clearing, earthwork and facility construction operations as the primary method of ground surface stabilization and erosion control. Two separate stages of groundlayer installation occur during the mine/mill construction.

The first stage will involve temporary vegetation for stabilization and erosion control of the site immediately following clearing and grading operations. At this time, all areas of the site will be brought to approximate finish grade. Interior areas of the site which will not be built upon immediately will be sown with a mixture of grasses and legumes selected from the tables presented in Appendix D. The grass varieties listed have been selected for their ability to adapt to low fertility levels, low pH and dry conditions. A list of legumes has also been included because their nitrogen-fixing capabilities will increase soil fertility, thereby promoting growth of the grasses. The selected seed mixture will control erosion and start the soil rebuilding process until the site is used for new facility construction.

The second stage will involve establishing permanent vegetation following facility construction on the interior site. In the areas of the site disturbed for the second time, three groundlayer vegetation treatments will be provided.

The first groundlayer treatment involves the establishment of maintained turf in high visibility areas, including the entrance zone, the area surrounding the services building, and the employee parking area. The maintained turf plant materials will be selected from the sod forming families including bluegrasses, fescues and ryes. These lawn grasses will stabilize the soil around the entrance zone facilities and also provide an easily maintained surface for the public area of the mine/mill site.

The second treatment involves a semi-maintained groundlayer approximately 46 cm (18 inches) in height. Roadway edges, the rail corridors, drainage ditches and cut slopes and embankments typify this condition. These spaces necessitate a low-growing groundlayer requiring plants selected from the list of grasses and legumes presented in Appendix D. The grass-legume mixture will consist of approximately 50 percent sod forming grasses in addition to the deep rooting clump grasses and legumes. The purpose of the sod forming grasses will be to minimize invasion of native trees and shrubs in spaces adjoining Project facilities where they would not be desirable. Sod forming grasses are also preferable for drainageways because they offer better erosion control characteristics.

The third groundlayer treatment involves seeding clump grasses and legumes in spaces at the interior and perimeter of the mine/mill site where large masses of overstory plants are to be encouraged. This treatment will stabilize the soil by providing an immediate vegetative cover and provide habitat suitable for naturally invading overstory, understory, and groundlayer species. Under this condition, the development of overstory trees and native shrubs will occur in the groundlayer through direct planting or invasion. Light application of a grass and legume seed mixture selected from the species list in Appendix D will provide the necessary soil stabilization while minimizing competition between the groundlayer and preferred native species. This treatment will cover the largest area of the mine/mill site requiring stabilization.

Perimeter areas of the site which will be immediately graded to their finished condition will also receive a mixture of grasses and legumes to control erosion (Appendix D). A 5 m (16.4 feet) strip outside of the security fence at the site perimeter will be maintained. Other outlying areas beyond the fence line will not be maintained; thus providing a groundlayer surface into which an overstory tree canopy and shrub layer enhancing wildlife habitat can be added or encouraged to develop under natural processes. These perimeter areas are not expected to be disturbed again.

To avoid the "monoculture" effect of the grass-legume mixture in the entrance zone of the site, native forbs will be used to add landscape character, seasonal interest and color. A grass cover crop and a limited amount of legumes will be included along with a mixture of forbs suitable for the site. A list of forbs suitable for use on the site is presented in Appendix D. This treatment will not inhibit natural invasion of native trees and shrubs. However, the invasion process will be slowed considerably when not supplemented with overstory plant material.

6.4.3 General Design Considerations

1) Diversity - The natural landscape surrounding the mine/mill site exhibits diversity in plant species due to varying orientation, soil and topographic conditions and moisture gradients. The Landscape Plan deliberately promotes the establishment of a variety of plant communities, hearty to the constructed site conditions, that will provide visual continuity with the surrounding natural landscape and seasonal interest throughout the year. Aspen/birch and maple/basswood communities will offer aesthetic qualities of mass, texture and fall color. Pine communities will also offer texture in addition to year-round evergreen mass and color, enhance the vegetative edge at the clearing limits, and provide wildlife cover.

In addition, these communities include plant species of various forms and sizes which will enhance man-made structures and earth forms. Large overstory species of the maple/basswood community will provide a transition in scale between the mine/mill buildings and the ground plane. Plant materials will also visually screen distracting elements and direct attention towards elements of interest.

2) Plant Massing - The plant masses and groundlayer texture represented in the Landscape Plan (Figure 6.0-1) indicate areas where revegetation will occur. They also represent the extent to which the site revegetation process will have advanced approximately 5 to 10 years after mine/mill construction.

The form given these plant masses has been chosen to reinforce the plan layout of circulation corridors, direct views, enhance topographic variation and provide a seed source for future reclamation of cleared lands.

Plant masses have been structured to emulate basic vegetative communities indigenous to the Project site. These communities will provide the basis for natural seeding and invasion processes.

The Landscape Plan has also maintained clearings in slope areas at drainage swales which typically parallel roadways, along the perimeter fence for security and fire control reasons and in those areas that functionally require clear zones, including the powerline corridor, soil absorption field and the surface drainage basins.

The strategy to be employed in revegetating rail embankments will be to provide for the basic groundlayer establishment and allow natural seeding and invasion processes to occur. In other clearings, a semi-maintained groundlayer will be provided.

3) Maintenance Considerations - The establishment of maintained and semi-maintained grasses in conjunction with direct overstory planting or the seeding of clump forming grasses to create habitat for naturally invading species are central to site revegetation processes. Minimal maintenance will result when these plants are selected because of their ability to tolerate the site conditions at the mine/mill site after construction.

4) Wind Controls - Plant masses can most effectively moderate microclimatic effects by channeling or buffering winds. The density and shape of the plant masses are critical in controlling wind patterns. For this reason, conifers have a leading role. The evergreen components of all the overstory plant masses can be used to buffer winter winds or

channel them to clear drifting snow from paved surfaces. With changes in the prevailing wind direction during summer months, the same masses help to direct breezes toward buildings and outdoor use areas.

In the Landscape Plan, plant masses near roadways and railroad corridors will be set back a sufficient distance to prevent snow drifts from accumulating in the circulation corridors. Parking areas will be buffered from winter winds to the extent possible.

5) Commercial Availability of Landscape Plants - The indigenous plant species identified on the Landscape Plan (Figure 6.0-1) and listed in Appendix B are normally available through commercial nurseries in seed or plant form. Availability at the time of implementation may be influenced by the desired quantities of plant species and nursery production schedules.

Specific sources of plant material reviewed by the landscape architect to verify availability include Seed and Planting Stock Dealers (USDA, Forest Service, 1979), 1981 Directory of Forest Trees in the United States (USDA, Forest Service, 1981), Regional Sources of Native Plants (Morrison, 1980), Wisconsin's Wholesale Source Booklet (Wisconsin Nurserymen's Association, 1983) and Sources of Shade Trees in the United States-1983 (Sydnor, 1983). It may also be possible to contract with project area foresters and horticulturists to gather seeds from indigenous plants on site or grow plants from locally gathered seed sources. Consideration will also be given to the feasibility of transplanting native plants gathered from within the area to be cleared for the mine waste disposal facility.

6.5 LANDSCAPE PLAN DESCRIPTION

The subdivision of the mine/mill site into three distinct zones for site design and functional and aesthetic reasons has been discussed in Section 5.0, Site Master Plan, of this report. The entrance zone will focus on arrival to the mine/mill complex and provide a tightly controlled access. Landscape treatments in this area will emphasize transition from the adjoining woodlands to the mine/mill facilities and the creation of an attractive experience. The operations zone, as the "working end" of the mine/mill complex, will emphasize revegetation utilizing functional and minimal maintenance landscapes. A perimeter zone will also be established to encompass those mine/mill facilities located outside the security fence. Landscape treatments in this area will emphasize the transition between the existing woodlands and the cleared site and will provide wildlife habitat. Establishment of facilities in this area will involve simple clearing and grading operations with minimal disturbance to the natural environment.

6.5.1 Entrance Zone

The development of the entrance zone will strongly contribute to the public image of the entire mine/mill development. Landscape plantings will be selected and located in an effort to provide a pleasing transition between the mine/mill complex and the adjoining undisturbed forested communities.

The powerline corridor will parallel the access road to the mine/mill site. To provide visual separation from the corridor and maintain the sense of enclosure provided by the existing forest cover, a 20 m (66 feet) buffer zone of existing vegetation will be maintained along the southern edge of the access road. As the road enters the mine/mill site, this edge will be reinforced with plants selected from the white pine/ red pine community presented in Appendix B to increase the visual separation from the powerline corridor as well as maintain the existing deciduous and evergreen character in that area of the site. The main approach drive will cut through the existing north-south ridge at the entrance to the mine/mill complex. The existing vegetation south of the approach road will be cleared with an undulating edge pattern to provide a spatial transition from the natural landscape to the openness of the mine/mill site. The forest edge will be reinforced with white pine/red pine groupings and shrub species known to enhance wildlife habitat (see Perimeter Zone, Section 6.5.3 for a more detailed explanation of forest edge).

Along the north side of the main approach drive, a 20 m (66 feet) buffer zone will be maintained to screen the security fence, concentrator service road and the concentrator. The existing vegetation will be supplemented with species selected from the aspen/birch community and reinforced with species selected from the white pine/red pine community to provide year-round visual interest, wind and snow control, and vegetative continuity with the existing woodland. Lists of the most prevalent species in these communities are presented in Appendix B.

At the entrance to the mine/mill site, the aspen/pine communities along the north edge of the road will be replaced with a maple/basswood overstory in the open space between the concentrator and the main approach drive. A similar overstory treatment will be continued adjacent to the services building and around the employee parking area. A few select areas along the main circulation corridor of the operations zone will also have a dominant maple/basswood overstory.

This community is the richest and most colorful of the region's vegetation types. It is highly characteristic of the "Northwoods" environment associated with the Project region and will provide the site visitor with a positive view of the mine/mill's integration into the environment.

The mine/mill site in its existing condition also has a natural maple/basswood understory. In time and through the successional process, these trees will become the dominant overstory replacing the aspen/birch community. This community is highly shade tolerant and, therefore, capable of growing with the aspen/birch. If left to mature, this community will outgrow and shade out the less shade tolerant aspen/birch community. Maple trees, for example, are not able to reproduce seeds until plants are 30 years old. This contrasts with birch and aspen which reproduce seed at 10 to 20 years of age (USDA, Forest Service, 1974a, Daniel et al., 1979).

To maintain the spirit of the successional process currently underway on the site, selected areas of high visibility within the mine/mill complex have been chosen for revegetation with the maple/basswood community as the predominant overstory. These areas are centrally located and are not expected to be disturbed when the mine/mill site is reclaimed following operations. These communities will be in a seed production stage when final reclamation occurs and will serve as a seed source for colonizing areas of the site left open after facilities are removed. Plantings from the white pine/red pine community will be interspersed with the maple/basswood community. These plants will provide intermittent shade for the slower growing maple/basswood community. This community will also provide year-round color, visually screen mine/mill facilities and buffer wind.

The groundlayer associated with the maple/basswood communities will consist of clump-forming grasses and legumes that will establish habitat for the invasion of native overstory and understory species. In the open spaces adjoining roadways and paralleling drainage corridors, a semi-maintained grass cover will be used. Open spaces around the services building and employee parking area will receive a maintained turf cover.

6.5.3 Operations Zone

The operations zone is the "working end" of the mine/mill complex. Landscape treatments will be more functional in their placement and will concentrate on site stabilization, revegetation of areas at the interior of the mine/mill site and the establishment of seed colonies for eventual site reclamation.

The operational requirements in this area require two relatively level ground planes separated by a sloping landscaped strip located north of the coarse ore storage facility. Surface drainage from the lower level will be directed to surface drainage basin No. 2 located north of the concentrator building, whereas the upper level will be partially drained by storm sewer and by surface run-off to surface drainage basin No. 1 located at the southeast corner of the operations zone.

Overstory landscape plantings will occupy the spaces between facilities and roadways, maintaining a setback for maintenance, drainage and equipment maneuverability. Overstory plantings will be selected from the maple/basswood and aspen/birch communities. The maple/basswood community will be located west of the concentrator and at the interior of the operations zone to visually reinforce the main circulation corridor. At the conclusion of mine/mill operations, these masses will be preserved as part of the site reclamation plan and serve as seed sources to colonize the clearings left by the removal of the mine/mill facilities.

The aspen/birch community will be located around the outside edge of the operations zone. This community is easily established and is tolerant of the low fertility soils and dry conditions that will be present (Bjorkbom, 1969; Marquis, 1969). At maturity, the texture and character of this community will be similar to that of the adjoining woodland and will blend well with the cleared edges of the site.

The groundlayer within the operations zone will consist of clump-forming grasses promoting invasion of native species in areas receiving overstory vegetation, and semi-maintained grasses along circulation corridors and drainageways. Slopes within the operations zone will be covered with the grasses creating habitat for natural invasion or semi-maintained grasses. Selection will be dependent on the degree that natural plant invasion will be encouraged. Plants of the aspen/birch community will likely invade slopes where this process is allowed.

The interior and exterior slopes of surface drainage basin No. 1 will be covered with semi-maintained grasses.

6.5.3 Perimeter Zone

The perimeter zone defines those mine/mill facilities located outside the security fence, including the soil absorption field, surface drainage basin No. 2, and preproduction ore storage area. The clear-cut forest edge directly outside the security fence is included as part of the perimeter zone offering an opportunity for visual enhancement of the surrounding woodlands and development of wildlife habitat.

Environmental conditions will vary widely in the perimeter zone due to slope and sun orientation. The final grades for the mine/mill site will generally slope downward to the adjoining woodlands. The cleared edges of the woodland will generally have north or south exposures. North facing edges will pose the least problem for revegetation because of minimal direct exposure to the sun, less root competition in the shadow zone and better moisture retention. The south facing edges will be more difficult to revegetate. Sunlight will be direct, and reflection and evaporation will be high. The east and west edges will represent variations between the north and south extremes.

To enhance forest edge aesthetics at the perimeter of the main plant, a varied rather than a clean, straight clearing edge will be established. The forest edge upon clearing is expected to be primarily deciduous overstory. This edge will be interspersed with plants from the white pine/red pine community in areas with south, east and west exposures. On edges with north exposure, fir and spruce species will be used. The dominant use of conifers will add color and textural variety to the site perimeter and provide a food source and cover for wildlife. Interspersed with the conifers will be plant groupings that will enhance wildlife habitat (Appendix C).

No additional overstory plant species will be installed at the cleared edges surrounding the facilities and access roads within the perimeter zone. Invasion of native plant species has been successful in similar revegetated areas associated with reclaimed drilling sites in the Project area (see Crandon Project Reclamation Plan, Appendix 3.9A; Exxon Minerals Company, 1982b). In the topsoil storage area, the cleared edge will be approximately 100 m (328 feet) from the perimeter of the mine/mill site. To encourage the growth of native species in this opening, clump forming grasses and legumes will be sown on the topsoil storage area to create invasion habitat. Species from the aspen/birch community will also be planted here to supplement the naturally invading overstory and understory species.

Clump forming grasses and legumes will typically be sown in the perimeter zone to encourage plant invasion and the natural revegetation process. Exceptions will include the clearings at the soil absorption field, drainage swales, edges of access roads and embankments bordering the explosives storage area and the interior and exterior slopes of surface drainage basin No. 2. These areas will be covered with semi-maintained grasses.

At abandonment of the site facility and the initiation of the reclamation phase, a diverse range of mature plant associations within the perimeter zone will help ensure that natural invasion will occur.

7.0 LANDSCAPE PLAN IMPLEMENTATION

7.1 INTRODUCTION

Construction of the mine/mill site facilities will be completed in approximately 4 years. During the construction process, the landscape plan will be successively staged to permit rapid stabilization of ground surfaces, restoration of the landscape perimeter, and development of major landscape spaces within the mine/mill site. The techniques that will be used in implementing the Landscape Plan, defining the landscape maintenance requirements, and defining a schedule for landscape implementation during the various phases of construction are summarized in this section.

Chapter 1, Description of the Proposed Action, of the Crandon Project Environmental Impact Report (Exxon Minerals Company, 1982a) supplements this discussion with a description of the overall mine/mill surface facilities construction program. In addition, the Crandon Project Reclamation Plan (Exxon Minerals Company, 1982b) provides a description of the nonpoint source control techniques for erosion control.

7.2 SURFACE FACILITIES CONSTRUCTION SUMMARY

Implementation of the Landscape Plan will closely follow the schedule for completion of surface facilities construction and will seek to establish permanent landscape features as soon as site work is completed. The sequence and duration of the principal construction activities for the mine/mill site are described below.

During the first year of construction, clearing, grubbing and rough grading will be performed in a continuous operation. Approximately 35.2 ha (89 acres) will be disturbed during this period. Following rough grading of the entire site, those areas not scheduled for immediate development will be seeded to control erosion. A stormwater drainage system will be extended to each construction zone before work is initiated in that area. Construction of the access road will begin during Year 1. Work will start simultaneously from both State Highway 55 and the mine/mill site. Construction of the railroad spur will also start during Year 1. Both of these facilities will be completed during Year 2. Other major facilities that will be started in Year 1 and completed during Year 1 or Year 2 include the sewage and water treatment plants, a perimeter security fence, and the fire protection and water storage system. Surface drainage basin No. 1 will also be constructed during Year 1. During Year 2, the concrete headframe will be completed and equipment installation started. Work will begin on the services building and foundations will be started for the concentrator, fine crushing facilities, fine ore storage bins, and the lime plant. Permanent hoisting, ventilation, and switch gear for these facilities will be installed in Year 3 and the services building will be completed.

During Year 3, work will start on the coarse ore storage building and most ancillary facilities. During Year 4, the final year of construction activities, mechanical, electrical and instrumentation work will increase as the civil and structural work decreases. All principal above ground structures will be completed at this time. Underground development will also be completed so that operational and production activities can be initiated on a limited scale. Clean-up and landscaping activities, which have been ongoing throughout the construction phases, will be completed.

7.3 SITE PREPARATION

7.3.1 Clearing and Grubbing

Clearing and grubbing will be completed to the site grading limits. In addition, an edge zone, varying from the grading limits to 15 m (50 feet) beyond, will be selectively cleared to remove diseased or damaged trees and create an undulating edge along the Project perimeter. Circulation and utility corridors will be cleared to the minimal width needed to construct the facilities, provide drainage and permit maintenance. During clearing operations all brush and slash will be chipped and stockpiled east of the east rail corridor.

7.3.2 Topsoil Salvage and Replacement

Following site clearing operations, available topsoil and forest floor litter will be salvaged within the grading limits. Soil reports indicate that minimal topsoil is available within the Project area (USDA, Soil Conservation Service, 1978). Salvaged topsoil will be stockpiled along the eastern edge of the site outside the security fence. Topsoil stockpiles that will be undisturbed for one or more years will be seeded with the semi-maintained grass cover described in Section 6.4.2, Groundlayer Vegetation Selection, of this report to control erosion.

Upon completion of final site earthwork operations, the available topsoil will be used with priority given to the more extensively landscaped areas around the entrance zone. Topsoil in these areas will be replaced at the minimum thickness of 10 cm (4 inches). Topsoil will also be applied to steep banks and in drainage swales to improve the vegetative cover and enhance erosion control. Topsoil remaining after site construction will be left in the stockpile area and revegetated until required for use at site reclamation.

7.3.3 Finish Grading in Preparation for Permanent and Temporary Landscaping

As temporary and final grading operations are completed, all disturbed surfaces will be finish graded in preparation for seeding. Finish grading will include finishing and trimming topsoil and non-topsoiled surfaces to blend with existing grades and to provide a smooth transition into the adjacent woodlands. In all areas, construction debris and chunks of wood will be removed and buried on site or hauled off site to an approved disposal area.

Upon completion of the above site preparation activities, soils to be permanently revegetated will be tested for pH and nutrient level. Specific fertilization and liming recommendations will be prepared to aid in establishing vegetation.

7.3.4 Erosion Control

The application of recommended erosion control techniques during the construction of mine/mill surface facilities is described in the Reclamation Plan (Exxon Minerals Company, 1982b). Techniques to be implemented during site landscaping include reuse of salvaged topsoil, mulching, slope and drainageway stabilization with sod or erosion control matting, and vegetative stabilization. Application of these techniques will stabilize exposed ground surfaces and enable site revegetation to occur.

7.4 INSTALLATION OF LANDSCAPE GROUNDLAYER

Installation of the landscape groundlayer will begin immediately after completion of either temporary or permanent site grading. The groundlayer revegetation process will continue throughout the mine/mill site construction process.

7.4.1 Short-Term and Long-Term Revegetation Needs

The construction schedule identifies that the entire mine/mill site will be cleared and graded as part of phase 1 of the Project. The construction of individual facilities will be phased over 4 years. As a result, a major portion of the site will need to be revegetated at the conclusion of initial grading operations. The objectives of short-term revegetation of the site include immediate stabilization of exposed ground surfaces, rebuilding the soil, and minimizing erosion until final revegetation can occur. To accomplish these short-term objectives, a grass and legume seed mix, similar to the mix sown to establish invasion habitat for native species described in Section 6.4.2, will be applied. If revegetation is required for only one summer season, annual rather than perennial grasses may be used. The grass and legume seed mix will remain in the perimeter zone because the area will not be disturbed following initial site grading. All other areas of the site are expected to be revegetated a second time because of site construction. At that point, long-term groundlayer recommendations will be implemented.

7.4.2 Ground Surface Preparation for Revegetation

Preparation of all exposed ground surfaces for groundlayer application will include disking or harrowing the temporary or final graded site to a 15.24 cm (6 inches) depth to break up the surface soils and create a suitable growing bed. On slopes where surface preparation equipment is not operable, surface preparation will be accomplished with earth moving equipment.

7.4.3 Fertilizer and Lime Requirements

The establishment of groundlayer vegetation on the subsoil conditions of the graded site may require the application of lime and a fertilizer. Soil conditions will be tested prior to revegetation and the results coordinated with the requirements of the vegetation to be installed. Fertilizer and lime will be applied and worked into the prepared ground surface prior to the installation of vegetation.

7.4.4 Methods of Vegetation Installation

Vegetation to be planted as part of the groundlayer will be either in seed or sod form. Following ground surface preparation, vegetation to be seeded shall be installed by hydroseeding or mechanical methods. Selection of the final method or combination of methods will be based on site surface character and site slope. Sod will be placed in areas where an immediate effect is required or where erosion control measures are paramount. Seed and sod will be installed in accordance with standard specifications for Road and Bridge Construction (State of Wisconsin, Department of Transportation, 1981).

7.4.5 Mulches and Soil Surface Stabilizers

Numerous types of mulches and soil surface stabilizers can be used in conjunction with seeding and sodding applications. These materials provide a degree of immediate erosion control, hold the seed or sod in place, shade the tender plants, and conserve surface moisture. Use of these measures will be determined in the field based on specific area needs, the degree of seeding and timing of the seed application, and the success desired.

7.4.6 Timing of Groundlayer Installation

The optimum seeding times for legume/grass seed mixtures is April to June. For sod forming grass mixtures August to September is optimum. When groundlayer installation is required outside these general time frames, mulches will be considered as a means of reducing heat and moisture stress (Exxon Minerals Company, 1982b).

7.5 INSTALLATION OF LANDSCAPE OVERSTORY

Installation of landscape overstory will begin when portions of the site are brought to finish grade. No landscape plants will be installed in temporarily disturbed or unfinished areas of the site.

7.5.1 Plant Materials

Plant materials will be selected seed or nursery grown stock obtained locally and regionally. All plants will conform to the requirements of the American Standard for Nursery Stock (American Association of Nurserymen, Inc., 1980) and the Wisconsin Administrative Code (State of Wisconsin 1981). Plants will be furnished in the following conditions: certified pure live seed, balled and burlapped, container grown, and bare root. Balled and burlapped, container grown or bare root stock will be used in high visibility areas of the site, areas requiring immediate restoration or where plant survival is essential.

Bare root stock consisting of smaller size trees and shrubs will be used in conjunction with balled and burlapped stock, or container grown stock. Bare root stock will also be planted in areas requiring mass planting and where small stock is applicable or mechanical installation methods are used. An advantage in using container grown stock is the ability to continue site landscaping operations throughout the growing season. The seeding of select overstory species may also have application where an immediate cover is not required. Birch species have been successfully seeded under controlled environmental conditions and achieved average heights of 2.9-4.4 m (9.6-14.5 feet) in 10 growing seasons (Bjorkbom, 1969; Marquis, 1969).

7.5.2 Plant Installation

Plant installation will occur throughout the spring, summer and autumn seasons. Balled and burlapped and bare root stock will be planted until June 1 and again after October 1. Container grown stock and on site transplants (if feasible) will be planted throughout the spring, summer and autumn. Seeding of overstory plants will be accomplished only in the spring. All plant materials will be planted following standard landscape practices.

A slow-release fertilizer high in nitrogen and phosphorus may be added to each plant hole to aid plant development. A thick layer of wood chips salvaged from the initial site clearing operations will be applied at the base of each plant to reduce weed competition and aid in moisture conservation. Major trees in the public areas of the site will be braced or guyed for several growing seasons until established.

7.6 LANDSCAPE MAINTENANCE

7.6.1 Short-Term Maintenance Requirements

The objective of short-term maintenance operations is the establishment of the permanent landscape. Short-term operations will be labor intensive and will be in effect for the first two growing seasons following plant and groundlayer installation. These operations will include regular monitoring of erosion control practices, watering, and weed and disease control. A higher level of maintenance activity will occur in the entrance zone and operations zone to maintain the desired aesthetic appearance.

Maintenance of landscape plants at the perimeter of the operations zone will focus on the control of weeds until the plants are established.

7.6.2 Long-Term Maintenance Requirements

The objective of long-term maintenance is to ensure the continued growth and health of the site landscape for aesthetic and functional considerations, and future reclamation purposes.

Operations will include mowing, fertilizing and disease control for maintained turf areas. Periodic mowings of the semi-maintained grass areas will also occur to facilitate operations and maintain fire breaks.

In the entrance zone, landscape plants in close public view will be monitored for continued growth, disease control and general aesthetic appearance. Plants visibly diseased or dead will be removed.

A 5 m (16 feet) strip along the security fence at the perimeter of the mine/mill site, and the perimeter of rail spurs and associated embankments will be maintained as clear zones. In other perimeter areas, revegetation through natural invasion will be allowed to proceed.

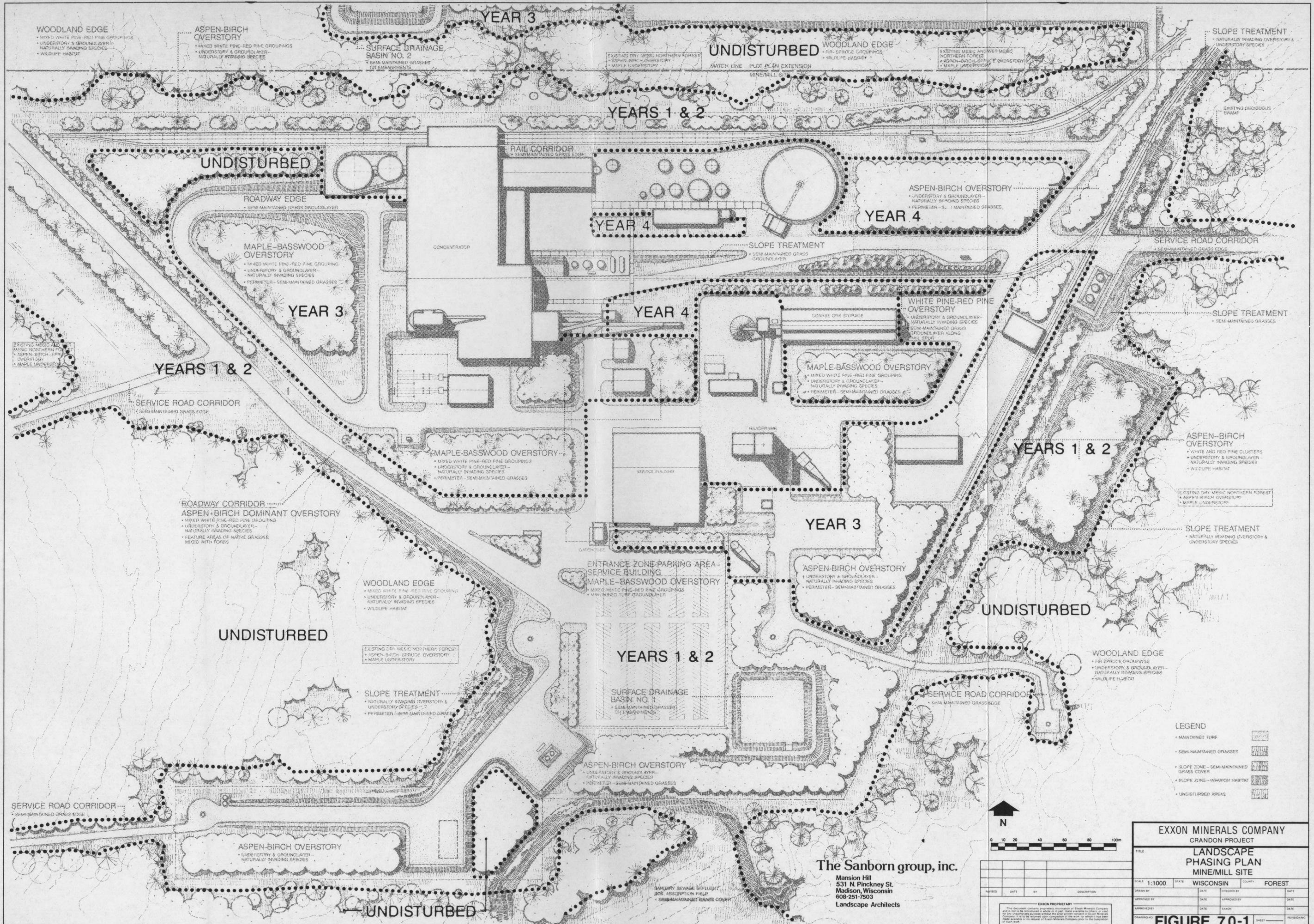
7.7 LANDSCAPE PHASING

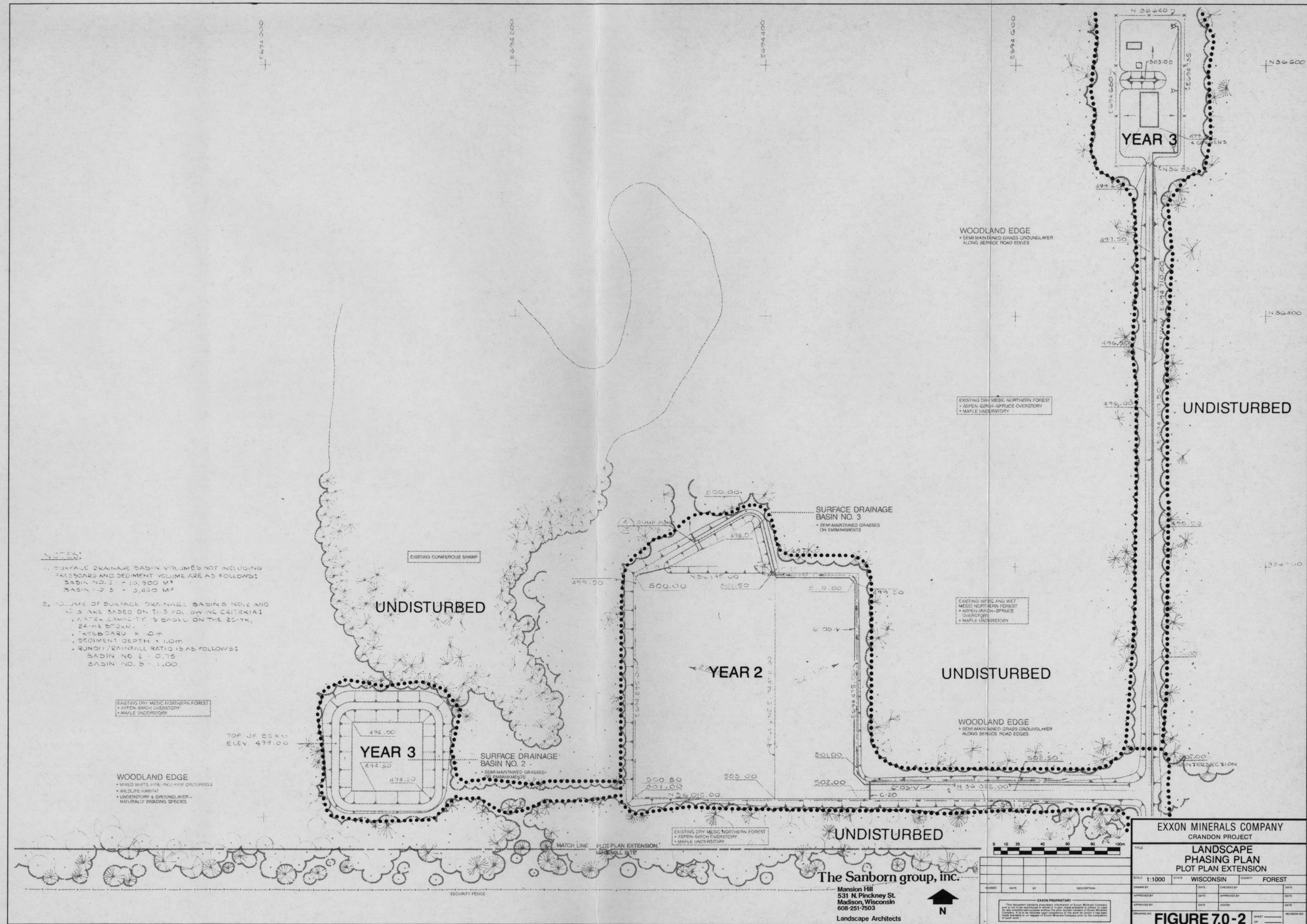
The primary objective of the Landscape Phasing Plan is to define an orderly process for implementation of the preceding site landscaping recommendations, and the implementation of erosion control measures which are described in the Crandon Project Reclamation Plan (Exxon Minerals Company, 1982b). Figure 7.0-1 describes the Landscape Phasing Plan for the immediate mine/mill site and Figure 7.0-2 describes the Landscape Phasing Plan for facilities located north of the main plant.

7.7.1 Phasing Process

Landscape implementation activities follow a sequence which involves site preparation, including clearing, grubbing, salvaging and replacing topsoil, erosion control, finish grading, and installation of landscape groundlayer and overstory plantings. The Landscape Phasing Plans (Figures 7.0-1 and 7.0-2) illustrate landscape implementation zones based on the sequence and duration of principal construction activities over the 4 year mine/mill construction period. Landscape groundlayer and overstory plantings contained within an implementation zone labeled by construction year are to be installed during that time period.

Site preparation operations described in Section 7.3, Site Preparation, will occur during Year 1 and Year 2 of construction. The perimeter zone and entrance zone will be finish graded at this time and permament landscape groundlayer and overstory plantings installed. All main circulation corridors will be constructed along with the site's main drainage channels and structures. Permanent groundlayer cover will be established on these facilities as soon as they are completed.


YEAR 3
UNDISTURBED
WOODLAND EDGE
ASPEN-BIRCH OVERSTORY
SURFACE DRAINAGE BASIN NO. 2
MATCH LINE PLOT PLAN EXTENSION
MINE/MILL SITE
SLOPE TREATMENT
YEARS 1 & 2
RAIL CORRIDOR
UNDISTURBED
ROADWAY EDGE
ASPEN-BIRCH OVERSTORY
YEAR 4
YEAR 4
MAPLE-BASSWOOD OVERSTORY
CONCENTRATOR
SLOPE TREATMENT
SERVICE ROAD CORRIDOR
YEAR 3
YEAR 4
WHITE PINE-RED PINE OVERSTORY
COARSE ORE STORAGE
SLOPE TREATMENT
YEARS 1 & 2
MAPLE-BASSWOOD OVERSTORY
SERVICE ROAD CORRIDOR
MAPLE-BASSWOOD OVERSTORY
ASPEN-BIRCH OVERSTORY
YEARS 1 & 2
ROADWAY CORRIDOR
ASPEN-BIRCH DOMINANT OVERSTORY
YEAR 3
SLOPE TREATMENT
ENTRANCE ZONE-PARKING AREA-SERVICE BUILDING
MAPLE-BASSWOOD OVERSTORY
WOODLAND EDGE
ASPEN-BIRCH OVERSTORY
UNDISTURBED
UNDISTURBED
YEARS 1 & 2
WOODLAND EDGE
SLOPE TREATMENT
SURFACE DRAINAGE BASIN NO. 1
SERVICE ROAD CORRIDOR
LEGEND
ASPEN-BIRCH OVERSTORY
SERVICE ROAD CORRIDOR
ASPEN-BIRCH OVERSTORY
N
UNDISTURBED
The Sanborn group, inc.
Mansion Hill
531 N. Pinckney St.
Madison, Wisconsin
608-251-7503
Landscape Architects
EXXON MINERALS COMPANY
CRANDON PROJECT
LANDSCAPE
PHASING PLAN
MINE/MILL SITE
1:1000
WISCONSIN
FOREST
FIGURE 7.0-1


YEAR 3
UNDISTURBED
WOODLAND EDGE
• SEMI-MAINTAINED GRASS GROUNDLAYER ALONG SERVICE ROAD EDGES
EXISTING DRY MESIC NORTHERN FOREST
• ASPEN-BIRCH-SPRUCE OVERSTORY
• MAPLE UNDERSTORY
SURFACE DRAINAGE BASIN NO. 3
• SEMI-MAINTAINED GRASSES ON EMBANKMENTS
EXISTING CONIFEROUS SWAMP
UNDISTURBED
YEAR 2
EXISTING MESIC AND WET MESIC NORTHERN FOREST
• ASPEN-BIRCH-SPRUCE OVERSTORY
• MAPLE UNDERSTORY
UNDISTURBED
WOODLAND EDGE
• SEMI-MAINTAINED GRASS GROUNDLAYER ALONG SERVICE ROAD EDGES
NOTES:
1. SURFACE DRAINAGE BASIN VOLUMES NOT INCLUDING FREEBOARD AND SEDIMENT VOLUME ARE AS FOLLOWS:
BASIN NO. 2 - 10,900 M³
BASIN NO. 3 - 3,460 M³
2. VOLUME OF SURFACE DRAINAGE BASINS NO. 2 AND NO. 3 ARE BASED ON THE FOLLOWING CRITERIA:
. WATER CAPACITY IS BASED ON THE 25-YR, 24-HR STORM.
. FREEBOARD = 1.0m
. SEDIMENT DEPTH = 1.0m
. RUNOFF/RAINFALL RATIO IS AS FOLLOWS:
BASIN NO. 2 - 0.75
BASIN NO. 3 - 1.00
EXISTING DRY MESIC NORTHERN FOREST
• ASPEN-BIRCH OVERSTORY
• MAPLE UNDERSTORY
TOP OF BERM ELEV. 499.00
YEAR 3
SURFACE DRAINAGE BASIN NO. 2
• SEMI-MAINTAINED GRASSES ON EMBANKMENTS
WOODLAND EDGE
EXISTING DRY MESIC NORTHERN FOREST
• ASPEN-BIRCH OVERSTORY
• MAPLE UNDERSTORY
UNDISTURBED
MATCH LINE PLOT PLAN EXTENSION
SECURITY FENCE
The Sanborn group, inc.
Mansion Hill
531 N. Pinckney St.
Madison, Wisconsin
608-251-7503
Landscape Architects
N
0 10 20 40 60 80 100m
REVISED DATE BY DESCRIPTION
EXXON PROPRIETARY
EXXON MINERALS COMPANY
CRANDON PROJECT
TITLE LANDSCAPE PHASING PLAN PLOT PLAN EXTENSION
SCALE 1:1000 STATE WISCONSIN COUNTY FOREST
DRAWN BY DATE CHECKED BY DATE
APPROVED BY DATE APPROVED BY DATE
APPROVED BY DATE EXXON DATE
DRAWING NO. FIGURE 7.0-2 SHEET OF REVISION NO.

In Year 3 of mine/mill construction, the concentrator, services building, headframe and ancillary structures will be completed. At that time, portions of the site surrounding these facilities and the adjoining construction laydown yards will be available for landscaping. Following the finish grading of the structure sites, the permanent groundlayer and tree overstory will be installed. All necessary erosion control structures and techniques will be employed as needed to ensure site stabilization.

During Year 4, construction of all facilities will have been completed, including the coarse ore storage building and the tailings thickener. Following finish grading, the permanent groundlayer and overstory trees will be installed. Erosion control practices will be implemented as required. Site landscaping will focus on the touch-up of any landscape work remaining in all site zones. Drainage swales and surface drainage basins will be permanently vegetated and long-term maintenance practices for the site wil be initiated.

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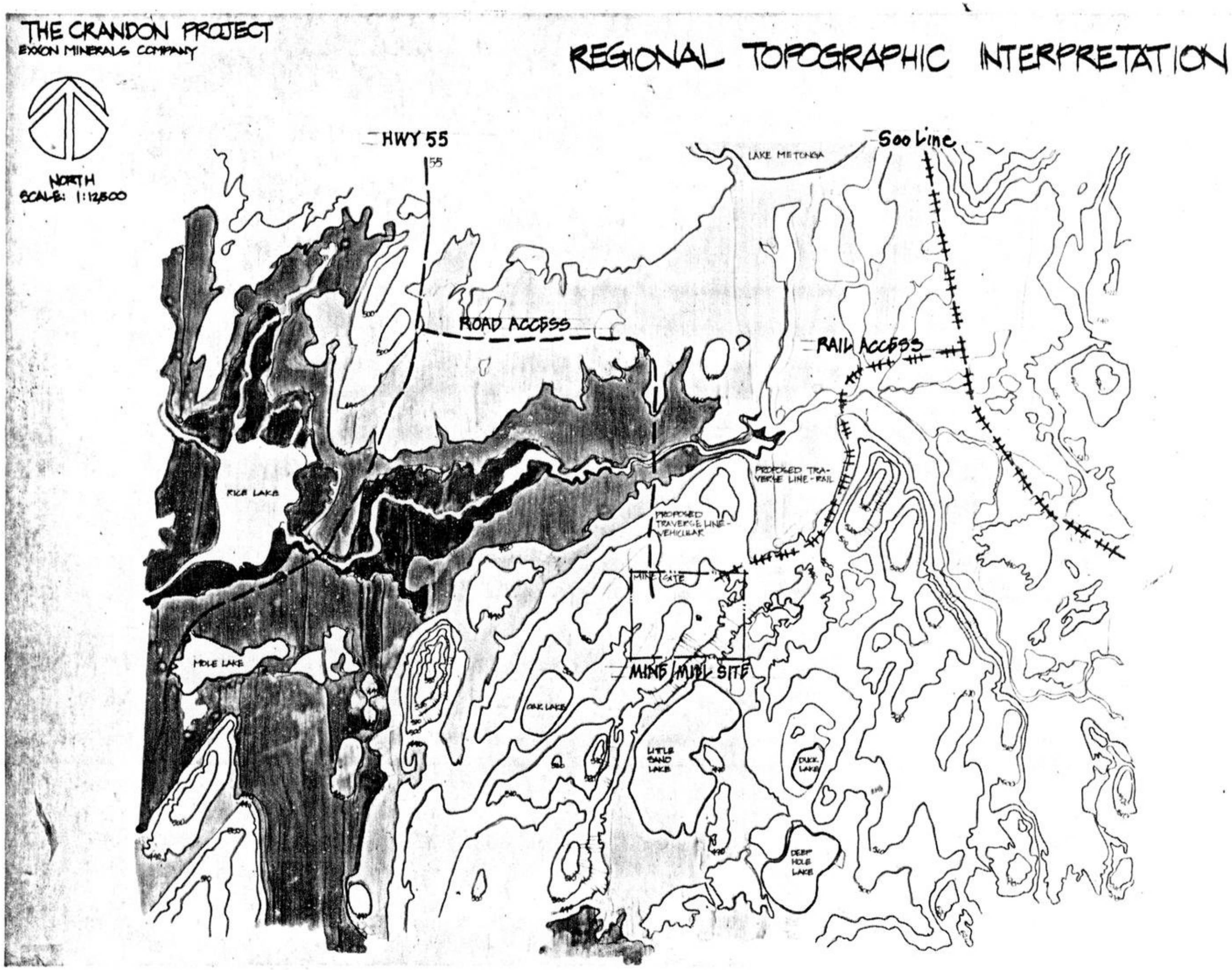
LIST OF APPENDICES

APPENDIX A

SITE INVENTORY AND ANALYSIS ILLUSTRATIONS



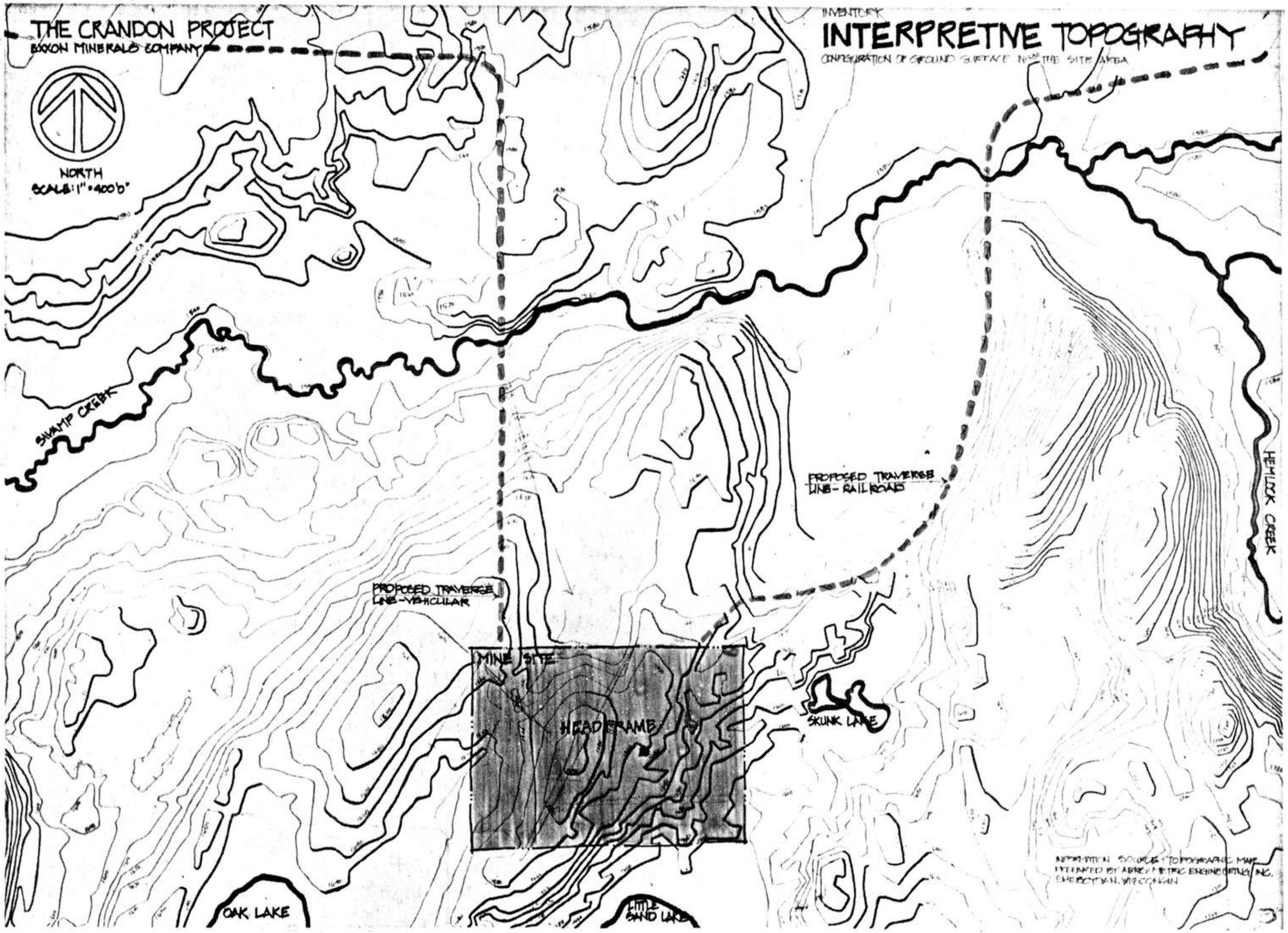
This figure describes the regional topography for a radius of 5 km (3 miles) around the Crandon mine/mill site. The darkest tones represent the areas of lowest topography while the lightest tones represent the areas of highest topography. The mine/mill site is located in an upland area that is characterized by a morraine-like landform system situated atop outwash plains that are interspersed with upland and lowland drainage corridors.

Base Map Reference:
Aerometric Engineering, Inc., 1976
Planimetric Mapping
1:12500
Exxon Crandon Project

EXXON MINERALS COMPANY

Fig. A-1:
REGIONAL INTERPRETIVE TOPOGRAPHY

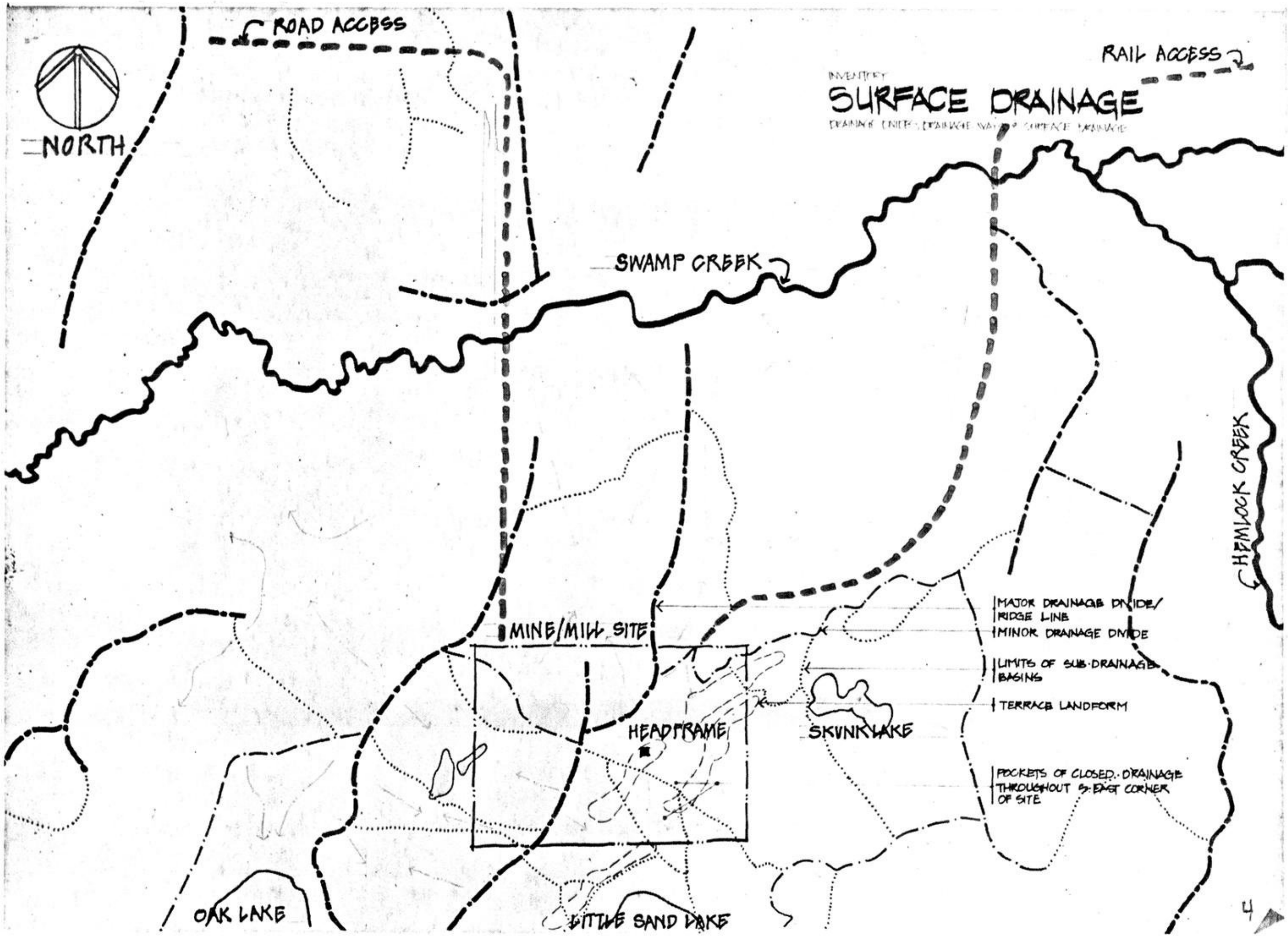
The Sanborn group, inc.
Mansion Hill
531 North Pinckney Street
Madison Wisconsin 53703



This figure describes the topography for the study area encompassing the mine/mill site. A general southwest trend of ridges and intervening valleys characterize the southern portion of the study area in which the mine/mill site is located. The Swamp Creek Valley, also a southwest trend, dominates the northern portion.

Base Map Reference:
Aerometric Engineering, Inc., 1976
Aerial Photogrammetric Mapping 1"=400'
Exxon Crandon Project

EXXON MINERALS COMPANY	Fig. A-2: **INTERPRETIVE TOPOGRAPHY—STUDY AREA**	The Sanborn group, inc. Mansion Hill 531 North Pinckney Street Madison, Wisconsin 53703



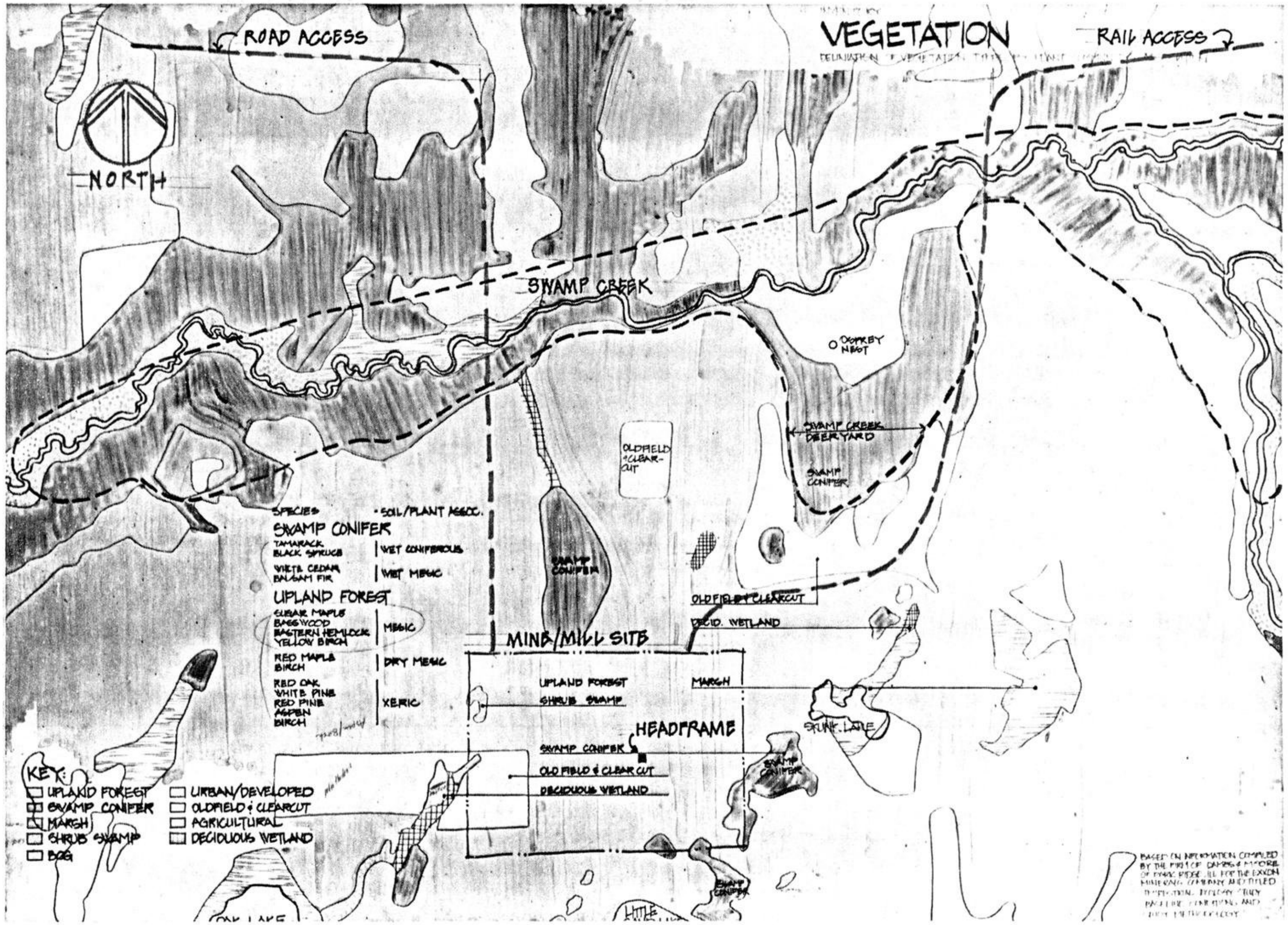
This figure illustrates the major and minor drainage divides and the limits of sub-drainage basins in the study area. Surface runoff in the study area drains to two major drainage basins, the Swamp Creek drainage system to the north and the Pickerel Creek system (not shown on the illustration) to the south.

Base Map Reference:
Aerometric Engineering, Inc., 1976
Aerial Photogrammetric Mapping 1"=400'
Exxon Crandon Project

EXXON MINERALS COMPANY

Fig. A-3:
SURFACE DRAINAGE—STUDY AREA

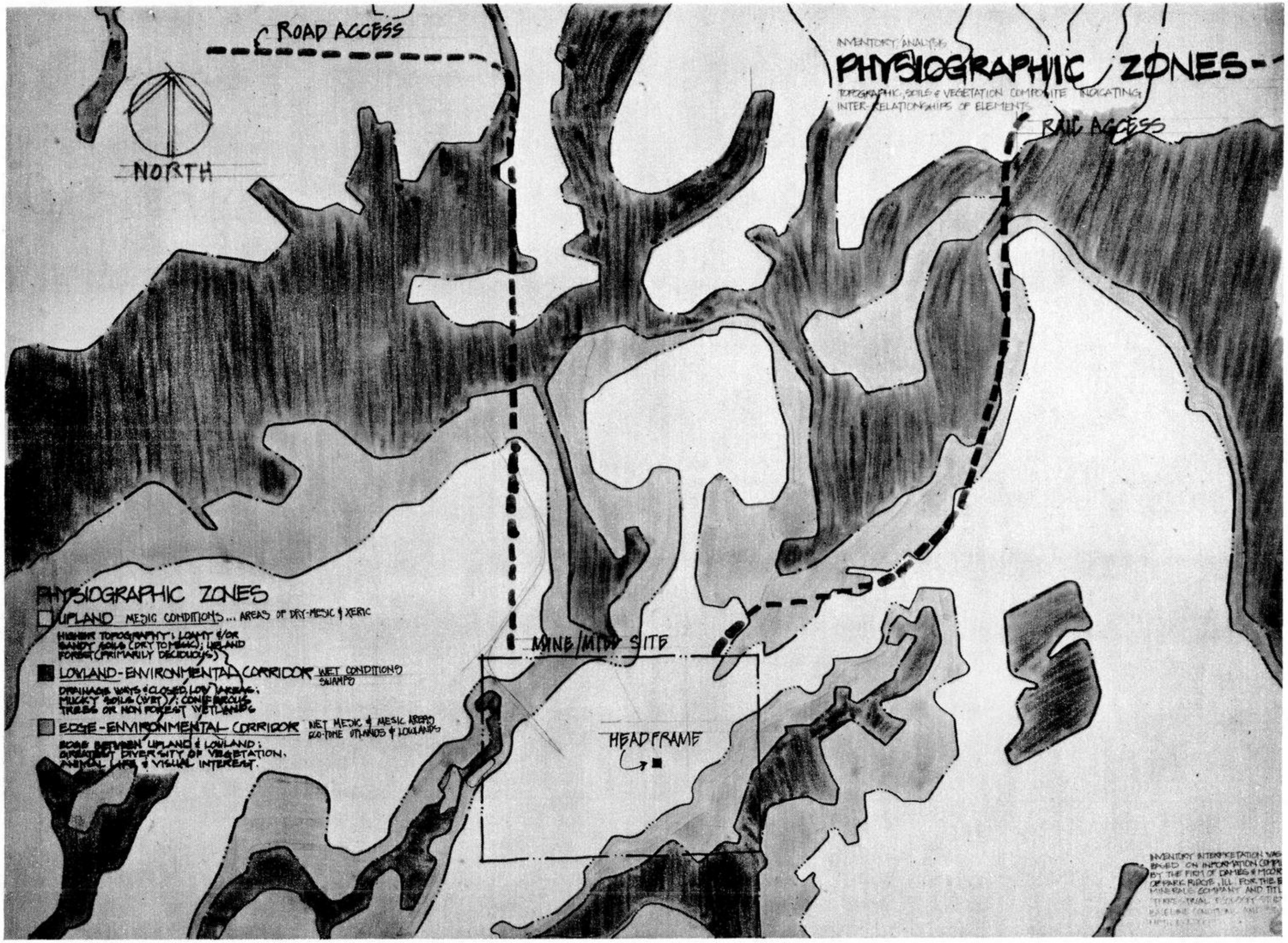
The Sanborn group, inc.
Mansion Hill
531 North Pinckney Street
Madison, Wisconsin 53703



This figure describes the vegetation in the study area. The Swamp Creek Valley is dominated by lowland forest vegetation referred to as Swamp Conifer (darker tones). The southern portion of the study area including the mine/mill site is dominated by upland forest vegetation (lighter tones).

Base Map Reference:
Aerometric Engineering, Inc., 1976
Aerial Photogrammetric Mapping 1"=400'
Exxon Crandon Project

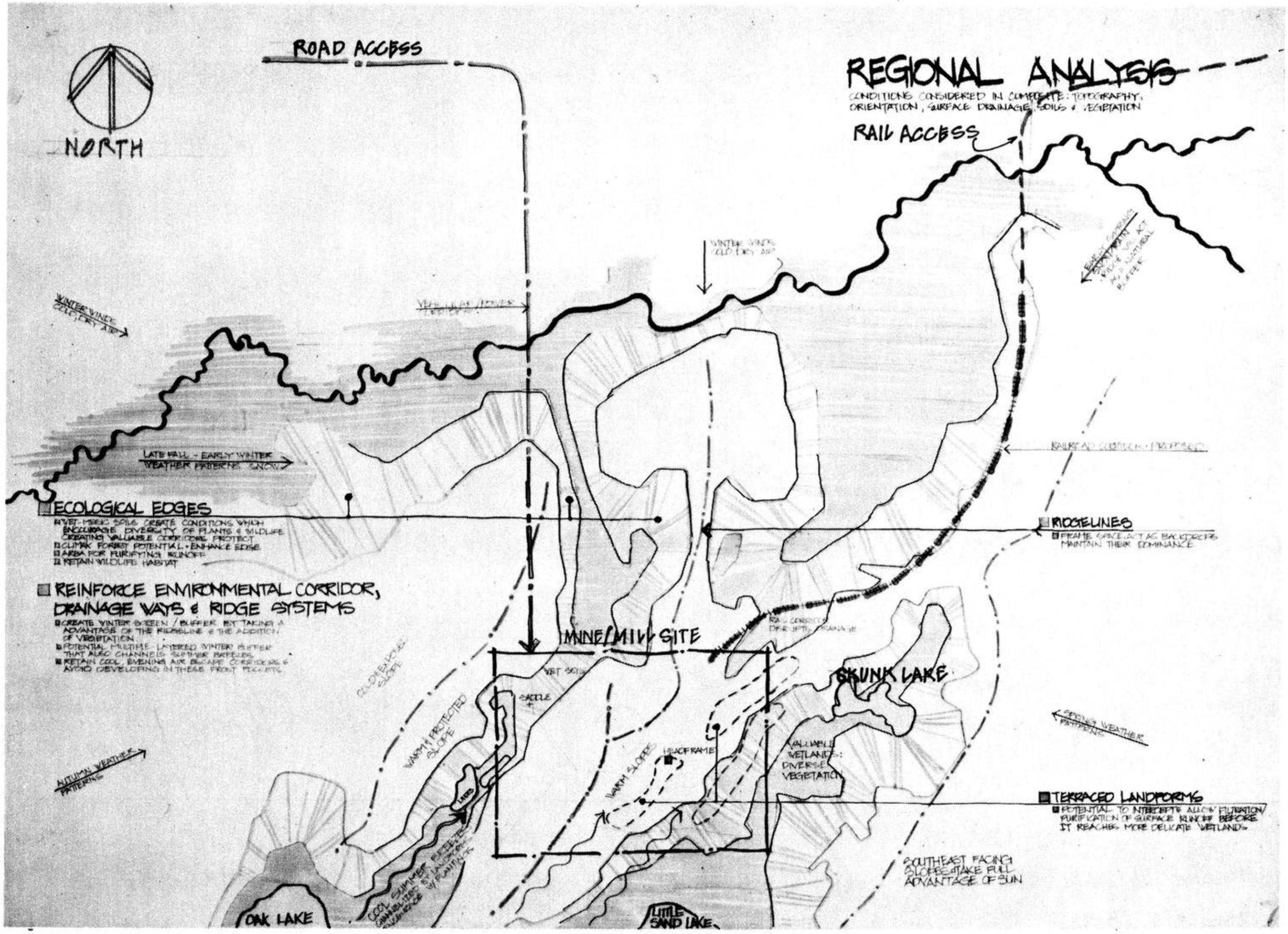
EXXON MINERALS COMPANY	Fig. A-4: **VEGETATION—STUDY AREA**	The Sanborn group, inc. Mansion Hill 531 North Pinckney Street Madison, Wisconsin 53703



This figure represents a composite analysis of the physiographic zones (topography, soils, vegetation) within the study area. Upland zones (lighter tones) and lowland zones (darker tones) represent the two main physiographic zones. Edge zones (medium tones) are transition areas between the upland and lowland zones that suggest greater diversity in vegetation and wildlife.

Base Map Reference:
Aerometric Engineering, Inc., 1976
Aerial Photogrammetric Mapping 1"=400'
Exxon Crandon Project

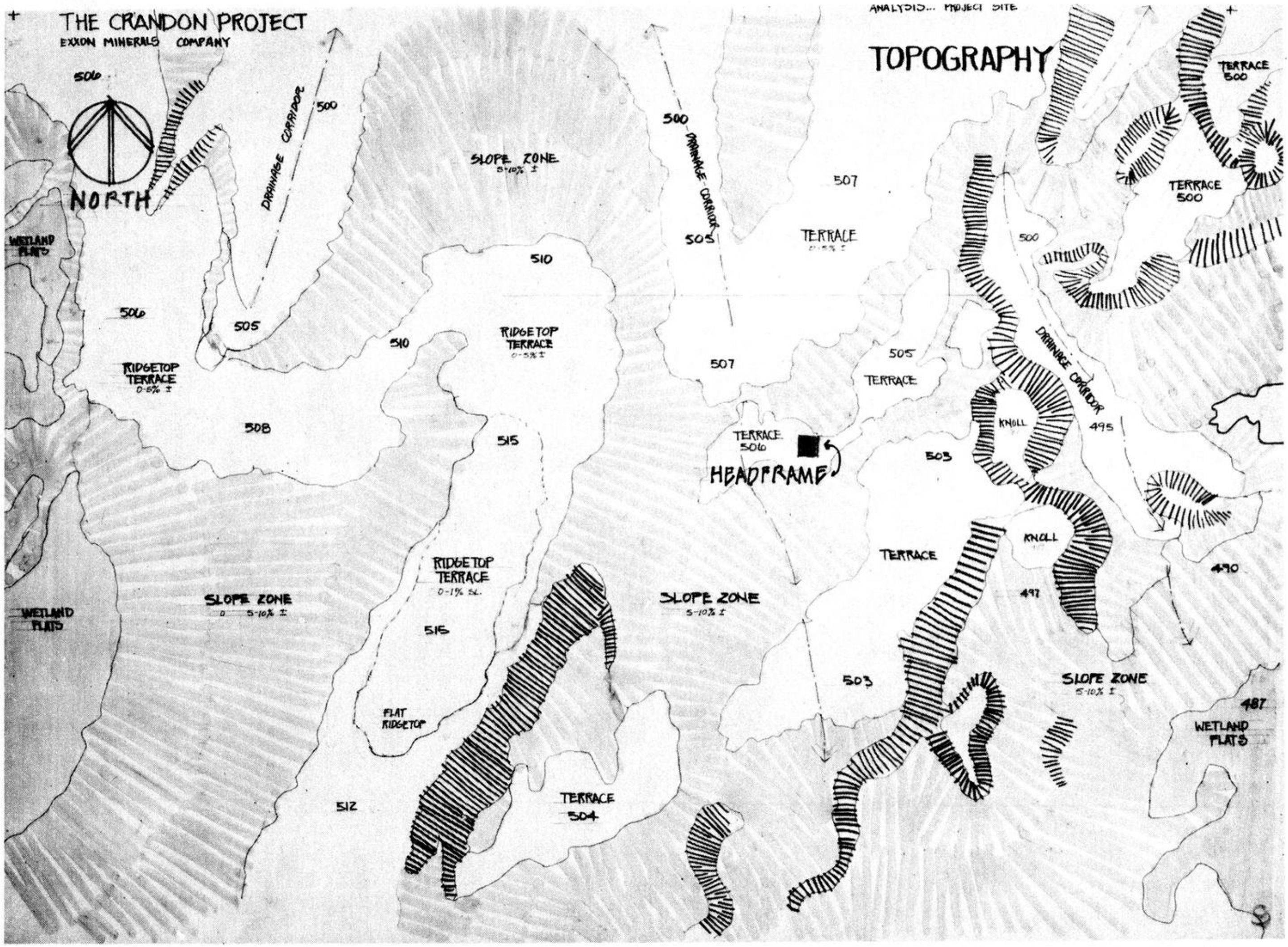
EXXON MINERALS COMPANY	Fig. A-5: **PHYSIOGRAPHIC ZONES—STUDY AREA**	The Sanborn group, inc. Mansion Hill 531 North Pinckney Street Madison, Wisconsin 53703



This figure represents a composite analysis of topography, orientation, surface drainage, soils and vegetation within the study area. The mine/mill site is dominated by a morraine-like upland system with lowland and edge conditions defining its northwest and southeast perimeters.

Base Map Reference:
Aerometric Engineering, Inc., 1976
Aerial Photogrammetric Mapping 1"=400'
Exxon Crandon Project

EXXON MINERALS COMPANY	Fig. A-6: **COMPOSITE ANALYSIS—STUDY AREA**	The Sanborn group, inc. Mansion Hill 531 North Pinckney Street Madison, Wisconsin 53703



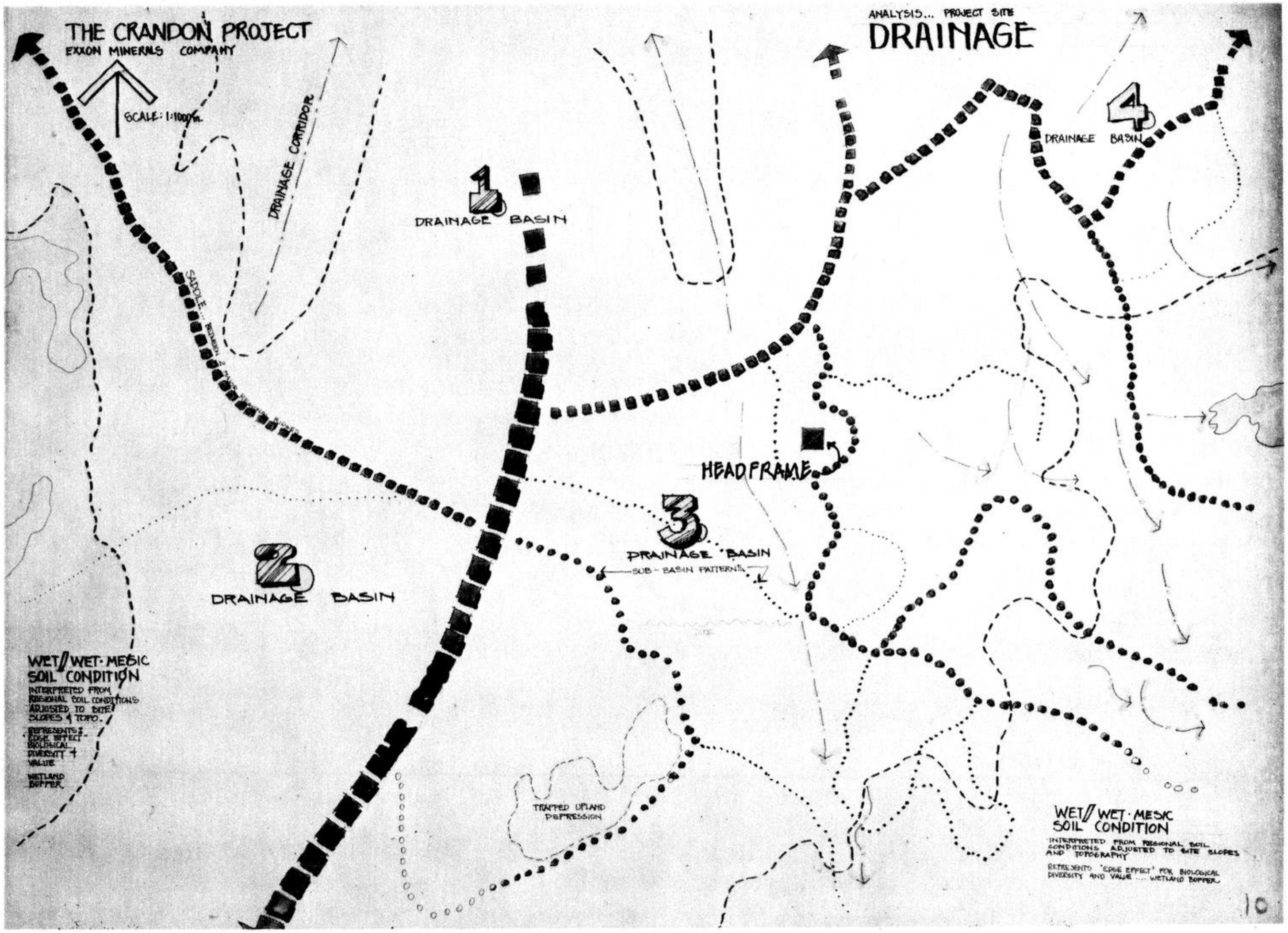
This figure presents a topographic analysis of the immediate mine/mill site. The mine/mill site comprises various slope zones including terrace areas of 0-5% slope (light tones), side slope areas of 5-10% slope (medium tones), and side slope areas of greater than 10% slope (dark tones).

Base Map Reference:
Exxon Minerals Company Planimetric Mapping, 1:1000
Exxon Crandon Project

EXXON MINERALS COMPANY

Fig. A-7:
TOPOGRAPHIC ANALYSIS—MINE/MILL SITE

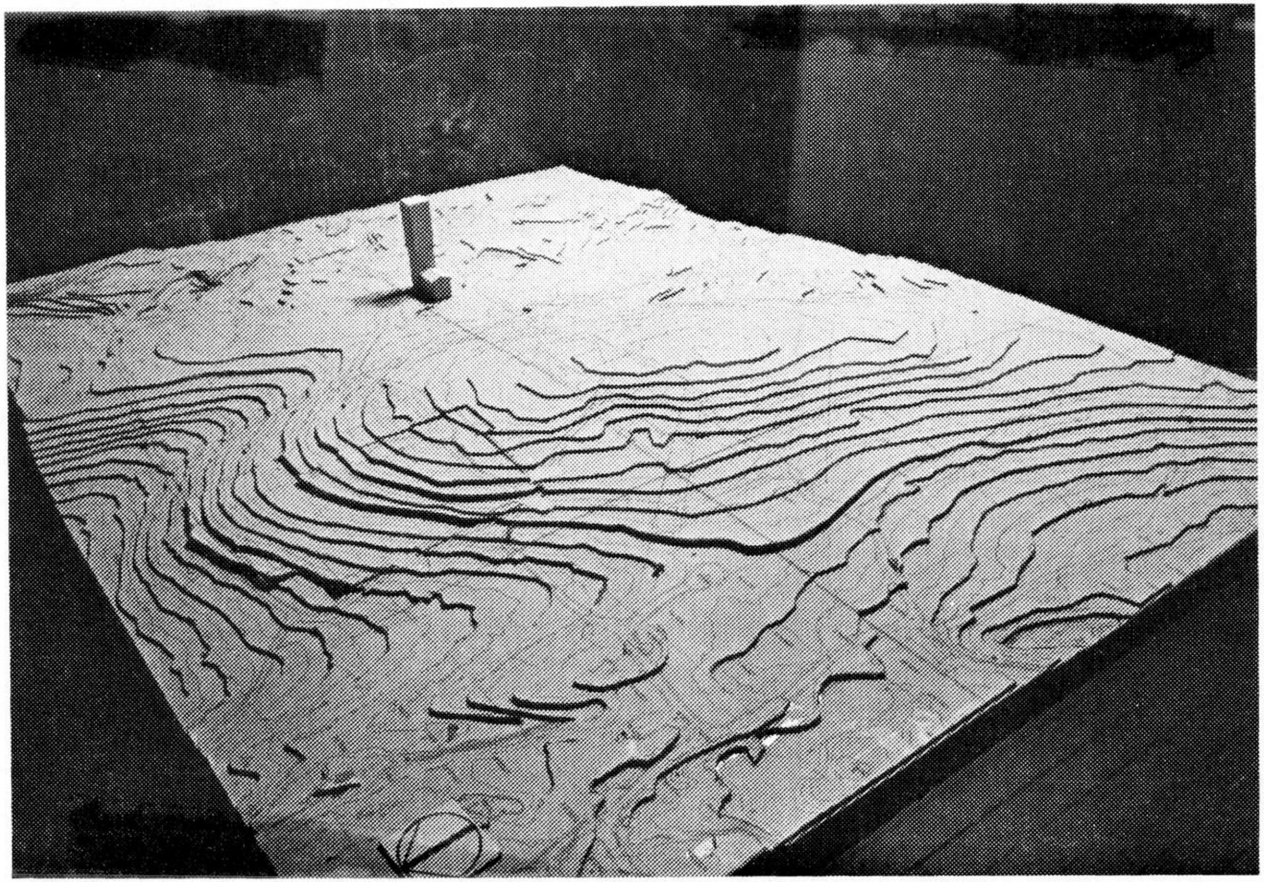
The Sanborn group, inc.
Mansion Hill
531 North Pinckney Street
Madison, Wisconsin 53703



This figure presents a drainage analysis for the immediate mine/mill site. A ridge system and its corresponding saddles divide drainage patterns and channel surface water with a predominant toward the south and the Pickerel Creek drainage basin.

Base Map Reference:
Exxon Minerals Company
Planimetric Mapping,
1:1000
Exxon Crandon Project

EXXON MINERALS COMPANY	Fig. A-8: **DRAINAGE ANALYSIS—MINE/MILL SITE**	The Sanborn group, inc. Mansion Hill 531 North Pinckney Street Madison, Wisconsin 53703



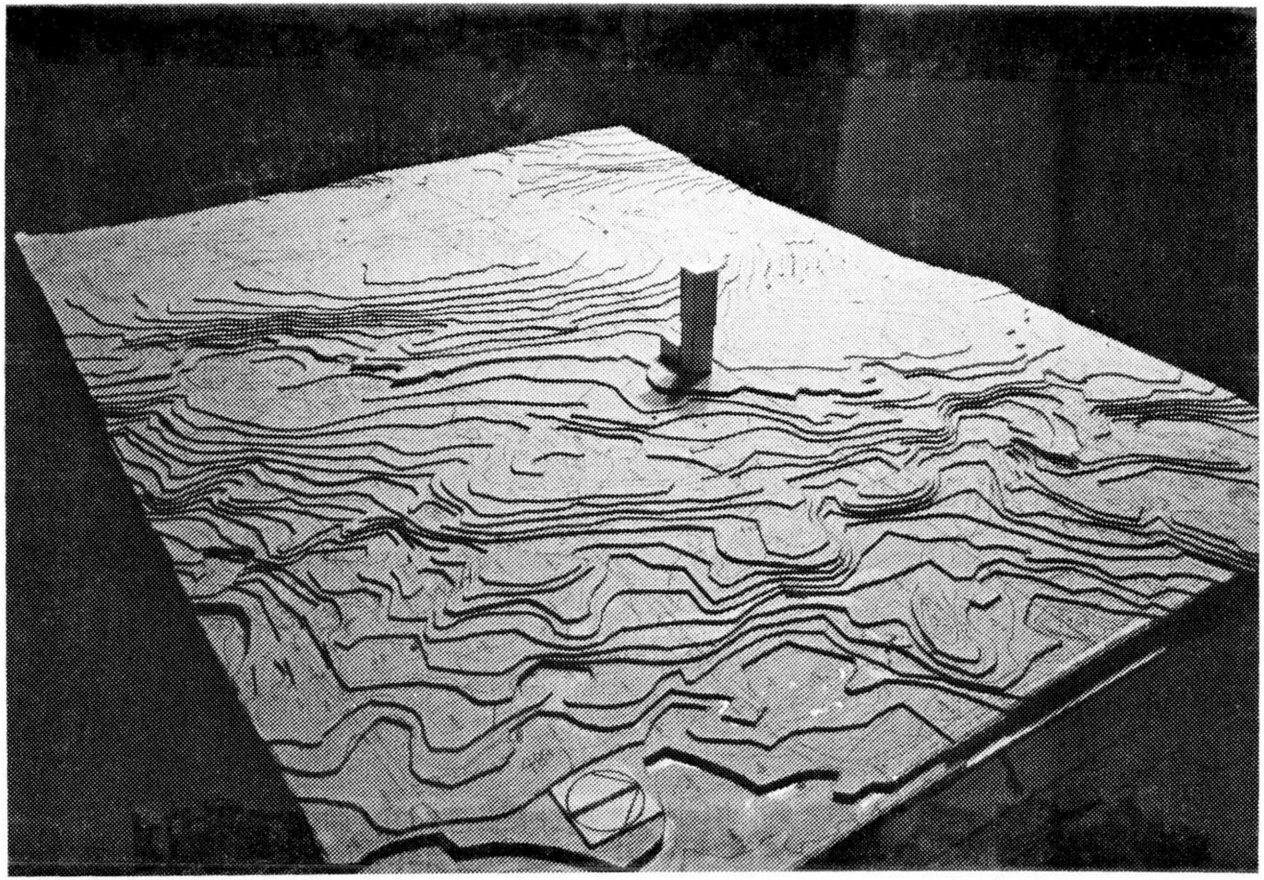
This figure presents a photograph of a model constructed to study the topography of the immediate mine/mill site. A view from the northwest shows the rising, morraine-like landform and its ridge system that bisects the site. The headframe for the underground mine is positioned in the background.

<u>Base Map Reference</u>:
The Sanborn Group, 1982
Exxon Crandon Project

EXXON MINERALS COMPANY

Fig. A-9:
MINE/MILL SITE STUDY MODEL

The Sanborn group, inc.
Mansion Hill
531 North Pinckney Street
Madison, Wisconsin 53703



A view from the southeast shows a series of terraced platforms that characterize the southerly slope of the ridge system that bisects the mine/mill site. The headframe for the underground mine is positioned on one of these platforms to the east of the ridge.

Base Map Reference:
The Sanborn Group, Inc.
Exxon Crandon Project

EXXON MINERALS COMPANY	Fig. A-10: **MINE/MILL SITE STUDY MODEL**	The Sanborn group, inc. Mansion Hill 531 North Pinckney Street Madison, Wisconsin 53703

APPENDIX B

NATIVE PLANT COMMUNITIES AND REPRESENTATIVE PLANT SPECIES

COMMON TO THE PROJECT REGION

NATIVE PLANT COMMUNITIES AND REPRESENTATIVE PLANT SPECIES

COMMON TO THE PROJECT REGION[a]

SCIENTIFIC NAME	COMMON NAME
ASPEN-BIRCH COMMUNITY[b]	
OVERSTORY SPECIES	
Acer rubrum	Red Maple
Acer saccharum	Sugar Maple
Betula papyrifera	Paper Birch
Pinus strobus	White Pine
Populus tremuloides	Quaking Aspen
Quercus rubra	Red Oak
UNDERSTORY & GROUNDLAYER INVASION SPECIES	
Aralia nudicaulis	Wild Sarsaparilla
Corylus cornuta	Beaked Hazel
Maianthemum canadense	Canada Mayflower
Mitchella repens	Partridgeberry
Pteridium aquilinum	Bracken Fern
Rubus strigosus	Red Raspberry
Trientalis borealis	Star Flower
MAPLE-BASEWOOD COMMUNITY[b]	
OVERSTORY SPECIES	
Acer saccharum	Sugar Maple
Betula alleghaniensis	Yellow Birch
Tilia americana	American Basswood
Tsuga canadensis	Hemlock
UNDERSTORY & GROUNDLAYER INVASION SPECIES	
Aralia nudicaulis	Wild Sarsaparilla
Corylus cornuta	Beaked Hazel
Maianthemum canadense	Canada Mayflower
Mitella nuda	Naked Miterwort
Viburnum acerifolium	Maple-Leafed Viburnum

WHITE PINE - RED PINE COMMUNITY[b]
OVERSTORY SPECIES

Pinus banksiana	Jack Pine
Pinus resinosa	Red Pine
Pinus strobus	White Pine
Populus tremuloides	Quaking Aspen
Quercus ellipsoidalis	Hill's Oak

UNDERSTORY & GROUNDLAYER INVASION SPECIES

Maianthemum canadense	Canada Mayflower
Pteridium aquilinum	Bracken Fern
Rubus pubescens	Dwarf Raspberry
Smilacina racemosa	Solomon's Plume
Vaccinium angustifolium	Lowbush Blueberry

BALSAM FIR-WHITE CEDAR COMMUNITY[b]
OVERSTORY SPECIES

Abies balsamea	Balsam Fir
Betula alleghaniensis	Yellow Birch
Fraxinus nigra	Black Ash
Thuja occidentalis	White Cedar
Tsuga canadensis	Hemlock

UNDERSTORY & GROUNDLAYER INVASION SPECIES

Aralia nudicaulis	Wild Sarsaparilla
Diervilla lonicera	Bush Honeysuckle
Galium triflorum	Fragrant Bedstraw
Maianthemum canadense	Canada Mayflower
Ribes sp.	Currant Species
Rubus pubescens	Dwarf Raspberry

TAMARACK - SPRUCE COMMUNITY[b]
OVERSTORY SPECIES

Abies balsamea	Balsam Fir
Larix laricina	Tamarack
Picea mariana	Black Spruce
Pinus banksiana	Jack Pine
Thuja occidentalis	White Cedar

UNDERSTORY & GROUNDLAYER INVASION SPECIES

Andromeda glaucophylla	Bog Rosemary
Carex disperma	Soft-Leaved Sedge
Gaultheria procumbens	Wintergreen
Ledum groenlandicum	Labrador Tea
Smilacina trifolia	Three Leaved False Solomon's Seal
Vaccinium myrtilloides	Velvet Leaf Blueberry

BRACKEN-GRASSLAND COMMUNITY
MAJOR DOMINANT SPECIES

Agropyron trachycaulum	Slender Wheatgrass
Danthonia spicata	Poverty Oatgrass
Poa compressa	Canada Bluegrass
Pteridium aquilinum	Bracken Fern

UNDERSTORY & GROUNDLAYER INVASION SPECIES

Anaphalis margaritacea	Pearly Everlasting
Corylus cornuta	Beaked Hazel
Fragaria virginiana	Strawberry
Gaultheria procumbens	Wintergreen
Salix discolor	Pussy Willow
Solidago nemoralis	Dyers Weed
Vaccinium angustifolium	Early Low Blueberry

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[a] Adapted from Curtis (1959).

[b] Plant community named after most prevalent overstory species.

APPENDIX C

UNDERSTORY PLANT SPECIES KNOWN TO ENHANCE WILDLIFE HABITAT

APPENDIX C

UNDERSTORY PLANT SPECIES KNOWN TO ENHANCE WILDLIFE HABITAT*

SCIENTIFIC NAME	COMMON NAME
Alnus rugosa	Speckled Alder
Corylus americana	American Hazel
Corylus cornuta	Beaked Hazel
Diervilla lonicera	Bush Honeysuckle
Gaultheria procumbens	Checkered Wintergreen
Hamamelis virginiana	Witch Hazel
Ilex verticillata	Common Winterberry
Lonicera canadensis	American Fly Honeysuckle
Lonicera oblongifolia	Swamp Fly Honeysuckle
Mitchella repens	Partridgeberry
Rosa sp.	Rose Species
Rubus allegheniensis	Allegheny Blackberry
Rubus strigosus	Red Raspberry
Vaccinium angustifolium	Lowbush Blueberry
Viburnum sp.	Viburnum Species

*Sources: Curtis (1959) and USDA, Forest Service (1974b).

APPENDIX D

POTENTIAL GROUNDLAYER SPECIES FOR USE IN TEMPORARY AND PERMANENT SOIL STABILIZATION

POTENTIAL GROUNDLAYER SPECIES FOR USE IN TEMPORARY AND PERMANENT SOIL STABILIZATION

SCIENTIFIC NAME	COMMON NAME
GRASSES	
Andropogon scoparius	Little Bluestem
Avena sativa	Oats
Bouteloua curtipendula	Side-Oats Grama
Bromus inermis	Brome Grass
Bromus kalmii	Prairie Brome
Dactylis glomerata	Orchard Grass
Elymus canadensis	Canadian Wild Rye
Festuca arundinacea	Tall Fescue (Reed Fescue)
Festuca ovina var. duriuscula	Durar Hard Fescue
Festuca rubra	Creeping Red Fescue
Koeleria cristata	June Grass
Lolium perenne	Perennial Ryegrass
Panicum clandestinum	Deer Tongue
Panicum virgatum	Switchgrass
Phleum pratense	Timothy
Poa pratensis	Kentucky Bluegrass
Secale cereale	Rye
Sorghastrum nutans	Indian Grass
Sporobolus heterolepis	Prairie Dropseed
Stipa spartea	Needlegrass
LEGUMES	
Coronilla varia	Crownvetch
Lathyrus latifolius	Perennial Pea
Lathyrus sylvestris	Wagner Flat Pea
Lotus corniculatus	Birdsfoot Trefoil
Trifolium hybridum	Alsike Clover
Trifolium pratense	Red Clover
Trifolium repens	Ladino Clover
FORBS	
Amorpha canescens	Leadplant
Anemone patens	Pasque Flower
Baptisia leucantha	Wild Indigo

Dodecatheon meadia	Shooting Star
Eryngium yuccifolium	Rattlesnake Master
Lespedeza capitata	Roundheaded Bushclover
Liatris aspara	Blazing Star
Lithospermum canescens	Puccoon
Monarda fistulosa	Wild Bergamot
Ratibida pinnata	Yellow Coneflower
Rudbeckia hirta	Black-Eyed Susan
Silphium laciniatum	Compassplant
Solidago rigida	Field Goldenrod

*Source: Hitchock (1971), Morrison (1980), and Nichols and Entine (1976).

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